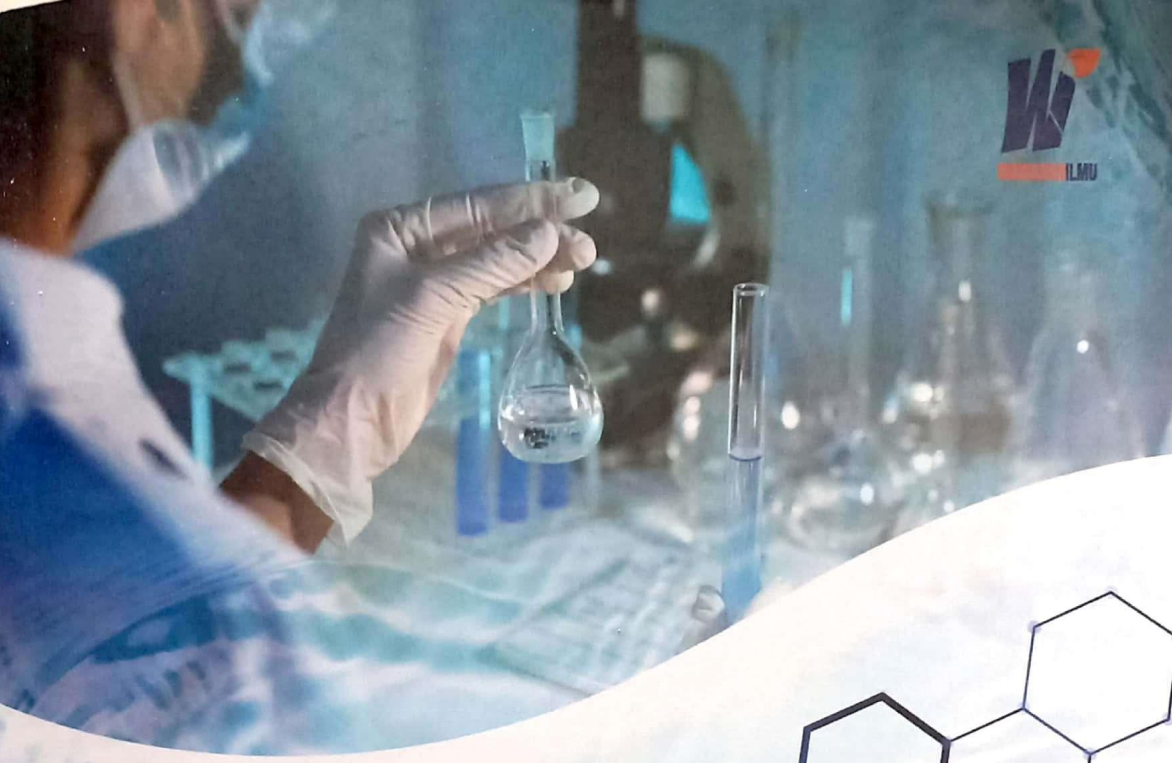

PEMODELAN DAN SIMULASI

Aliran Polimer dalam Media Berpori Menggunakan Metode Lattice Gas Automata

Muhammad Toufiq Fathaddin
Pri Agung Rakhmanto
Dwi Atty Mardiana
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MONOGRAF PEMODELAN DAN SIMULASI ALIRAN POLIMER DALAM MEDIA BERPORI MENGGUNAKAN METODE LATTICE GAS AUTOMATA

Undang-Undang Republik Indonesia Nomor 28 Tahun 2014 tentang Hak Cipta

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Hak Cipta sebagaimana dimaksud dalam Pasal 3 huruf a merupakan hak eksklusif yang terdiri atas hak moral dan hak ekonomi.
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**Muhammad Taufiq Fathaddin, Pri Agung Rakhmanto,
Dwi Atty Mardiana, Alvita Kumala Sari, Daddy Sutansyah,
Hardi Maifra Kurniadi**

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WAWASANILMU

MONOGRAF PEMODELAN DAN SIMULASI ALIRAN POLIMER DALAM MEDIA BERPORI MENGGUNAKAN METODE LATTICE GAS AUTOMATA

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PRAKATA

Segala puja dan puji hanyalah kepada Allah SWT yang Maha Mengetahui, Maha Pengasih, dan Maha Penyayang. Dengan Rahmat-Nya buku yang berjudul "PEMODELAN DAN SIMULASI ALIRAN POLIMER DALAM MEDIA BERPORI MENGGUNAKAN METODE LATTICE GAS AUTOMATA" ini dapat diselesaikan.

Buku ini memaparkan pemodelan dan simulasi penginjeksian larutan polimer. Di samping itu juga dimodelkan dan disimulasikan fenomena akibat adanya interaksi antara larutan polimer dengan sistem media berpori seperti proses adsorpsi dan pembentukan gel. Proses adsorpsi dimodelkan untuk kondisi statik yaitu selama perendaman batuan dengan larutan polimer dan kondisi dinamis yaitu adsorpsi yang terjadi saat mengalirnya larutan polimer. Buku ini juga dilengkapi dengan program-program komputer yang ditulis dengan bahasa fortran.

DAFTAR ISI

DAFTAR GAMBAR

DAFTAR SIMBOL

C	–	konsentrasi (ppm)
c	–	kecepatan partikel
d	–	mean density per link
D_{eff}	–	efficiensi pendesakan, %
k	–	permeabilitas
k_{ro}	–	permeabilitas relative minyak
k_{ro}^{o}	–	titik ujung permeabilitas relatif minyak
k_{rw}	–	permeabilitas relatif air
k_{rw}^{o}	–	titik ujung permeabilitas relatif air
L	–	panjang media
n	–	jumlah partikel
n_w	–	pangkat
$N_e(r,t)$	–	populasi rata-rata partikel fluida
p	–	tekanan
r	–	lokasi situs
RF	–	faktor perolehan minyak
S	–	Saturasi fluida
s	–	situs
S_o	–	saturasi minyak
S_w	–	saturasi air
s(r)	–	situs
$s_{cv}(r)$	–	situs pori berhubungan
$s_{iv}(r)$	–	situs pori terisolasi
$s_s(r)$	–	situs padat
$s_v(r)$	–	situs pori
t	–	waktu
u	–	laju alir per satuan luas
V	–	volume
v	–	kecepatan
V_b	–	volume bulk
V_p	–	volume pori
X^p	–	Panjang kisi-kisi pada sumbu x

Greek

φ	–	porositas
φ_{abs}	–	porositas absolut
φ_{eff}	–	porositas efektif
μ	–	viskositas dinamik
ν	–	viskositas kinematik
ρ	–	densitas
$\int_x$	–	perubahan rata-rata komponen x momentum pada satu titik pada batas x = 0

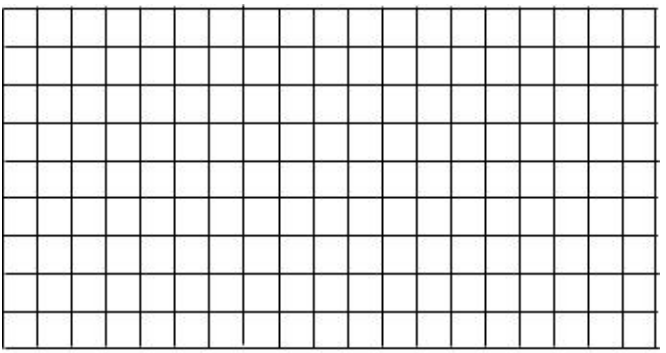
Subscripts and Superscripts

o	–	minyak
p	–	pori-pori
t	–	waktu
t_{dis}	–	waktu penginjeksian
w	–	air
x	–	arah arah x
y	–	arah sumbu y

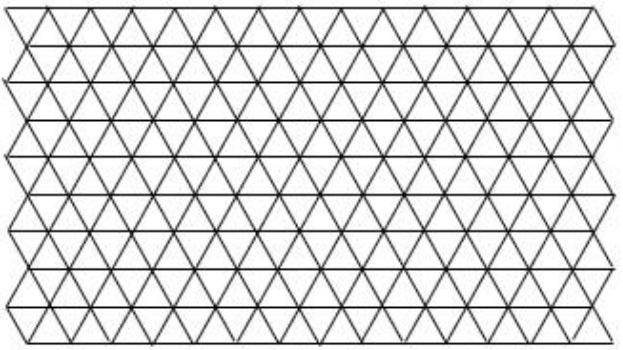
BAB 1

Pengembangan Model Lattice Gas Automata

Lattice Gas Automata (LGA) merupakan model yang digunakan umumnya pada sekala meso dan mikro untuk menggambarkan aliran fluida. LGA terdiri dari media aliran, partikel fluida dan padatan, serta aturan tumbukan. Media aliran berbentuk kisi (lattice) terdiri dari situs dan tautan. Situs adalah pertemuan beberapa tautan. Partikel fluida bergerak dari satu situs ke situs lainnya. Sedangkan partikel padatan tetap pada suatu situs. Bentuk kisi yang paling populer digunakan adalah kisi persegi (Gambar 1.1) dan kisi heksagonal (Gambar 1.2) yang berturut-turut dikenal sebagai model Hardy-de Pazzis-Pomeau (HPP) dan model Frisch-Hasslacher-Pomeau (FHP) (Fathaddin, 2006; Pachalieva, 2021).

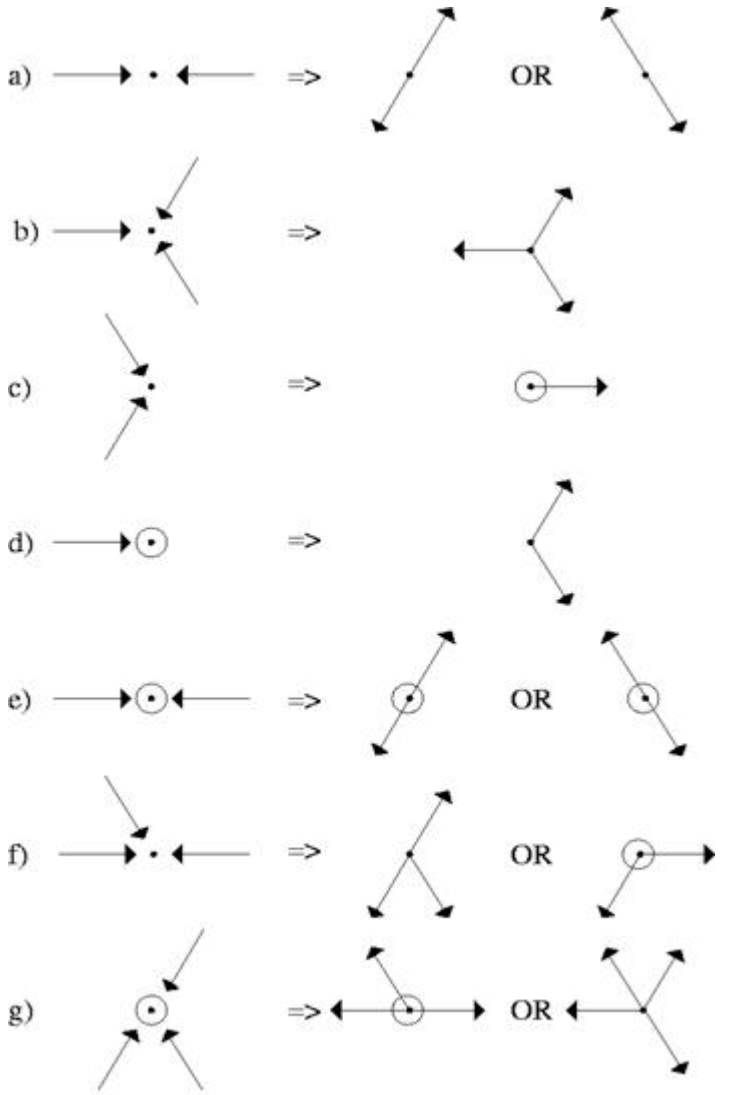


Gambar 1.1 Model kisi segi empat



Gambar 1.2 Model kisi segi enam

Tumbukan dapat terjadi di suatu situs baik antar partikel fluida atau antara partikel fluida dengan partikel padatan. Aturan tumbukan dibuat untuk menentukan interaksi tumbukan partikel di setiap lokasi. Aturan tumbukan dipilih sedemikian rupa sehingga memenuhi hukum kekekalan massa dan momentum. Seperangkat aturan tumbukan pada model FHP ditunjukkan pada Gambar 1.3 Tumbukan dapat terjadi di suatu situs baik antar partikel fluida atau antara partikel fluida dengan partikel padatan. Aturan tumbukan dibuat untuk menentukan interaksi tumbukan partikel di setiap lokasi. Aturan tumbukan dipilih sedemikian rupa sehingga memenuhi hukum kekekalan massa dan momentum. Seperangkat aturan tumbukan pada model FHP ditunjukkan pada Gambar 1.3

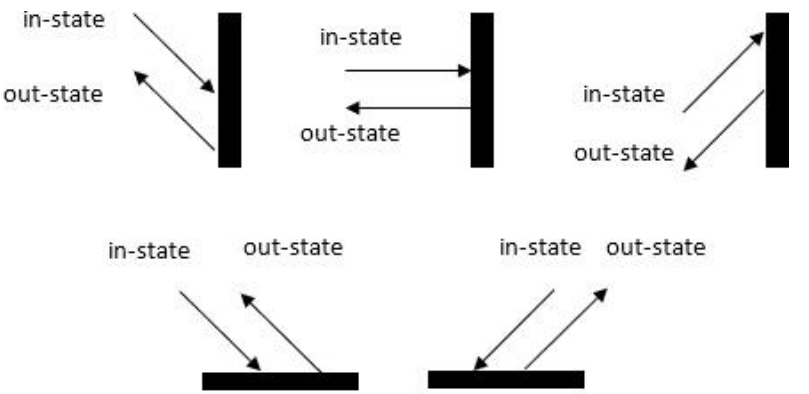


Gambar 1.3 Satu set aturan tumbukan (Buick, 1997)

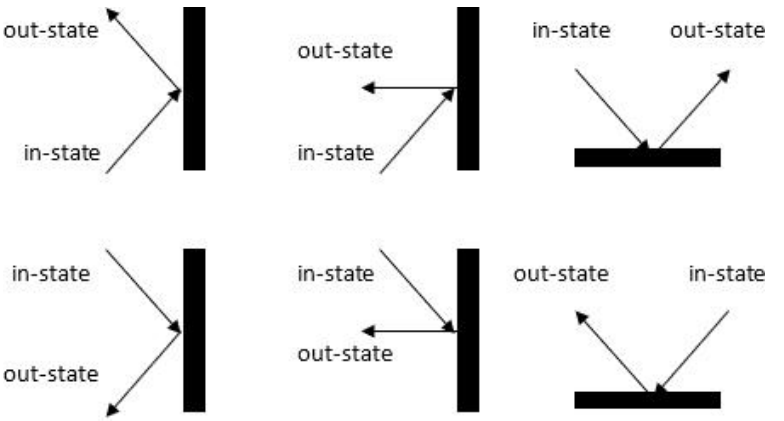
Gambar 1.3 memperlihatkan aturan tumbukan untuk FHP-III antar partikel fluida. Lingkaran kecil hitam mewakili lokasi situs. Partikel fluida bergerak diwakili oleh panah, sedangkan partikel fluida diam dinyatakan oleh lingkaran kosong yang besar. Gambar di sisi kiri menyatakan berbagai konfigurasi partikel-partikel di sebuah sesaat sebelum terjadi tumbukan. Sedangkan gambar di sisi kanan menyatakan konfigurasi partikel-partikel

setelah terjadinya tumbukan. Aturan tabrakan bersifat lokal sehingga, semua interaksi di situs tertentu sepenuhnya tidak bergantung dari pola tumbukan antar partikel fluida yang terjadi di situs-situs lainnya.

Tumbukan antara partikel fluida dengan partikel solid juga diatur dengan aturan tumbukan. Tumbukan tersebut memenuhi hukum kekekalan masa namun tidak memenuhi hukum kekekalan momentum. Ada dua jenis tumbukan antara partikel fluida dan padatan yaitu *no-slip boundary condition* (kondisi batas tanpa selip) dan *free-slip boundary condition* (kondisi batas selip bebas). Untuk kondisi batas tanpa selip ditetapkan dengan memaksa setiap partikel fluida yang bertabrakan dengan padatan untuk kembali ke tautan yang dilaluinya (Cornubert dkk., 1991). Sedangkan untuk kondisi batas slip bebas ditetapkan dengan memantulkan setiap partikel fluida yang bertabrakan dengan padatan ke suatu sudut. Refleksi ini dikenal sebagai *refleksi specular* (Frisch dkk., 1986; Hayot, 1987). Kekasaran permukaan dapat dimodelkan secara eksplisit dengan mengatur sudut pantul dari kondisi batas tersebut. Gambar 1.4 dan 1.5 berturut-turut menunjukkan kondisi batas tanpa selip dan kondisi batas dengan slip bebas untuk model FHP.

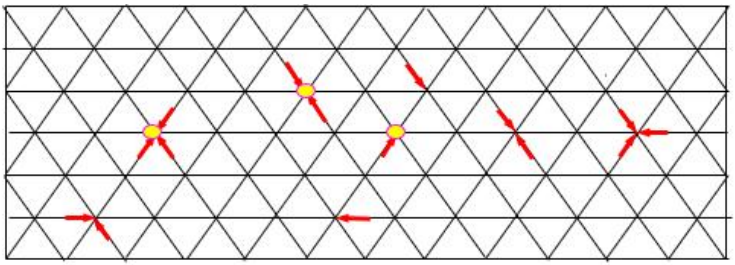


Gambar 1.4 Kondisi batas tanpa selip

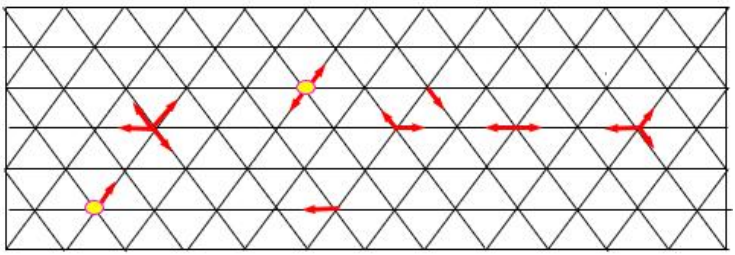


Gambar 1.5 Kondisi batas dengan slip bebas

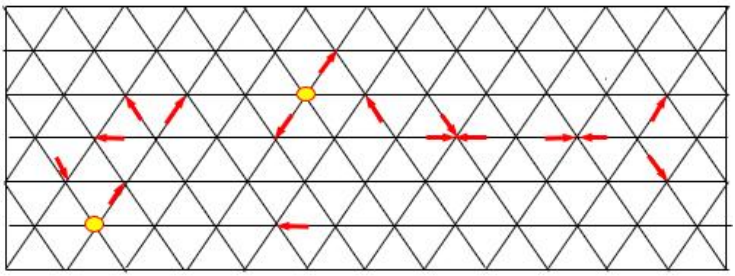
Evolusi partikel terdiri dari dua Langkah, yaitu tumbukan dan perambatan. Evelosi ini berterusan. Gambar 1.6 menunjukkan tumbukan dan perambatan pada kisi heksagonal menurut aturan tumbukan FHP. Pada fasa perambatan untuk langkah waktu (*time step*) t (Gambar 1.6a), ada partikel fluida yang bertemu dengan satu atau beberapa partikel fluida lain pada situs. Di samping itu ada partikel fluida yang tidak betemu dengan partikel fluida lainnya. Pada Gambar 1.6b yaitu fasa tumbukan pada langkah waktu t+1, partikel-partikel fluida yang bertemu pada suatu situ mengalami tumbukan dan perubahan arah. Arah partikel setelah bertumbukan akan diubah sesuai dengan aturan tumbukan tertentu seperti yang diberikan pada Gambar 1.3. Aturan tumbukan yang dipilih berdasarkan pada jumlah dan konfigurasi partikel-partikel fluida sebelum terjadinya tumbukan. Untuk partikel yang tidak bertemu dengan partikel fluida lainnya akan bergerak bergerak dalam garis lurus sepanjang tautan sampai tiba di situs berikutnya, sementara untuk setiap partikel diam pada suatu situs tetap tidak bergerak di situs tersebut seperti yang ditunjukkan dari Gambar 1.6b. Pada Gambar 1.6c yaitu fasa perambatan pada langkah waktu t+1 partikel bergerak ke situs terdekat mengikut arah pergerakan setelah tumbukan. Sedangkan partikel diam, baik untuk partikel yang tidak bertumbukan atau partikel yang menjadi diam akibat tumbukan tetap menempati situsnya (Luo dkk., 1991).



(a). Propagation stage of particles at time step t.



(b). Collision stage of particles at time step t + 1.



(c). Propagation stage of particles at time step t + 1.

Gambar 1.6 Evolusi partikel pada area kisi heksagonal dari waktu t ke waktu t+1. Panah merah mewakili partikel bergerak dan partikel diam diwakili oleh lingkaran kuning

Perhatikan bahwa meskipun prinsip pengecualian memungkinkan hanya satu partikel untuk melakukan perjalanan sepanjang setiap arah tautan, dua partikel yang bergerak dalam arah yang berlawanan diizinkan pada tautan yang sama, partikel-partikel ini saling melewati selama tahap propagasi tanpa bertabrakan. Selain mempertimbangkan ruang diskrit dari situs kisi, waktu juga dianggap sebagai diskrit.

Perhatikan bahwa meskipun prinsip pengecualian memungkinkan hanya satu partikel untuk melakukan perjalanan sepanjang setiap arah tautan, dua partikel yang bergerak dalam arah yang berlawanan diizinkan pada tautan yang sama, partikel-partikel ini saling melewati selama tahap propagasi tanpa bertabrakan. Selain mempertimbangkan ruang diskrit dari situs kisi, waktu juga dianggap sebagai diskrit.

Viskositas kinematik, n, dalam automata gas kisi adalah fungsi dari kerapatan partikel fluida. Viskositas dihitung oleh Frisch et al (1987) menggunakan pendekatan Boltzmann dan juga oleh Henon (1987), dengan mempertimbangkan gerakan partikel pada grid. Nilai viskositas kinematik untuk model FHP-III adalah (Lee dan Chung, 1993; Buick, 1997).

$$\nu = \frac{1}{28}\frac{1}{d(1-d)}\frac{1}{1-8d\,(1-d)/7} - \frac{1}{8} \tag{1.1}$$

Hubungan antara viskositas kinematik, ν, dan viskositas (viskositas dinamis), μ, fluida diberikan oleh persamaan berikut:

$$\mu = \nu\rho \tag{1.2}$$

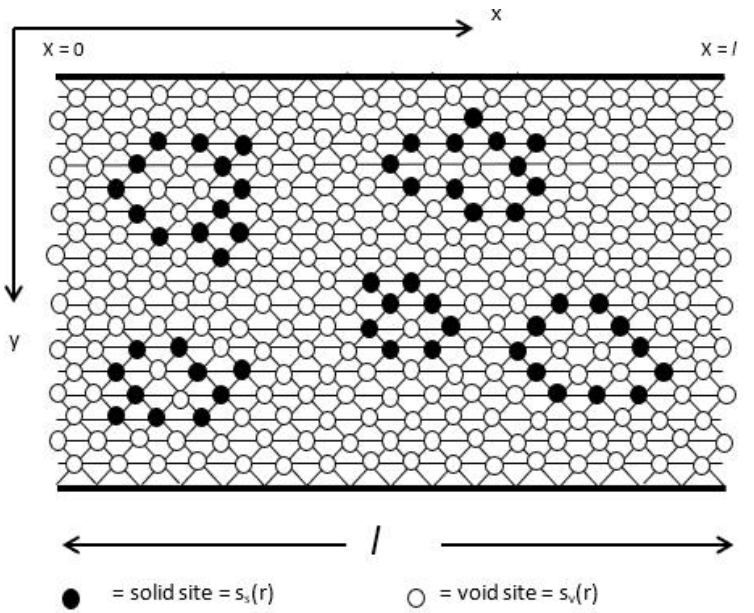
Porositas media berpori dapat dibedakan menjadi dua jenis, yaitu porositas absolut dan porositas efektif (Ahmed, 2019; Fathaddin dkk., 2022). Porositas absolut didefinisikan sebagai rasio volume pori terhadap volume bulk (total), terlepas dari interkoneksi rongga pori. Dalam bentuk persamaan:

$$\phi_{abs} = \frac{V_p}{V_b} \tag{1.3}$$

Dalam LGA, porositas absolut didefinisikan sebagai jumlah situs yang mewakili situs pori (baik situs pori yang terhubung maupun situs pori yang terisolasi) dibagi dengan jumlah total situs kisi (Gambar 1.7). Dalam bentuk persamaan (Fathaddin, 2006):

$$\phi_{abs} = \frac{\sum_r s_{cv}(r) + \sum_r s_{iv}(r)}{\sum_r s_{cv}(r) + \sum_r s_{iv}(r) + \sum_r s_s(r)} = \frac{\sum_r s_v(r)}{\sum_r s(r)} = 1 - \frac{\sum_r s_s(r)}{\sum_r s(r)} \tag{1.4}$$

Ruang pori diklasifikasikan menjadi ruang pori terisolasi dan ruang pori yang saling berhubungan. Ruang pori terisolasi adalah ruang pori yang seluruhnya tertutup oleh daerah padat. Cairan di ruang ini tidak berhubungan dengan larutan polimer yang diinjeksikan.



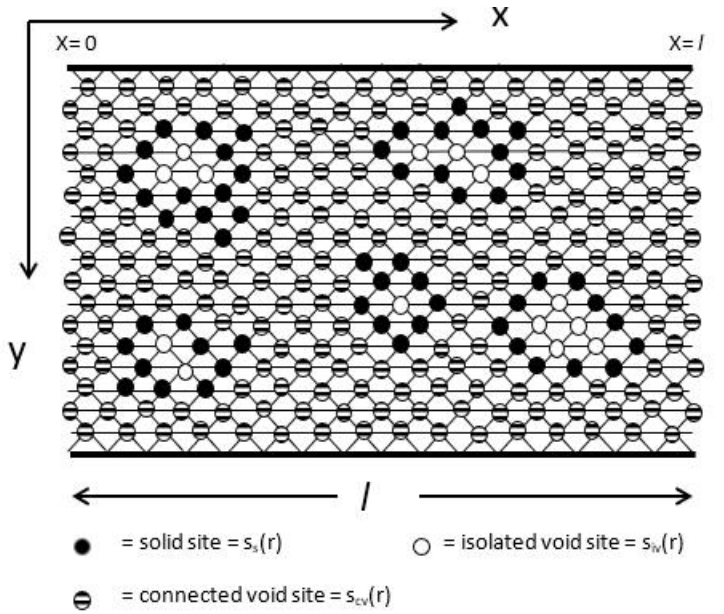
Gambar 1.7 Skema situs padat dan kosong di media berpori LGA

Porositas efektif didefinisikan sebagai rasio ruang hampa yang saling berhubungan dengan volume bulk (total). Dalam bentuk persamaan:

$$\phi_{eff} = \frac{V_{cp}}{V_b} \tag{1.5}$$

Dalam LGA, porositas efektif didefinisikan sebagai jumlah situs yang mewakili situs pori yang terhubung dibagi dengan jumlah total situs kisi (Gambar 1.8). Dalam bentuk persamaan (Fathaddin, 2006):

$$\phi_{eff} = \frac{\sum_r s_{cv}(r)}{\sum_r s_{cv}(r) + \sum_r s_{iv}(r) + \sum_r s_s(r)} = \frac{\sum_r s_{cv}(r)}{\sum_r s(r)} \tag{1.6}$$



Gambar 1.8 Skema situs padat, situs pori terisolasi, dan situs pori terhubung di media berpori LGA

Gradien tekanan, dp/dX, didefinisikan sebagai perubahan rata-rata dalam komponen momentum x pada batas hulu di atas luas penampang batas per panjang kisi per langkah waktu. Dalam bentuk persamaan, gradien tekanan diberikan oleh (Rothman, 1988)

$$\frac{dp}{dX} = -\frac{\int x}{\sqrt{3}/_2 X} \tag{1.7}$$

di mana ∫x adalah perubahan rata-rata dalam komponen x momentum pada satu titik pada batas x = 0. X adalah panjang kisi dalam arah x.

Aliran fluida dalam media berpori dapat digambarkan dengan persamaan Darcy. Persamaan Darcy diberikan oleh persamaan:

$$v = -\frac{k}{\mu}\frac{dp}{dX} \tag{1.8}$$

atau

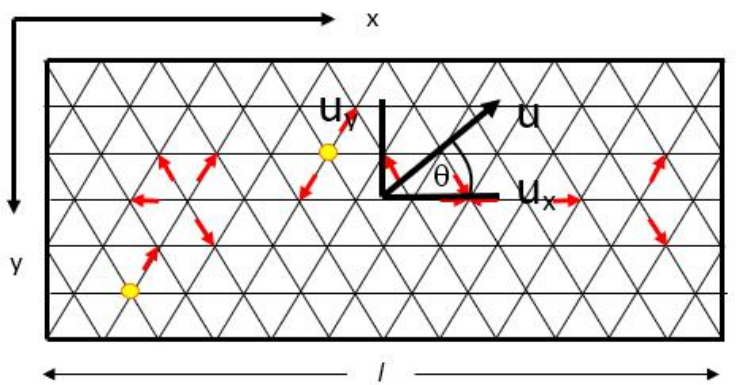
$$u = -\frac{k}{\mu}\frac{dp}{dX} \tag{1.9}$$

di mana u adalah laju aliran volumetrik per satuan luas. Vektor kecepatan rata-rata ($\bar{v}$) dari seluruh daerah kisi ditunjukkan pada Gambar 1.9. Hal ini dapat dihitung dengan menggunakan Persamaan (1.8). Komponen kecepatan rata-ratanya dalam arah x dan y ditentukan oleh hubungan berikut (Buick, 1997):

$$\bar{v}_x(r,t) = \frac{\sum_e c_{x_e} N_e(r,t)}{\sum_e N_e(r,t)} \tag{1.10}$$

dan

$$\bar{v}_y(r,t) = \frac{\sum_e c_{y_e} N_e(r,t)}{\sum_e N_e(r,t)} \tag{1.11}$$



Gambar 1.9 Vektor kecepatan rata-rata dari seluruh kisi. Panah merah mewakili kecepatan partikel-partikel dan panah besar mewakili vektor kecepatan resultan

kecepatan rata-rata partikel fluida diberikan oleh:

$$\bar{v}(r,t) = \sqrt{\bar{v}_x^2(r,t) + \bar{v}_y^2(r,t)} \tag{1.12}$$

Rothman (1988) mendefinisikan laju aliran volumetrik per satuan luas, u, untuk aliran fluida dari sisi kiri ke sisi kanan sebagai berikut:

$$u = \phi v_x \tag{1.13}$$

Persamaan permeabilitas untuk LGA dapat diperoleh dengan mensubstitusi Persamaan (1.7) dan (1.13) ke dalam Persamaan (1.9) sebagai berikut:

$$k = \frac{\sqrt{3} X \phi \bar{v}_x \bar{\rho}\, v}{2 \int_x} \tag{1.14}$$

Substitusi persamaan (1.1) ke dalam persamaan (1.14) memberikan persamaan permeabilitas untuk model FHP-III sebagai berikut:

$$k = \frac{\sqrt{3} X \phi \bar{v}_x \bar{\rho}}{2 \int_x} \left(\frac{1}{28} \frac{1}{d(1-d)} \frac{1}{1 - 8d\,(1-d)/7} - \frac{1}{8} \right) \tag{1.15}$$

BAB 2

Pemodelan dan Simulasi Proses Adsorpsi pada Kondisi Dinamik

Dalam bab ini dibahas pengembangan metode lattice gas automata (LGA) untuk proses adsorpsi. Pengembangan tersebut dilakukan dengan penambahan pemodelan adsorpsi pada model LGA. Model adsorpsi yang diusulkan berupa aturan tumbukan yang merupakan interaksi antara partikel polimer dan partikel padatan (batuan). Di samping itu diberikan pemrograman komputer untuk simulasi adsorpsi polimer.

2.1 Pemodelan Proses Adsorpsi pada Kondisi Dinamik

Larutan polimer yang diinjeksikan ke dalam reservoir minyak akan berinteraksi dengan batuan dan fluida. Salah satu interaksi antara polimer dan batuan reservoir adalah adsorpsi (Fathaddin, 2021). Dalam fenomena itu batuan reservoir menarik dan mengikat partikel polimer dari larutan pada permukaan saluran (dinding pori-pori atau rekahan batuan). Untuk mensimulasikan fenomena adsorpsi polimer pada permukaan batuan dengan menggunakan model LGA, maka diperkenalkan aturan tumbukan antara partikel fluida dan batuan seperti yang ditunjukkan pada Gambar 2.1 (Fathaddin, 2006). Dalam gambar tersebut diperkenalkan tiga aturan tumbukan. Aturan tumbukan tersebut memungkinkan polimer untuk melekat pada partikel pada partikel pada. Dan situs dimana polimer yang telah teradsorpsi berperilaku sebagai situs padat yang tidak bergerak de-

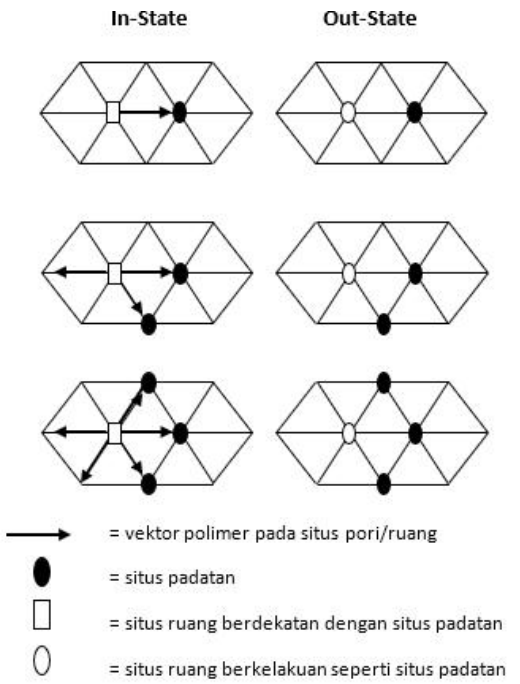
ngan adanya tumbukan dengan partikel fluida lainnya. Akibat adanya proses adsorpsi ini, jumlah total partikel polimer dalam larutan berkurang. Proses pengikatan dapat berlanjut sampai seluruh permukaan ditutupi dengan partikel polimer yang teradsorpsi.

Susunan molekul polimer teradsorpsi pada permukaan padat diklasifikasikan menjadi dua jenis yaitu monolayer dan multilayer. Untuk adsorpsi monolayer, molekul-molekul polimer yang teradsorpsi hanya membentuk satu lapisan molekul pada permukaan padatan. Pada adsorpsi jenis ini, semua molekul terikat bersentuhan langsung dengan permukaan batuan. Sedangkan untuk multilayer, molekul polimer teradsorpsi dapat membentuk lebih dari satu lapisan molekul (Sing, 1983). Berdasarkan percobaan hasil percobaan (Fathaddin dan Awang, 2004), kurva adsorpsi isotermal pada butiran pasir sesuai dengan adsorpsi polimer monolayer. Oleh karena itu dalam buku ini diusulkan aturan tumbukan untuk pemodelan proses adsorpsi polimer monolayer mengacu pada percobaan.

Kombinasi faktor polimer, media berpori, dan pelarut menentukan tingkat adsorpsi polimer. Karena kombinasi faktor-faktor ini tidak seragam di seluruh media berpori, maka proses pengikatan partikel polimer tidak sama di setiap bagian permukaan padat media berpori. Untuk memenuhi kondisi ini, digunakan faktor probabilitas terjadinya adsorpsi polimer. Faktor ini terkait dengan aturan tabrakan. Faktor probabilitas (P_{pa}) dapat didefinisikan dengan persamaan berikut:

$$P_{pa} = f(C) \tag{2.1}$$

dimana C adalah konsentrasi polimer dalam larutan (ppm). Dalam penelitian ini, model adsorpsi digunakan untuk sistem statik (batch) dan dinamik.



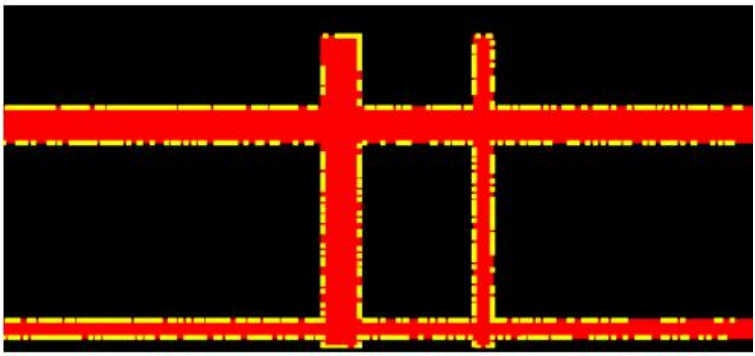
Gambar 2.1 Aturan tumbukan untuk proses adsorpsi polimer (Fathaddin, 2006)

2.2 Simulasi Proses Adsorpsi pada Kondisi Dinamik

Simulasi sistem dinamik untuk validasi dan prediksi dilakukan dengan prosedur sebagai berikut (Fathaddin dan Awang, 2004, Fathaddin, 2006):

1. Buat sebuah media berpori LGA yang mewakili sandpack/sampel core seperti yang diperlihatkan pada Gambar 2.2a. Porositas media sama dengan porositas pasir.

(a)



(b)

Gambar 2.2 Adsorpsi polimer dalam sistem dinamik. (a) Kondisi awal sistem. (b) Proses adsorpsi telah terjadi. Area hitam mewakili padatan, area merah mewakili larutan polimer, dan titik kuning mewakili polimer yang teradsorpsi

2. Partikel air dimasukkan dari sisi kiri media LGA. Setelah mencapai kondisi tunak, permeabilitas awal dihitung menggunakan persamaan Darcy (Rothman, 1988). Permeabilitas awal media LGA harus sama dengan sandpack/sampel core. Jika tidak, langkah pertama akan diulang.
3. Setelah itu, partikel polimer secara terus menerus dimasukkan ke dalam medium (Gambar 2.2b). Selama pengaliran polimer, aturan tumbukan untuk proses adsorpsi polimer (Gambar 2.1) diterapkan. Sebuah faktor probabilitas (Ppa) ditetapkan.
4. Akhirnya, partikel air dimasukkan lagi ke dalam medium. Aturan tumbukan untuk proses adsorpsi polimer (Gambar 2.1) dihentikan untuk menghentikan proses adsorpsi. Setelah mencapai kondisi tunak, per-

meabilitas akhir dihitung menggunakan persamaan Darcy (Rothman, 1988). Permeabilitas akhir media LGA harus sama dengan sandpack/ sampel core. Jika permeabilitas akhir media tidak sama dengan sandpack maka langkah ketiga diulangi.

2.3 Program Simulasi Proses Adsorpsi pada Kondisi Dinamik

Program komputer dibuat untuk mensimulasikan proses adsorpsi pada kondisi dinamik yang terjadi akibat interaksi antara polimer dan batuan berpori selama penginjeksian polimer. Program komputer dibuat dalam Bahasa FORTRAN sebagai berikut:

```
C SIMULATOR for validation
Integer I,J,K,xdir,ydir,g, gg, bb, cc, ddreal Tol, t
Integer site(1702,269), newsite(1702,269)
Integer nbs1(1702,269),nbs2(1702,269),nbs3(1702,269)
Integer nbs4(1702,269),nbs5(1702,269),nbs6(1702,269)
Integer aps(256,6),mass(256), csreal*4 zr, kosong
real*4 momx(256),momy(256),d,kinevis,dynavisreal*4 flow
real*4 velx, pressreal*4 pressgrad Integer a,seed, ts
Data  a,m,seed/1027,1048576,1/
c
c   - Calling data file and output file –
c
OPEN(UNIT=5,FILE='C:\Simulata.OUT',
+STATUS = 'old')
z=seedzm=m
c ----------
c - data -
c ----------
c Number of sites in x directionxdir = 1652
c Number of sites in y directionydir = 229
c time stepts = 6608
c Existing fluid particle (codes = 0 - 127)tyok = 0
tyol = 0
```

```
tyom = 0
tyon = 0
c Injecting fluid particle (codes = 0 - 7)
tyoo = 2
tyop = 1
tyoq = 2
tyor = 4
c Polymer concentration (ppm)
xn = 5000
c Types of layer (Tol) (Monolayer: Tol = 1 ; Multilayer: Tol = 2)
Tol = 1
c The beginning of adsorption processboa = 3305
c The end of adsorption processeoa = 4956
c
c - setting the obstacles -
c
do 10 i=1,xdir
do 10 j=1,ydir
site(i,j)=128
newsite(i,j)=128
10  continue
C ==========
c = First Part=
c ==========
c The main channel1ado 980 i=1,190
do 980 j=12,20
site(i,j)=0
980 continue
do 981 i=360,560
do 981 j=12,20
site(i,j)=0
981 continue
```

```
do 982 i=730,930
do 982 j=12,20
site(i,j)=0
982 continue
do 983 i=1100,1290
do 983 j=12,20
site(i,j)=0
983 continue
do 984 i=1460,xdir
do 984 j=12,20
site(i,j)=0
984 continue
c The main channel1b
do 985 i=180,370
do 985 j=2,10
site(i,j)=0
985 continue
do 986 i=540,740
do 986 j=2,10
site(i,j)=0
986 continue
do 987 i=910,1110
do 987 j=2,10
site(i,j)=0
987 continue
do 988 i=1280,1480
do 988 j=2,10
site(i,j)=0
988 continue
c The main channel2a
do 990 i=1,190
do 990 j=42,50
```

```
site(i,j)=0
990 continue
do 991 i=360,560
do 991 j=42,50
site(i,j)=0
991 continue
do 992 i=730,930
do 992 j=42,50
site(i,j)=0
992 continue
do 993 i=1100,1290
do 993 j=42,50
site(i,j)=0
993 continue
do 994 i=1460,xdir
do 994 j=42,50
site(i,j)=0
994 continue
c The main channel2b
do 995 i=180,370
do 995 j=27,35
site(i,j)=0
995 continue
do 996 i=540,740
do 996 j=27,35
site(i,j)=0
996 continue
do 997 i=910,1110
do 997 j=27,35
site(i,j)=0
997 continue
do 998 i=1280,1480
```

```
do 998 j=27,35
site(i,j)=0
998  continue
c Cluster1
c Branch1
do 1010 i=41,65
do 1010 j=20,225
site(i,j)=0
1010 continue
c Branch2
do 1013 i=101,125
do 1013 j=20,225
site(i,j)=0
1013 continue
c Cluster2
c Branch1
do 1015 i=180,205
do 1015 j=7,225
site(i,j)=0
1015 continue
c Branch2
do 1020 i=245,270
do 1020 j=7,225
site(i,j)=0
1020 continue
c Branch3
do 1025 i=305,330
do 1025 j=7,225
site(i,j)=0
1025 continue
c Branch4
do 1027 i=345,370
```

```
do 1027 j=7,225
site(i,j)=0
1027 continue
c       Cluster3
c       Branch1
do 1030 i=401,425
do 1030 j=20,225
site(i,j)=0
1030 continue
c       Branch2
do 1035 i=461,485
do 1035 j=20,225
site(i,j)=0
1035 continue
c       Cluster4
c       Branch1
do 1040 i=540,565
do 1040 j=7,225
site(i,j)=0
1040 continue
c       Branch2
do 1045 i=615,639
do 1045 j=7,225
site(i,j)=0
1045 continue
c       Branch3
do 1050 i=715,739
do 1050 j=7,225
site(i,j)=0
1050 continue
c       cluster5
c       Branch3
```

```
do 1063 i=831,855
do 1063 j=20,225
site(i,j)=0
1063 continue
c       cluster6
c       Branch1
do 1065 i=911,935
do 1065 j=7,225
site(i,j)=0
1065 continue
c       Branch2
do 1070 i=1005,1029
do 1070 j=7,225
site(i,j)=0
1070 continue
c       Branch3
do 1075 i=1075,1099
do 1075 j=7,225
site(i,j)=0
1075 continue
c       Cluster7
c       Branch1
do 1080 i=1146,1170
do 1080 j=20,225
site(i,j)=0
1080 continue
c       Branch2
do 1090 i=1241,1265
do 1090 j=20,225
site(i,j)=0
1090 continue
c       Cluster8
```

```
c          Branch1
do 1095 i=1281,1305
do 1095 j=7,225
site(i,j)=0
1095 continue
c          Branch2
do 1097 i=1341,1365
do 1097 j=7,225
site(i,j)=0
1097 continue
c          Branch4
do 1101 i=1451,1475
do 1101 j=7,225
site(i,j)=0
1101 continue
c          cluster9
c          Branch1
do 1102 i=1501,1525
do 1102 j=20,225
site(i,j)=0
1102 continue
c          Branch3
do 1107 i=1611,1635
do 1107 j=20,225
site(i,j)=0
1107 continue
c          ==============
c          = Second Part=
c          ==============
c          Cluster1
c                    The main channel1a
do 1990 i=200,420
```

```
do 1990 j=78,86
site(i,j)=0
1990 continue
do 1991 i=615,830
do 1991 j=78,86
site(i,j)=0
1991 continue
do 1992 i=1030,1250
do 1992 j=78,86
site(i,j)=0
1992 continue
do 1994 i=1440,xdir
do 1994 j=78,86
site(i,j)=0
1994 continue
c                    The main channel1b
do 1995 i=1,210
do 1995 j=59,67
site(i,j)=0
1995 continue
do 1996 i=405,630
do 1996 j=59,67
site(i,j)=0
1996 continue
do 1997 i=820,1040
do 1997 j=59,67
site(i,j)=0
1997 continue
do 1998 i=1230,1450
do 1998 j=59,67
site(i,j)=0
1998 continue
```

```
c                    The main channel3a
do 2095 i=1,210
do 2095 j=89,97
site(i,j)=0
2095 continue
do 2096 i=405,630
do 2096 j=89,97
site(i,j)=0
2096 continue
do 2097 i=820,1040
do 2097 j=89,97
site(i,j)=0
2097 continue
do 2098 i=1230,1450
do 2098 j=89,97
site(i,j)=0
2098 continue
c        ==============
c        = Third Part=
c        ==============
c        Cluster1
c                    The main channel1a
do 2990 i=1,190
do 2990 j=116,124
site(i,j)=0
2990 continue
do 2991 i=360,560
do 2991 j=116,124
site(i,j)=0
2991 continue
do 2992 i=730,930
do 2992 j=116,124
```

```
site(i,j)=0
2992 continue
do 2993 i=1100,1290
do 2993 j=116,124
site(i,j)=0
2993 continue
do 2994 i=1460,xdir
do 2994 j=116,124
site(i,j)=0
2994 continue
c                    The main channel1b
do 2995 i=180,370
do 2995 j=126,134
site(i,j)=0
2995 continue
do 2996 i=540,740
do 2996 j=126,134
site(i,j)=0
2996 continue
do 2997 i=910,1110
do 2997 j=126,134
site(i,j)=0
2997 continue
do 2998 i=1280,1480
do 2998 j=126,134
site(i,j)=0
2998 continue
c          ==============
c          = Fourth Part=
c          ==============
c                    The main channel1a
do 3990 i=1,190
```

```
do 3990 j=172,180
site(i,j)=0
3990 continue
do 3991 i=360,560
do 3991 j=172,180
site(i,j)=0
3991 continue
do 3992 i=730,930
do 3992 j=172,180
site(i,j)=0
3992 continue
do 3993 i=1100,1290
do 3993 j=172,180
site(i,j)=0
3993 continue
do 3994 i=1460,xdir
do 3994 j=172,180
site(i,j)=0
3994 continue
c                    The main channel1b
do 3995 i=180,370
do 3995 j=152,160
site(i,j)=0
3995 continue
do 3996 i=540,740
do 3996 j=152,160
site(i,j)=0
3996 continue
do 3997 i=910,1110
do 3997 j=152,160
site(i,j)=0
3997 continue
```

```
do 3998 i=1280,1480
do 3998 j=152,160
site(i,j)=0
3998 continue
c                The main channel2a
do 4000 i=1,255
do 4000 j=203,211
site(i,j)=0
4000 continue
do 4002 i=534,855
do 4002 j=203,211
site(i,j)=0
4002 continue
do 4004 i=1134,1455
do 4004 j=203,211
site(i,j)=0
4004 continue
c                The main channel2b
do 4006 i=200,559
do 4006 j=187,195
site(i,j)=0
4006 continue
do 4005 i=830,1159
do 4005 j=187,195
site(i,j)=0
4005 continue
do 4008 i=1430,xdir
do 4008 j=187,195
site(i,j)=0
4008 continue
c                The main channel3b
do 4016 i=230,559
```

```
do 4016 j=217,225
site(i,j)=0
4016 continue
do 4015 i=830,1159
do 4015 j=217,225
site(i,j)=0
4015 continue
do 4018 i=1430,xdir
do 4018 j=217,225
site(i,j)=0
4018 continue
cc
cc          - setting the boundary –
cc
do 20 i=1,xdir
site(i,1)=128
newsite(i,1)=128
site(i,ydir)=128
newsite(i,ydir)=128
20 continue
c
c           - Define neighbor sites
-c
do 25 I=1,xdir
do  25  J=2,ydir-1  nbs1(I,J)=site(I+1,J-1)
nbs2(I,J)=site(I-1,J-1)
nbs3(I,J)=site(I-1,J)
nbs4(I,J)=site(I-1,J+1)nbs5(I,J)=site(I+1,J+1)
nbs6(I,J)=site(I+1,J)
25 continue
c
c           - Contact surface –
```

```
c
cs=0
do 30 I=1,xdir
do 30 J=1,ydir
if(site(I,J).ne.128) goto 30 if((nbs1(I,J).LT.128).OR.(nbs2(I,J).LT.128).
OR.(nbs3(I,J).LT.128)
+.OR.(nbs4(I,J).LT.128).OR.(nbs5(I,J).LT.128).OR.
+(nbs6(I,J).LT.128)) cs = cs + 1
30 continue
c
c          - setting the open sites –
c
void = 0
kosong = 0
do 50 I=1,xdir
do 40 J=1,ydir if(site(I,J).ne.128)void=void+1
40 continue
kosong = kosong + voidvoid = 0
50 continue
c
c          - calculating porosity –
c
total = xdir*ydir porosity = kosong/total
c
c          - Distributing fluid particles for given density and calculating oil
mass –
c
do 70 I=1,xdir
do 70 J=1,ydir
if(site(I,J).eq.128) goto 7171
z=mod(a*z,m)
zr=z/zm g=nint(zr*4.)
```

```
if(g.eq.0)site(1,J)=tyok
if(g.eq.1)site(1,J)=tyol
if(g.eq.2)site(1,J)=tyom
if(g.eq.3)site(1,J)=tyon
7171 ssss=0
70  continue
c
c          - Calculating fluid mass
-c
masstot=0
do 80 I=1,xdir
do 80 J=1,ydir
if ((site(I,J).eq.128).or.(site(I,J).eq.192)) goto 80
if (site(I,J).eq.256) goto 80
if(mod(site(I,J),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/2),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/4),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/8),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/16),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/32),2).eq.1)masstot=masstot+1
if(site(I,J).ge.64)masstot=masstot+1
80 continue denc=masstot/kosong
c
c          - Calculating intial oil and polymer saturation –
c
print *,"Porosity(fraction)=",porosity
write (5,*)"Porosity(fraction)=",porosity
print *,"Surface length(cm)=",cs/100
write (5,*)"Surface length(cm)=",cs/100
print *,"T(sec),Vel(cm/sec),K(Darcy),NumberofAdsorbedParticles"
write   (5,*)"T(sec),Vel(cm/sec),K(Darcy),NumberofAdsorbedParticles"
c
```

```
c          - Main program –
c                ____
do 90 t=1,ts
z=mod(a*z,m)zr=z/zm g=nint(zr*4.)
c                ____
c          - Input the particles along the left boundary –
c                ____
do 95 j=1,ydir
if(g.eq.0)site(0,J)=tyoo
if(g.eq.1)site(0,J)=tyop
if(g.eq.2)site(0,J)=tyoq
if(g.eq.3)site(0,J)=tyor
95 continue
c                ____
c          - Periodic boundary –
c                ____
do 110 J=1,ydir
if(mod((site(0,J)/32),2).eq.1)site(xdir,ydir+1-J)=32
if(mod((site(0,J)/16),2).eq.1)site(xdir,ydir+1-J)=16
if(mod((site(0,J)/8),2).eq.1)site(xdir,ydir+1-J)=8 if((mod((site(0,J)/32),2).
eq.1).and.(mod((site(0,J)/16),2).eq.1
+))site(xdir,ydir+1-J)=48 if((mod((site(0,J)/32),2).eq.1).and.
(mod((site(0,J)/8),2).eq.1)
+)site(xdir,ydir+1-J)=40 if((mod((site(0,J)/16),2).eq.1).and.
(mod((site(0,J)/8),2).eq.1)
+)site(xdir,ydir+1-J)=24 if((mod((site(0,J)/32),2).eq.1).and.
(mod((site(0,J)/16),2).eq.1
+).and.(mod((site(xdir,J)/8),2).eq.1))site(xdir,ydir+1-J)=56
c
if(mod(site(xdir,J),2).eq.1)site(0,ydir+1-J)=1
if(mod((site(xdir,J)/2),2).eq.1)site(0,ydir+1-J)=2
if(mod((site(xdir,J)/4),2).eq.1)site(0,ydir+1-J)=4 if((mod(site(xdir,J),2).
eq.1).and.(mod((site(xdir,J)/2),2).eq.1))
```

```
+site(0,ydir+1-J)=3 if((mod(site(xdir,J),2).eq.1).and.(mod((site(xdir,J)/4),2).
eq.1))
+site(0,ydir+1-J)=5 if((mod((site(xdir,J)/2),2).eq.1).and.(mod((site(x-
dir,J)/4),2)
+.eq.1)) site(0,ydir+1-J)=6 if((mod(site(xdir,J),2).eq.1).and.(mod((site(x-
dir,J)/2),2).eq.1)
+.and.(mod((site(xdir,J)/4),2).eq.1))site(0,ydir+1-J)=7 110 continue


c
c          - Forcing rules along the left boundary –
c
do 100 J=1,ydir if(mod((site(0,J)/32),2).eq.1)site(0,J)=1
if(mod((site(0,J)/16),2).eq.1)site(0,J)=2
if(mod((site(0,J)/8),2).eq.1)site(0,J)=4 if((mod((site(0,J)/32),2).eq.1).and.
(mod((site(0,J)/16),2).eq.1
+))site(0,J)=3
if((mod((site(0,J)/32),2).eq.1).and.(mod((site(0,J)/8),2).eq.1)
 +)site(0,J)=5 if((mod((site(0,J)/16),2).eq.1).and.(mod((site(0,J)/8),2).eq.1)
 +)site(0,J)=6  if((mod((site(0,J)/32),2).eq.1).and.(mod((site(0,J)/16),2).eq.1
+).and.(mod((site(xdir,J)/8),2).eq.1))site(0,J)=7 100 continue
c
c          - Define neighbor sites –
c
do 120 I=1,xdir
do  120  J=2,ydir-1  nbs1(I,J)=site(I+1,J-1)
nbs2(I,J)=site(I-1,J-1)
nbs3(I,J)=site(I-1,J)
nbs4(I,J)=site(I-1,J+1)nbs5(I,J)=site(I+1,J+1)nbs6(I,J)=site(I+1,J)
120 continue
c
c          - Translation procedure –
c
c          Reset newsite(I,J)
```

```
do 150 I = 1,xdir do 150
J = 1,ydir newsite(I,J)=0
150 continue
c ___
c - Define added particles from neighbor sites after particle collisions –
c -
do 130 K=1,128
c Reset added particle from neighbor sites aps(K,1)=0
aps(K,2)=0
aps(K,3)=0
aps(K,4)=0
aps(K,5)=0
aps(K,6)=0
c Reset mass and momentum at neighbor sitesmass(K)=0
momx(K)=0
momy(K)=0
130 continue
do 140 K=0,128
c Added particles to site(I,J) from the first nighbor site
if(mod((K/8),2).eq.1)aps(K,1)=8
c Added particles to site(I,J) from the second nighbor site
if(mod((K/4),2).eq.1)aps(K,2)=4
c Added particles to site(I,J) from the third nighbor site
if(mod((K/2),2).eq.1)aps(K,3)=2
c Added particles to site(I,J) from the fourth nighbor site
if(mod(K,2).eq.1)aps(K,4)=1
c Added particles to site(I,J) from the fifth nighbor site
if(mod((K/32),2).eq.1)aps(K,5)=32
c Added particles to site(I,J) from the sixth nighbor site
if(mod((K/16),2).eq.1)aps(K,6)=16
c Define mass and momentum of particle moving toward the first nighbor
site
```

```
if(mod(K,2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)+0.5
momy(K)=momy(K)+((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the second nighbor site
if(mod((K/32),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-0.5
momy(K)=momy(K)+((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the third nighbor site
if(mod((K/16),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-1
momy(K)=0
endif
c Define mass and momentum of particle moving toward the fourth nighbor site
if(mod((K/8),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-0.5
momy(K)=momy(K)-((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the fifth nighbor site
if(mod((K/4),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)+0.5
momy(K)=momy(K)-((sqrt(3.0))/2.0)
endif
```

```
c Define mass and momentum of particle moving toward the sixth nighbor
site
if(mod((K/2),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)+1
momy(K)=0
endif
if(K.ge.64) mass(K)=mass(K)+1
140 continue
c
c          - Polymer adsorption process –
c
dddd = 0.00000464427119*xn**0.706571160678112
do 410 I=1,xdir
do 410 J=1,ydir
if(I.gt.(t-boa)) goto 410
if(I.lt.(t-eoa)) goto 410
z=mod(a*z,m)
zr=z/zm
gg=nint(zr/dddd)
aa=0
if(Tol.gt.1) goto 143
c Monolayer (Langmuir) Type
c To the first nighbor site
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/32),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/4),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+0.866
c To the second nighbor site
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+1
```

```
if((mod((site(I,J)/16),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/2),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+0.866
c To the third nighbor site
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/8),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-1
if((mod(site(I,J),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+0.866
c To the fourth nighbor site
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/4),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/32),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+0.866
c To the fifth nighbor site
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/2),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+0.866
if((mod(site(I,J),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/16),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+0.866
c To the sixth nighbor site
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+1
if((mod(site(I,J),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/8),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-0.866
```

```
if((mod((site(I,J)/4),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+0.866 goto 147
143 zzzzz=0
c Multilayer Type
c To the first nighbor site
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/32),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/4),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+0.866
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/32),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/4),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa+0.866
c To the second nighbor site
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/16),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/2),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/16),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/2),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa+0.866
c To the third nighbor site
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/8),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+0.866
```

```
if((mod((site(I,J)/4),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-1
if((mod(site(I,J),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/8),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa-1
if((mod(site(I,J),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa+0.866
c To the fourth nighbor site
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/4),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/32),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/4),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/32),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa+0.866
c To the fifth nighbor site
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/2),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+0.866
if((mod(site(I,J),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/16),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/2),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa+0.866
```

```
if((mod(site(I,J),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/16),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa+0.866
c To the sixth nighbor site
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+1
if((mod(site(I,J),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/8),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa+1
if((mod(site(I,J),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/8),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa+0.866 147
zzzzz=0
if((site(I,J).eq.128).or.(site(I,J).eq.0).or.(site(I,J).eq.64)
+.or.(site(I,J).eq.192)) goto 410
if((gg.gt.0).or.(aa.le.0)) goto 410
if((aa.gt.0).and.(gg.eq.0)) bb = mass(site(I,J))
if((aa.gt.0).and.(gg.eq.0)) site(I,J) = 192cc = cc + bb
newsite(I,J)=192site(I,J)=192
410 continue
c   ___
c - Translation procedure –
c   ___
c Translation schemedo 160 I=1,xdir
do 160 J=1,ydir
c Collision rule between fluid and solid particle
if((site(I,j).eq.0).or.(site(I,j).eq.64).or.(site(i,j).eq.128)
```

```
+.or.(site(i,j).eq.192).or.(site(i,j).eq.256))goto 160
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.128))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.128))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.128))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.128))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.128))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.128))nbs6(I,J)=16
c Collision rule between fluid and adsorbed polymer particle
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.192))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.192))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.192))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.192))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.192))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.192))nbs6(I,J)=16
c Collision rule between fluid and gelled polymer particle
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.256))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.256))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.256))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.256))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.256))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.256))nbs6(I,J)=16
160 continue
c
c          - New configuration of particles in site(I,J) –
c
do 165 i=1,xdir
do 165 j=1,ydir
if(site(i,j).ge.64)newsite(i,j)=64
newsite(I,J)=newsite(I,J)+aps(nbs1(I,J),1)
newsite(I,J)=newsite(I,J)+aps(nbs2(I,J),2)
newsite(I,J)=newsite(I,J)+aps(nbs3(I,J),3)
newsite(I,J)=newsite(I,J)+aps(nbs4(I,J),4)
```

```
newsite(I,J)=newsite(I,J)+aps(nbs5(I,J),5)
newsite(I,J)=newsite(I,J)+aps(nbs6(I,J),6)
if(site(I,J).eq.128)newsite(I,J)=128
if(site(I,J).eq.192)newsite(I,J)=192
if(site(I,J).eq.256)newsite(I,J)=256
165 continue
do 167 i=1,xdir
do 167 j=1,ydir
nbs1(I,J)=0
nbs2(I,J)=0
nbs3(I,J)=0
nbs4(I,J)=0
nbs5(I,J)=0
nbs6(I,J)=0
167 continue
c
c          - Updating site(I,J) –
c
do 170 I=1,xdir
do 170 J=1,ydir
site(I,J)=newsite(I,J)
if(newsite(I,J).eq.128)site(I,J)=128
if(newsite(I,J).eq.192)site(I,J)=192
if(newsite(I,J).eq.256)site(I,J)=256
170 continue
c
c          - Rotation rule –
c
do 180 I=1,xdir
do 180 J=1,ydir
if(site(I,J).eq.0)newsite(I,J)=0
if(site(I,J).eq.1)newsite(I,J)=1
```

```
if(site(I,J).eq.2)newsite(I,J)=2
if(site(I,J).eq.3)newsite(I,J)=3
if(site(I,J).eq.4)newsite(I,J)=4
if(site(I,J).eq.6)newsite(I,J)=6
if(site(I,J).eq.7)newsite(I,J)=7
if(site(I,J).eq.8)newsite(I,J)=8
if(site(I,J).eq.12)newsite(I,J)=12
if(site(I,J).eq.14)newsite(I,J)=14
if(site(I,J).eq.15)newsite(I,J)=15
if(site(I,J).eq.16)newsite(I,J)=16
if(site(I,J).eq.24)newsite(I,J)=24
if(site(I,J).eq.28)newsite(I,J)=28
if(site(I,J).eq.30)newsite(I,J)=30
if(site(I,J).eq.32)newsite(I,J)=32
if(site(I,J).eq.33)newsite(I,J)=33
if(site(I,J).eq.35)newsite(I,J)=35
if(site(I,J).eq.39)newsite(I,J)=39
if(site(I,J).eq.48)newsite(I,J)=48
if(site(I,J).eq.49)newsite(I,J)=49
if(site(I,J).eq.51)newsite(I,J)=51
if(site(I,J).eq.56)newsite(I,J)=56
if(site(I,J).eq.57)newsite(I,J)=57
if(site(I,J).eq.60)newsite(I,J)=60
if(site(I,J).eq.63)newsite(I,J)=63
if(site(I,J).eq.64)newsite(I,J)=64
if(site(I,J).eq.67)newsite(I,J)=67
if(site(I,J).eq.70)newsite(I,J)=70
if(site(I,J).eq.71)newsite(I,J)=71
if(site(I,J).eq.76)newsite(I,J)=76
if(site(I,J).eq.78)newsite(I,J)=78
if(site(I,J).eq.79)newsite(I,J)=79
if(site(I,J).eq.88)newsite(I,J)=88
```

```
if(site(I,J).eq.92)newsite(I,J)=92
if(site(I,J).eq.94)newsite(I,J)=94
if(site(I,J).eq.95)newsite(I,J)=95
if(site(I,J).eq.97)newsite(I,J)=97
if(site(I,J).eq.99)newsite(I,J)=99
if(site(I,J).eq.103)newsite(I,J)=103
if(site(I,J).eq.111)newsite(I,J)=111
if(site(I,J).eq.112)newsite(I,J)=112
if(site(I,J).eq.113)newsite(I,J)=113
if(site(I,J).eq.115)newsite(I,J)=115
if(site(I,J).eq.119)newsite(I,J)=119
if(site(I,J).eq.120)newsite(I,J)=120
if(site(I,J).eq.121)newsite(I,J)=121
if(site(I,J).eq.123)newsite(I,J)=123
if(site(I,J).eq.124)newsite(I,J)=124
if(site(I,J).eq.125)newsite(I,J)=125
if(site(I,J).eq.126)newsite(I,J)=126
if(site(I,J).eq.127)newsite(I,J)=127
c
if(site(I,J).eq.5)newsite(I,J)=66
if(site(I,J).eq.10)newsite(I,J)=68
if(site(I,J).eq.17)newsite(I,J)=96
if(site(I,J).eq.20)newsite(I,J)=72
if(site(I,J).eq.21)newsite(I,J)=42
if(site(I,J).eq.31)newsite(I,J)=110
if(site(I,J).eq.34)newsite(I,J)=65
if(site(I,J).eq.40)newsite(I,J)=80
if(site(I,J).eq.42)newsite(I,J)=21
if(site(I,J).eq.47)newsite(I,J)=87
if(site(I,J).eq.55)newsite(I,J)=107
if(site(I,J).eq.59)newsite(I,J)=117
if(site(I,J).eq.61)newsite(I,J)=122
```

```
if(site(I,J).eq.62)newsite(I,J)=93
if(site(I,J).eq.65)newsite(I,J)=34
if(site(I,J).eq.66)newsite(I,J)=5
if(site(I,J).eq.68)newsite(I,J)=10
if(site(I,J).eq.72)newsite(I,J)=20
if(site(I,J).eq.80)newsite(I,J)=40
if(site(I,J).eq.85)newsite(I,J)=106
if(site(I,J).eq.87)newsite(I,J)=47
if(site(I,J).eq.93)newsite(I,J)=62
if(site(I,J).eq.96)newsite(I,J)=17
if(site(I,J).eq.106)newsite(I,J)=85
if(site(I,J).eq.107)newsite(I,J)=55
if(site(I,J).eq.110)newsite(I,J)=31
if(site(I,J).eq.117)newsite(I,J)=59
if(site(I,J).eq.122)newsite(I,J)=61
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.9).and.(g.eq.0))newsite(I,J)=36
if((site(I,J).eq.9).and.(g.eq.1))newsite(I,J)=18
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.11).and.(g.eq.0))newsite(I,J)=38
if((site(I,J).eq.11).and.(g.eq.1))newsite(I,J)=69
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.13).and.(g.eq.0))newsite(I,J)=74
if((site(I,J).eq.13).and.(g.eq.1))newsite(I,J)=22
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.18).and.(g.eq.0))newsite(I,J)=9
if((site(I,J).eq.18).and.(g.eq.1))newsite(I,J)=36
z=mod(a*z,m)
```

```
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.19).and.(g.eq.0))newsite(I,J)=98
if((site(I,J).eq.19).and.(g.eq.1))newsite(I,J)=37
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.22).and.(g.eq.0))newsite(I,J)=13
if((site(I,J).eq.22).and.(g.eq.1))newsite(I,J)=74
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.23).and.(g.eq.0))newsite(I,J)=102
if((site(I,J).eq.23).and.(g.eq.1))newsite(I,J)=75
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.25).and.(g.eq.0))newsite(I,J)=52
if((site(I,J).eq.25).and.(g.eq.1))newsite(I,J)=104
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.26).and.(g.eq.0))newsite(I,J)=84
if((site(I,J).eq.26).and.(g.eq.1))newsite(I,J)=44
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.27).and.(g.eq.0))newsite(I,J)=45
if((site(I,J).eq.27).and.(g.eq.1))newsite(I,J)=54
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.29).and.(g.eq.0))newsite(I,J)=90
if((site(I,J).eq.29).and.(g.eq.1))newsite(I,J)=108
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.36).and.(g.eq.0))newsite(I,J)=18
if((site(I,J).eq.36).and.(g.eq.1))newsite(I,J)=9
z=mod(a*z,m)
```

```
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.37).and.(g.eq.0))newsite(I,J)=19
if((site(I,J).eq.37).and.(g.eq.1))newsite(I,J)=98
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.38).and.(g.eq.0))newsite(I,J)=69
if((site(I,J).eq.38).and.(g.eq.1))newsite(I,J)=11
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.41).and.(g.eq.0))newsite(I,J)=81
if((site(I,J).eq.41).and.(g.eq.1))newsite(I,J)=50
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.43).and.(g.eq.0))newsite(I,J)=83
if((site(I,J).eq.43).and.(g.eq.1))newsite(I,J)=101
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.44).and.(g.eq.0))newsite(I,J)=26
if((site(I,J).eq.44).and.(g.eq.1))newsite(I,J)=84
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.45).and.(g.eq.0))newsite(I,J)=54
if((site(I,J).eq.45).and.(g.eq.1))newsite(I,J)=27
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.46).and.(g.eq.0))newsite(I,J)=77
if((site(I,J).eq.46).and.(g.eq.1))newsite(I,J)=86
z=mod(a*z,m)zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.50).and.(g.eq.0))newsite(I,J)=41
if((site(I,J).eq.50).and.(g.eq.1))newsite(I,J)=81
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
```

```
if((site(I,J).eq.52).and.(g.eq.0))newsite(I,J)=104
if((site(I,J).eq.52).and.(g.eq.1))newsite(I,J)=25
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.53).and.(g.eq.0))newsite(I,J)=105
if((site(I,J).eq.53).and.(g.eq.1))newsite(I,J)=114
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.54).and.(g.eq.0))newsite(I,J)=27
if((site(I,J).eq.54).and.(g.eq.1))newsite(I,J)=45
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.58).and.(g.eq.0))newsite(I,J)=116
if((site(I,J).eq.58).and.(g.eq.1))newsite(I,J)=89
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.69).and.(g.eq.0))newsite(I,J)=11
if((site(I,J).eq.69).and.(g.eq.1))newsite(I,J)=38
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.73).and.(g.eq.0))newsite(I,J)=100
if((site(I,J).eq.73).and.(g.eq.1))newsite(I,J)=82
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.74).and.(g.eq.0))newsite(I,J)=22
if((site(I,J).eq.74).and.(g.eq.1))newsite(I,J)=13
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.75).and.(g.eq.0))newsite(I,J)=23
if((site(I,J).eq.75).and.(g.eq.1))newsite(I,J)=102
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
```

```
if((site(I,J).eq.77).and.(g.eq.0))newsite(I,J)=86
if((site(I,J).eq.77).and.(g.eq.1))newsite(I,J)=46
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.81).and.(g.eq.0))newsite(I,J)=50
if((site(I,J).eq.81).and.(g.eq.1))newsite(I,J)=41
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.82).and.(g.eq.0))newsite(I,J)=73
if((site(I,J).eq.82).and.(g.eq.1))newsite(I,J)=100
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.83).and.(g.eq.0))newsite(I,J)=101
if((site(I,J).eq.83).and.(g.eq.1))newsite(I,J)=43
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.84).and.(g.eq.0))newsite(I,J)=44
if((site(I,J).eq.84).and.(g.eq.1))newsite(I,J)=26
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.86).and.(g.eq.0))newsite(I,J)=46
if((site(I,J).eq.86).and.(g.eq.1))newsite(I,J)=77
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.89).and.(g.eq.0))newsite(I,J)=58
if((site(I,J).eq.89).and.(g.eq.1))newsite(I,J)=116
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.90).and.(g.eq.0))newsite(I,J)=108
if((site(I,J).eq.90).and.(g.eq.1))newsite(I,J)=29
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
```

```
if((site(I,J).eq.91).and.(g.eq.0))newsite(I,J)=109
if((site(I,J).eq.91).and.(g.eq.1))newsite(I,J)=118
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.98).and.(g.eq.0))newsite(I,J)=37
if((site(I,J).eq.98).and.(g.eq.1))newsite(I,J)=19
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.100).and.(g.eq.0))newsite(I,J)=82
if((site(I,J).eq.100).and.(g.eq.1))newsite(I,J)=73
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.) if((site(I,J).eq.101).and.(g.eq.0))newsite(I,J)=43
if((site(I,J).eq.101).and.(g.eq.1))newsite(I,J)=83
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.102).and.(g.eq.0))newsite(I,J)=75
if((site(I,J).eq.102).and.(g.eq.1))newsite(I,J)=23
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.104).and.(g.eq.0))newsite(I,J)=25
if((site(I,J).eq.104).and.(g.eq.1))newsite(I,J)=52
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.105).and.(g.eq.0))newsite(I,J)=114
if((site(I,J).eq.105).and.(g.eq.1))newsite(I,J)=53
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.108).and.(g.eq.0))newsite(I,J)=29
if((site(I,J).eq.108).and.(g.eq.1))newsite(I,J)=90
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
```

```
if((site(I,J).eq.109).and.(g.eq.0))newsite(I,J)=118
if((site(I,J).eq.109).and.(g.eq.1))newsite(I,J)=91
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.114).and.(g.eq.0))newsite(I,J)=53
if((site(I,J).eq.114).and.(g.eq.1))newsite(I,J)=105
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.116).and.(g.eq.0))newsite(I,J)=89
if((site(I,J).eq.116).and.(g.eq.1))newsite(I,J)=58
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.118).and.(g.eq.0))newsite(I,J)=91
if((site(I,J).eq.118).and.(g.eq.1))newsite(I,J)=109
if(site(I,J).eq.128)newsite(I,J)=128
if(site(I,J).eq.192)newsite(I,J)=192
if(site(I,J).eq.256)newsite(I,J)=256
if(site(I,J).eq.0)newsite(I,J)=0
site(I,J) = newsite(I,J)
180 continue
if(t.eq.1)goto 222
if(t.eq.ts)goto 222
if(mod(t,100).ne.0) goto 90
c
c          - Recalculating porosity in iteration –
c
222 ddddd=0
void = 0
voida = 0
kosong = 0
kosonga = 0
do 4209 I = 1, xdir
```

```
do 4309 J = 1, ydir
if(site(I,J).ne.128) void = void + 1
if((site(I,J).ne.128).and.(site(I,J).ne.192).and.(site(I,J).ne.
+256))voida = voida + 14309 continue
kosong = kosong + void
kosonga = kosonga + voida
void = 0
voida = 0
4209 continue
total = xdir * ydir
porosity = kosong/total
c
c          - Calculating the number of adsorbed polymer particles –
c
dd = cc
c
c          - Calculated variables –
c
masstot = 0
vxt = 0
mxt = 0
do 4409 I = 1, xdir
do 4409 J = 1, ydir
if(site(I,J).eq.128) goto 4409
if(site(I,J).eq.192) goto 4409
if(site(I,J).eq.256) goto 4409
if(site(I,J).eq.0) goto 4409
if(mod(site(I,J),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/2),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/4),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/8),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/16),2).eq.1)masstot=masstot+1
```

```
if(mod((site(I,J)/32),2).eq.1)masstot=masstot+1
if(site(I,J).ge.64)masstot=masstot+1
4409 continue
do 4509 I = 1, xdir
do 4509 J = 1, ydir
masite = 0
if(site(I,J).eq.128) goto 4709
if(site(I,J).eq.192) goto 4709
if(site(I,J).eq.256) goto 4709
if(site(I,J).eq.0) goto 4709
if(mod(site(I,J),2).eq.1)masite=masite+1
if(mod((site(I,J)/2),2).eq.1)masite=masite+1
if(mod((site(I,J)/4),2).eq.1)masite=masite+1
if(mod((site(I,J)/8),2).eq.1)masite=masite+1
if(mod((site(I,J)/16),2).eq.1)masite=masite+1
if(mod((site(I,J)/32),2).eq.1)masite=masite+1
if(site(I,J).ge.64)masite=masite+1
4709 zzzzz=0
if(site(I,J).eq.64) goto 4509
if((site(I,J).gt.0).and.(site(I,J).lt.128))vxt=vxt +
+(momx(site(I,J)))/masite
if((site(I,J).gt.0).and.(site(I,J).lt.128))mxt=mxt +
+momx(site(I,J))4509 continue
c    ___
c - Density -
c    ___
denc = masstot/kosong
c    ___
c - Kinematic viscosity –
c    ___
d=denc/7
kinevis=(1.0/28/(d*(1-d))/(1-8*d*(1-d)/7))-(1/8)
```

```
c    ___
c - Dynamic viscosity –
c    ___
dynavis = denc * kinevis
c    ___
c - Velocity –
c    ___
velx = vxt / kosong
c    ___
c - Flow rate –
c    ___
flow = velx * porosity
c    ___
c - Calculate momentum at left boundary –
c    ___
wx = 0
void = 0
do 4809 J = 1, ydir
if((site(0,J).eq.0).or.(site(0,J).eq.64)) goto 4809
if((site(0,J).eq.128).or.(site(0,J).eq.192)) goto 4809
if(site(0,J).eq.256) goto 4809
if((site(0,J).gt.0).and.(site(0,J).lt.128)) wx=wx+momx(site(0,J))
4809 continue
c    ___
c - Pressure –
c    ___
press =  wx/(ydir*0.8660254)
c    ___
c - Pressure gradient
c    ___
pressgrad =  wx/(ydir*0.8660254)/xdir
c    ___
```

```
c - Permeability –
c ___
permeability = (vxt/kosong*porosity)*dynavis/pressgrad
c ___
c - Print on screen and write on file –
c ___
print *,t,velx,permeability,cc
write (5,*)t,velx,permeability,cc
90 continue
2222 end
```

BAB 3

Pemodelan dan Simulasi Proses Adsorpsi pada Kondisi Statik

Dalam bab ini dibahas mengenai simulasi metode lattice gas automata (LGA) untuk proses adsorpsi statik. Pada kondisi ini proses adsorpsi berlangsung Ketika fluida dalam kondisi tidak mengalir dan kontak dengan permukaan batuan. Pada bagian akhir diberikan pemrograman komputer untuk simulasi adsorpsi polimer kondisi statik.

3.1 Pemodelan Proses Adsorpsi pada Kondisi Statik

Aturan tumbukan untuk proses adsorpsi polimer juga perlu ditambahkan untuk simulasi adsorpsi polimer pada kondisi statik (*batch*). Aturan tumbukan yang digunakan pada kondisi dinamik, juga dapat digunakan untuk proses adsorpsi pada kondisi statik sebagaimana diberikan pada Gambar 2.1.

3.2 Simulasi Proses Adsorpsi pada Kondisi Statik

Simulasi adsorpsi polimer pada sistem statik untuk validasi dilakukan dengan prosedur berikut (Fathaddin dan Awang, 2004; Fathaddin, 2006):

1. Kisi-kisi model LGA disusun dengan situs-situs untuk padatan dan situs-situs untuk saluran fluida yang mewakili sandpack/sampel core

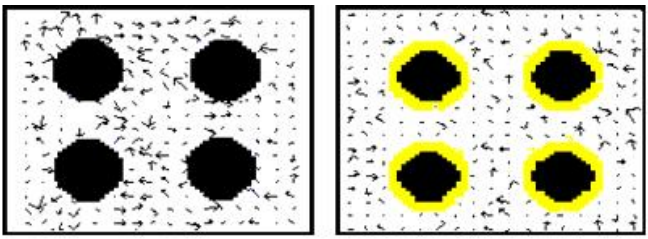
seperti yang digambarkan pada Gambar 3.1a. Pada gambar, panjang permukaan partikel padat sesuai dengan luas permukaan butiran pasir.

2. Partikel fluida yang bergerak ditempatkan pada area kosong untuk mewakili gerakan larutan polimer di antara butiran pasir dalam kemasan terguncang.
3. Aturan tumbukan (Gambar 2.1) diterapkan untuk mengaktifhan proses adsorpsi. Jumlah kumulatif partikel polimer teradsorpsi dihitung selama langkah ini.

Distribusi molekul polimer teradsorpsi pada permukaan pasir dapat diwakili oleh partikel LGA yang teradsorpsi seperti yang ditunjukkan pada Gambar 3.1b.

3.3 Program Simulasi Proses Adsorpsi pada Kondisi Statik

Program komputer dibuat untuk mensimulasikan proses adsorpsi pada kondisi statik yang terjadi akibat interaksi antara polimer dan batuan berpori selama perendaman polimer dalam batuan berpori. Program komputer dibuat dalam Bahasa FORTRAN sebagai berikut:



Gambar 3.1 Adsorpsi polimer dalam sistem statik (batch). (a) Kondisi awal sistem. (b) Proses adsorpsi telah terjadi. Area hitam mewakili solid, area putih mewakili area kosong (pori-pori), panah mewakili partikel polimer, dan lapisan kuning mewakili polimer teradsorpsi

```
C SIMULATOR  for  validation
Integer I,J,K,xdir,ydir,g, gg, bb, cc, dd
real Tol, t
Integer site(500,500), newsite(500,500)
Integer nbs1(500,500),nbs2(500,500),nbs3(500,500)
Integer nbs4(500,500),nbs5(500,500),nbs6(500,500)
Integer aps(256,6),mass(256), csreal*4 zr, denc, kosong
real*4 momx(256),momy(256)
Integer a,seed, ts
Data  a,m,seed/1027,1048576,1/
c ____
c- Calling data file and output file –
c ____
OPEN(UNIT=5,FILE='C:\Simulata.OUT',
+STATUS = 'old')
z=seedzm=m
c ----------
c - data -
c ----------
c Number of sites in x direction
xdir = 230
c Number of sites in y direction
ydir = 230
c time stept
s = 10800
c Existing fluid particle (codes = 0 - 127)
tyoo = 1
tyop = 2
tyoq = 4
tyor = 2
c Polymer concentration (ppm)
xn = 5000
```

```
c Types of layer (Tol) (Monolayer: Tol = 1 ; Multilayer: Tol = 2)
Tol = 1
c ___
c - setting the obstacles -
c ___
do 10 i=1,xdir
do 10 j=1,ydir
site(i,j)=0
newsite(i,j)=0
10 continue
C ======================
c = Iranian Validation =
c ======================
c First Row
do 1000 i=5,15
c First Circle
do 1001 j=5,15
site(i,j)=128
1001  continue
c Second Circle
do 1002 j=35,45
site(i,j)=128
1002 continue
c Third Circle
do 1003 j=65,75
site(i,j)=128
1003 continue
c Fourth Circle
do 1004 j=95,105
site(i,j)=128
1004 continue
c Fifth Circle
```

```
do 1005 j=125,135
site(i,j)=128
1005 continue
c Sixth Circle
do 1006 j=155,165
site(i,j)=128
1006 continue
c  Seventh Circle
do 1007 j=185,195
site(i,j)=128
1007 continue
c Eight Circle
do 1008 j=215,225
site(i,j)=128
1008 continue
1000 continue
c Second Row
do 1010 i=35,45
c First Circle
do 1011 j=5,15
site(i,j)=128
1011  continue
c Second Circle
do 1012 j=35,45
site(i,j)=128
1012 continue
c Third Circle
do 1013 j=65,75
site(i,j)=128
1013 continue
c Fourth Circle
do 1014 j=95,105
```

```
site(i,j)=128
1014 continue
c Fifth Circle
do 1015 j=125,135
site(i,j)=128
1015 continue
c Sixth Circle
do 1016 j=155,165
site(i,j)=128
1016 continue
c Sixth Circle
do 1017 j=185,195
site(i,j)=128
1017 continue
c Sixth Circle
do 1018 j=215,225
site(i,j)=128
1018 continue
1010 continue
c Third Row
do 1020 i=65,75
c First Circle
do 1021 j=5,15
site(i,j)=128
1021  continue
c Second Circle
do 1022 j=35,45
site(i,j)=128
1022 continue
c Third Circle
do 1023 j=65,75
site(i,j)=128
```

```
1023 continue
c Fourth Circle
do 1024 j=95,105
site(i,j)=128
1024 continue
c Fifth Circle
do 1025 j=125,135
site(i,j)=128
1025 continue
c Sixth Circle
do 1026 j=155,165
site(i,j)=128
1026 continue
c Seventh Circle
do 1027 j=185,195
site(i,j)=128
1027 continue
c Eight Circle
do 1028 j=215,225
site(i,j)=128
1028 continue
1020 continue
c Fourth Row
do 1030 i=95,105
c First Circle
do 1031 j=5,15
site(i,j)=128
1031  continue
c Second Circle
do 1032 j=35,45
site(i,j)=128
1032 continue
```

```
c Third Circle
do 1033 j=65,75
site(i,j)=128
1033 continue
c Fourth Circle
do 1034 j=95,105
site(i,j)=128
1034 continue
c Fifth Circle
do 1035 j=125,135
site(i,j)=128
1035 continue
c Sixtth Circle
do 1036 j=155,165
site(i,j)=128
1036 continue
c Seventh Circle
do 1037 j=185,195
site(i,j)=128
1037 continue
c Eight Circle
do 1038 j=215,225
site(i,j)=128
1038 continue
1030 continue
c Fifth Row
do 1040 i=125,135
c First Circle
do 1041 j=5,15
site(i,j)=128
1041  continue
c Second Circle
```

```
do 1042 j=35,45
site(i,j)=128
1042 continue
c Third Circle
do 1043 j=65,75
site(i,j)=128
1043 continue
c Fourth Circle
do 1044 j=95,105
site(i,j)=128
1044 continue
c Fifth Circle
do 1045 j=125,135
site(i,j)=128
1045 continue
c Sixth Circle
do 1046 j=155,165
site(i,j)=128
1046 continue
c Seventh Circle
do 1047 j=185,195
site(i,j)=128
1047 continue
c Eight Circle
do 1048 j=215,225
site(i,j)=128
1048 continue
1040 continue
c Sixth Row
do 1050 i=155,165
c First Circle
do 1051 j=5,15
```

```
site(i,j)=128
1051  continue
c Second Circle
do 1052 j=35,45
site(i,j)=128
1052 continue
c Third Circle
do 1053 j=65,75
site(i,j)=128
1053 continue
c Fourth Circle
do 1054 j=95,105
site(i,j)=128
1054 continue
c Fifth Circle
do 1055 j=125,135
site(i,j)=128
1055 continue
c Sixth Circle
do 1056 j=155,165
site(i,j)=128
1056 continue
c Seventh Circle
do 1057 j=185,195
site(i,j)=128
1057 continue
c Eight Circle
do 1058 j=215,225
site(i,j)=128
1058 continue
1050 continue
c Seventh Row
```

```
do 1060 i=185,195
c First Circle
do 1061 j=5,15
site(i,j)=128
1061  continue
c Second Circle
do 1062 j=35,45
site(i,j)=128
1062 continue
c Third Circle
do 1063 j=65,75
site(i,j)=128
1063 continue
c Fourth Circle
do 1064 j=95,105
site(i,j)=128
1064 continue
c Fifth Circle
do 1065 j=125,135
site(i,j)=128
1065 continue
c Sixth Circle
do 1066 j=155,165
site(i,j)=128
1066 continue
c Seventh Circle
do 1067 j=185,195
site(i,j)=128
1067 continue
c Eight Circle
do 1068 j=215,225
site(i,j)=128
```

```
1068 continue
1060 continue
c Eight Row
do 2060 i=215,225
c First Circle
do 2061 j=5,15
site(i,j)=128
2061  continue
c Second Circle
do 2062 j=35,45
site(i,j)=128
2062 continue
c Third Circle
do 2063 j=65,75
site(i,j)=128
2063 continue
c Fourth Circle
do 2064 j=95,105
site(i,j)=128
2064 continue
c Fifth Circle
do 2065 j=125,135
site(i,j)=128
2065 continue
c Sixth Circle
do 2066 j=155,165
site(i,j)=128
2066 continue
c Seventh Circle
do 2067 j=185,195
site(i,j)=128
2067 continue
```

```
c Eight Circle
do 2068 j=215,225
site(i,j)=128
2068 continue
2060 continue
c ================
c = Sisi depan 1 =
c ================
c First  row
do 1070 i=4,4
c First Circle
do 1071 j=6,14
site(i,j)=128
1071  continue
c Second Circle
do 1072 j=36,44
site(i,j)=128
1072 continue
c Third Circle
do 1073 j=66,74
site(i,j)=128
1073 continue
c Fourth Circle
do 1074 j=96,104
site(i,j)=128
1074 continue
c  Fifth Circle
do 1075 j=126,134
site(i,j)=128
1075 continue
c Sixth Circle
do 1076 j=156,164
```

```
site(i,j)=128
1076 continue
c Seventh Circle
do 1077 j=186,194
site(i,j)=128
1077 continue
c Sixth Circle
do 1078 j=216,224
site(i,j)=128
1078 continue
1070 continue
c Second row
do 1080 i=34,34
c First Circle
do 1081 j=6,14
site(i,j)=128
1081  continue
c Second Circle
do 1082 j=36,44
site(i,j)=128
1082 continue
c Third Circle
do 1083 j=66,74
site(i,j)=128
1083 continue
c Fourth Circle
do 1084 j=96,104
site(i,j)=128
1084 continue
c Fifth Circle
do 1085 j=126,134
site(i,j)=128
```

```
1085 continue
c Sixth Circle
do 1086 j=156,164
site(i,j)=128
1086 continue
c Seventh Circle
do 1087 j=186,194
site(i,j)=128
1087 continue
c Eight Circle
do 1088 j=216,224
site(i,j)=128
1088 continue
1080 continue
c Third row
do 1090 i=64,64
c First Circle
do 1091 j=6,14
site(i,j)=128
1091  continue
c Second Circle
do 1092 j=36,44
site(i,j)=128
1092 continue
c Third Circle
do 1093 j=66,74
site(i,j)=128
1093 continue
c Fourth Circle
do 1094 j=96,104
site(i,j)=128
1094 continue
```

```
c Fifth Circle
do 1095 j=126,134
site(i,j)=128
1095 continue
c Sixth Circle
do 1096 j=156,164
site(i,j)=128
1096 continue
c Seventh Circle
do 1097 j=186,194
site(i,j)=128
1097 continue
c Eight Circle
do 1098 j=216,224
site(i,j)=128
1098 continue
1090 continue
c Fourth row
do 1100 i=94,94
c First Circle
do 1101 j=6,14
site(i,j)=128 1101 continue
c Second Circle
do 1102 j=36,44
site(i,j)=128
1102 continue
c Third Circle
do 1103 j=66,74
site(i,j)=128
1103 continue
c Fourth Circle
do 1104 j=96,104
```

```
site(i,j)=128
1104 continue
c Fifth Circle
do 1105 j=126,134
site(i,j)=128
1105 continue
c Sixth Circle
do 1106 j=156,164
site(i,j)=128
1106 continue
c Seventh Circle
do 1107 j=186,194
site(i,j)=128
1107 continue
c Eight Circle
do 1108 j=216,224
site(i,j)=128
1108 continue
1100 continue
c Fifth row
do 1110 i=124,124
c First Circle
do 1111 j=6,14
site(i,j)=128
1111  continue
c Second Circle
do 1112 j=36,44
site(i,j)=128
1112 continue
c Third Circle
do 1113 j=66,74
site(i,j)=128
```

```
1113 continue
c Fourth Circle
do 1114 j=96,104
site(i,j)=128
1114 continue
c Fifth Circle
do 1115 j=126,134
site(i,j)=128
1115 continue
c Sixth Circle
do 1116 j=156,164
site(i,j)=128
1116 continue
c Seventh Circle
do 1117 j=186,194
site(i,j)=128
1117 continue
c Eight Circle
do 1118 j=216,224
site(i,j)=128
1118 continue
1110 continue
c Sixth row
do 1120 i=154,154
c First Circle
do 1121 j=6,14
site(i,j)=128
1121  continue
c Second Circle
do 1122 j=36,44
site(i,j)=128
1122 continue
```

```
c Third Circle
do 1123 j=66,74
site(i,j)=128
1123 continue
c Fourth Circle
do 1124 j=96,104
site(i,j)=128
1124 continue
c Fifth Circle
do 1125 j=126,134
site(i,j)=128
1125 continue
c Sixth Circle
do 1126 j=156,164
site(i,j)=128
1126 continue
c Seventh Circle
do 1127 j=186,194
site(i,j)=128
1127 continue
c Sixth Circle
do 1128 j=216,224
site(i,j)=128
1128 continue
1120 continue
c Seventh row
do 1130 i=184,184
c First Circle
do 1131 j=6,14
site(i,j)=128
1131  continue
c Second Circle
```

```
do 1132 j=36,44
site(i,j)=128
1132 continue
c Third Circle
do 1133 j=66,74
site(i,j)=128
1133 continue
c Fourth Circle
do 1134 j=96,104
site(i,j)=128
1134 continue
c Fifth Circle
do 1135 j=126,134
site(i,j)=128
1135 continue
c Sixth Circle
do 1136 j=156,164
site(i,j)=128 1136 continue
c Seventh Circle
do 1137 j=186,194
site(i,j)=128
1137 continue
c Sixth Circle
do 1138 j=216,224
site(i,j)=128
1138 continue
1130 continue
c Eight row
do 2130 i=214,214
c First Circle
do 2131 j=6,14
site(i,j)=128
```

```
2131  continue
c Second Circle
do 2132 j=36,44
site(i,j)=128
2132 continue
c Third Circle
do 2133 j=66,74
site(i,j)=128
2133 continue
c Fourth Circle
do 2134 j=96,104
site(i,j)=128
2134 continue
c Fifth Circle
do 2135 j=126,134
site(i,j)=128
2135 continue
c Sixth Circle
do 2136 j=156,164
site(i,j)=128
2136 continue
c Seventh Circle
do 2137 j=186,194
site(i,j)=128
2137 continue
c Eight Circle
do 2138 j=216,224
site(i,j)=128
2138 continue
2130 continue
c ====================
c = Sisi belakang 1 =
```

```
c ====================
c First row
do 1140 i=16,16
c First Circle
do 1141 j=6,14
site(i,j)=128
1141  continue
c Second Circle
do 1142 j=36,44
site(i,j)=128
1142 continue
c Third Circle
do 1143 j=66,74
site(i,j)=128
1143 continue
c Fourth Circle
do 1144 j=96,104
site(i,j)=128
1144 continue
c Fifth Circle
do 1145 j=126,134
site(i,j)=128
1145 continue
c Sixth Circle
do 1146 j=156,164
site(i,j)=128
1146 continue
c Seventh Circle
do 1147 j=186,194
site(i,j)=128
1147 continue
c Eight Circle
```

```
do 1148 j=216,224
site(i,j)=128
1148 continue
1140 continue
c Second row
do 1150 i=46,46
c First Circle
do 1151 j=6,14
site(i,j)=128
1151 continue
 c Second Circle
do 1152 j=36,44
site(i,j)=128
1152 continue
c Third Circle
do 1153 j=66,74
site(i,j)=128
1153 continue
c Fourth Circle
do 1154 j=96,104
site(i,j)=128
1154 continue
c Fifth Circle
do 1155 j=126,134
site(i,j)=128
1155 continue
c Sixth Circle
do 1156 j=156,164
site(i,j)=128
1156 continue
c Seventh Circle
do 1157 j=186,194
```

```
site(i,j)=128
1157 continue
c Eight Circle
do 1158 j=216,224
site(i,j)=128
1158 continue
1150 continue
c Third row
do 1160 i=76,76
c First Circle
do 1161 j=6,14
site(i,j)=128
1161  continue
c Second Circle
do 1162 j=36,44
site(i,j)=128
1162 continue
c Third Circle
do 1163 j=66,74
site(i,j)=128
1163 continue
c Fourth Circle
do 1164 j=96,104
site(i,j)=128
1164 continue
c Fifth Circle
do 1165 j=126,134
site(i,j)=128
1165 continue
c Sixth Circle
do 1166 j=156,164
site(i,j)=128
```

```
1166 continue
c Seventh Circle
do 1167 j=186,194
site(i,j)=128
1167 continue
c Eight Circle
do 1168 j=216,224
site(i,j)=128
1168 continue
1160 continue
c Fourth row
do 1170 i=106,106
c First Circle
do 1171 j=6,14
site(i,j)=128
1171  continue
c Second Circle
do 1172 j=36,44
site(i,j)=128
1172 continue
c Third Circle
do 1173 j=66,74
site(i,j)=128
1173 continue
c Fourth Circle
do 1174 j=96,104
site(i,j)=128
1174 continue
c Fifth Circle
do 1175 j=126,134
site(i,j)=128
1175 continue
```

```
c Sixth Circle
do 1176 j=156,164
site(i,j)=128
1176 continue
c Seventh Circle
do 1177 j=186,194
site(i,j)=128
1177 continue
c Eight Circle
do 1178 j=216,224
site(i,j)=128
1178 continue
1170 continue
c Fifth row
do 1180 i=136,136
c First Circle
 do 1181 j=6,14
site(i,j)=128
1181  continue
c Second Circle
do 1182 j=36,44
site(i,j)=128
1182 continue
c Third Circle
do 1183 j=66,74
site(i,j)=128
1183 continue
c Fourth Circle
do 1184 j=96,104
site(i,j)=128
1184 continue
c Fifth Circle
```

```
do 1185 j=126,134
site(i,j)=128
1185 continue
c Sixth Circle
do 1186 j=156,164
site(i,j)=128
1186 continue
c Seventh Circle
do 1187 j=186,194
site(i,j)=128
1187 continue c Eight Circle
do 1188 j=216,224
site(i,j)=128
1188 continue
1180 continue
c Sixth row
do 1190 i=166,166
c First Circle
do 1191 j=6,14
site(i,j)=128
1191  continue
c Second Circle
do 1192 j=36,44
site(i,j)=128
1192 continue
c Third Circle
do 1193 j=66,74
site(i,j)=128
1193 continue
c Fourth Circle
do 1194 j=96,104
site(i,j)=128
```

```
1194 continue
c Fifth Circle
 do 1195 j=126,134
site(i,j)=128
1195 continue
c Sixth Circle
do 1196 j=156,164
site(i,j)=128
1196 continue
c Seventh Circle
do 1197 j=186,194
site(i,j)=128
1197 continue
c Eight Circle
do 1198 j=216,224
site(i,j)=128
1198 continue
1190 continue
c Seventh row
do 1200 i=196,196
c First Circle
do 1201 j=6,14
site(i,j)=128
1201  continue
c Second Circle
do 1202 j=36,44
site(i,j)=128
1202 continue
c Third Circle
do 1203 j=66,74
site(i,j)=128
1203 continue
```

```
c Fourth Circle
do 1204 j=96,104
site(i,j)=128
1204 continue
c Fifth Circle
do 1205 j=126,134
site(i,j)=128
1205 continue
c Sixth Circle
do 1206 j=156,164
site(i,j)=128
1206 continue
c Seventh Circle
do 1207 j=186,194
site(i,j)=128
1207 continue
c Eight Circle
do 1208 j=216,224
site(i,j)=128
1208 continue
1200 continue
c Eight row
do 2300 i=226,226
c First Circle
do 2301 j=6,14
site(i,j)=128
2301  continue
c Second Circle
do 2302 j=36,44
site(i,j)=128
2302 continue
c Third Circle
```

```
do 2303 j=66,74
site(i,j)=128
2303 continue
c Fourth Circle
do 2304 j=96,104
site(i,j)=128
2304 continue
c Fifth Circle
do 2305 j=126,134
site(i,j)=128
2305 continue
c Sixth Circle
do 2306 j=156,164
site(i,j)=128
2306 continue
c Seventh Circle
do 2307 j=186,194
site(i,j)=128
2307 continue
c Eight Circle
do 2308 j=216,224
site(i,j)=128
2308 continue
2300 continue
c ================
c = sisi depan 2 =
c ================
c First  row
do 1210 i=3,3
c First Circle
do 1211 j=8,12
site(i,j)=128
```

```
1211  continue
c Second Circle
do 1212 j=38,42
site(i,j)=128
1212 continue
c Third Circle
do 1213 j=68,72
site(i,j)=128
1213 continue
c Fourth Circle
do 1214 j=98,102
site(i,j)=128
1214 continue
c Fifth Circle
do 1215 j=128,132
site(i,j)=128
1215 continue
c Sixth Circle
do 1216 j=158,162
site(i,j)=128
1216 continue
c Seventh Circle
do 1217 j=188,192
site(i,j)=128
1217 continue
c Eight Circle
do 1218 j=218,222
site(i,j)=128
1218 continue
1210 continue
c Second row
do 1220 i=33,33
```

```
c First Circle
do 1221 j=8,12
site(i,j)=128
1221  continue
c Second Circle
do 1222 j=38,42
site(i,j)=128
1222 continue
c Third Circle
do 1223 j=68,72
site(i,j)=128
1223 continue
c Fourth Circle
do 1224 j=98,102
site(i,j)=128
1224 continue
c Fifth Circle
do 1225 j=128,132
site(i,j)=128
1225 continue
c Sixth Circle
do 1226 j=158,162
site(i,j)=128
1226 continue
c Seventh Circle
do 1227 j=188,192
site(i,j)=128
1227 continue
c Eight Circle
do 1228 j=218,222
site(i,j)=128
1228 continue
```

```
1220 continue
c Third row
do 1230 i=63,63
c First Circle
do 1231 j=8,12
site(i,j)=128
1231  continue
c Second Circle
do 1232 j=38,42
site(i,j)=128
1232 continue
c Third Circle
do 1233 j=68,72
site(i,j)=128
1233 continue
c Fourth Circle
do 1234 j=98,102
site(i,j)=128
1234 continue
c Fifth Circle
do 1235 j=128,132
site(i,j)=128
1235 continue
c Sixth Circle
do 1236 j=158,162
site(i,j)=128
1236 continue
c Seventh Circle
do 1237 j=188,192
site(i,j)=128
1237 continue
c Eight Circle
```

```
do 1238 j=218,222
site(i,j)=128
1238 continue
1230 continue
c Fourth row
do 1240 i=93,93
c First Circle
do 1241 j=8,12
site(i,j)=128
1241  continue
c Second Circle
do 1242 j=38,42
site(i,j)=128
1242 continue
c Third Circle
do 1243 j=68,72
site(i,j)=128
1243 continue
c Fourth Circle
do 1244 j=98,102
site(i,j)=128
1244 continue
c Fifth Circle
do 1245 j=128,132
site(i,j)=128
1245 continue
c Sixth Circle
do 1246 j=158,162
site(i,j)=128
1246 continue
c Seventh Circle
do 1247 j=188,192
```

```
site(i,j)=128
1247 continue
c Eight Circle
do 1248 j=218,222
site(i,j)=128
1248 continue
1240 continue
c Fifth row
do 1250 i=123,123
c First Circle
do 1251 j=8,12
site(i,j)=128
1251  continue
c Second Circle
do 1252 j=38,42
site(i,j)=128
1252 continue
c Third Circle
do 1253 j=68,72
site(i,j)=128
1253 continue
c Fourth Circle
do 1254 j=98,102
site(i,j)=128
1254 continue
c Fifth Circle
do 1255 j=128,132
site(i,j)=128
1255 continue
c Sixth Circle
do 1256 j=158,162
site(i,j)=128
```

```
1256 continue
c Seventh Circle
do 1257 j=188,192
site(i,j)=128
1257 continue
c Eight Circle
do 1258 j=218,222
site(i,j)=128
1258 continue
1250 continue
c Sixth row
do 1260 i=153,153
c First Circle
do 1261 j=8,12
site(i,j)=128
1261  continue
c Second Circle
do 1262 j=38,42
site(i,j)=128
1262 continue
c Third Circle
do 1263 j=68,72
site(i,j)=128
1263 continue
c Fourth Circle
do 1264 j=98,102
site(i,j)=128
1264 continue
c Fifth Circle
do 1265 j=128,132
site(i,j)=128
1265 continue
```

```
c Sixth Circle
do 1266 j=158,162
site(i,j)=128
1266 continue
c Seventh Circle
do 1267 j=188,192
site(i,j)=128
1267 continue
c Eight Circle
do 1268 j=218,222
site(i,j)=128
1268 continue
1260 continue
c Seventh row
do 1270 i=183,183
c First Circle
do 1271 j=8,12
site(i,j)=128
1271  continue
c Second Circle
do 1272 j=38,42
site(i,j)=128
1272 continue
c Third Circle
do 1273 j=68,72
site(i,j)=128
1273 continue
c Fourth Circle
do 1274 j=98,102
site(i,j)=128
1274 continue
c Fifth Circle
```

```
do 1275 j=128,132
site(i,j)=128
1275 continue
c Sixth Circle
do 1276 j=158,162
site(i,j)=128
1276 continue
c Seventh Circle
do 1277 j=188,192
site(i,j)=128
1277 continue
c Eight Circle
do 1278 j=218,222
site(i,j)=128
1278 continue
1270 continue
c Eight row
do 2270 i=213,213
c First Circle
do 2271 j=8,12
site(i,j)=128
2271  continue
c Second Circle
do 2272 j=38,42
site(i,j)=128
2272 continue
c Third Circle
do 2273 j=68,72
site(i,j)=128
2273 continue
c Fourth Circle
do 2274 j=98,102
```

```
site(i,j)=128
2274 continue
c Fifth Circle
do 2275 j=128,132
site(i,j)=128
2275 continue
c Sixth Circle
do 2276 j=158,162
site(i,j)=128
2276 continue
c Seventh Circle
do 2277 j=188,192
site(i,j)=128
2277 continue
c Eight Circle
do 2278 j=218,222
site(i,j)=128
2278 continue
2270 continue
c ====================
c = sisi belakang 2 =
c ====================
c First row
do 1280 i=17,17
c First Circle
do 1281 j=9,11
site(i,j)=128
1281  continue
c Second Circle
do 1282 j=39,41
site(i,j)=128
1282 continue
```

```
c Third Circle
do 1283 j=69,71
site(i,j)=128
1283 continue
c Fourth Circle
do 1284 j=99,101
site(i,j)=128
1284 continue
c Fifth Circle
do 1285 j=129,131
site(i,j)=128
1285 continue
c Sixth Circle
do 1286 j=159,161
site(i,j)=128
1286 continue
c Seventh Circle
do 1287 j=189,191
site(i,j)=128
1287 continue
c Eight Circle
do 1288 j=219,221
site(i,j)=128
1288 continue
1280 continue
c Second row
do 1290 i=47,47
c First Circle
do 1291 j=9,11
site(i,j)=128 1291 continue
c Second Circle
do 1292 j=39,41
```

```
site(i,j)=128
1292 continue
c Third Circle
do 1293 j=69,71
site(i,j)=128
1293 continue
c Fourth Circle
do 1294 j=99,101
site(i,j)=128
1294 continue
c Fifth Circle
do 1295 j=129,131
site(i,j)=128
1295 continue
c Sixth Circle
do 1296 j=159,161
site(i,j)=128
1296 continue
c Seventh Circle
do 1297 j=189,191
site(i,j)=128
1297 continue
c Eight Circle
do 1298 j=219,221
site(i,j)=128
1298 continue
1290 continue
c Third row
do 1300 i=77,77
c First Circle
do 1301 j=9,11
site(i,j)=128
```

```
1301  continue
c Second Circle
do 1302 j=39,41
site(i,j)=128
1302 continue
c Third Circle
do 1303 j=69,71
site(i,j)=128
1303 continue
c Fourth Circle
do 1304 j=99,101
site(i,j)=128
1304 continue
c  Fifth Circle
do 1305 j=129,131
site(i,j)=128
1305 continue
c Sixth Circle
do 1306 j=159,161
site(i,j)=128
1306 continue
c Seventh Circle
do 1307 j=189,191
site(i,j)=128 1307
continue
c Eight Circle
do 1308 j=219,221
site(i,j)=128
1308 continue
1300 continue
c Fourth row
do 1400 i=107,107
```

```
c First Circle
do 1401 j=9,11
site(i,j)=128
1401  continue
c Second Circle
do 1402 j=39,41
site(i,j)=128
1402 continue
c Third Circle
do 1403 j=69,71
site(i,j)=128
1403 continue
c Fourth Circle
do 1404 j=99,101
site(i,j)=128
1404 continue
c Fifth Circle
do 1405 j=129,131
site(i,j)=128
1405 continue
c Sixth Circle
do 1406 j=159,161
site(i,j)=128
1406 continue
c Seventh Circle
do 1407 j=189,191
site(i,j)=128
1407 continue
c Eight Circle
do 1408 j=219,221
site(i,j)=128
1408 continue
```

```
1400 continue
c Fifth row
do 1410 i=137,137
c First Circle
do 1411 j=9,11
site(i,j)=128
1411  continue
c Second Circle
do 1412 j=39,41
site(i,j)=128
1412 continue
c Third Circle
do 1413 j=69,71
site(i,j)=128
1413 continue
c Fourth Circle
do 1414 j=99,101
site(i,j)=128
1414 continue
c Fifth Circle
do 1415 j=129,131
site(i,j)=128
1415 continue
c Sixth Circle
do 1416 j=159,161
site(i,j)=128
1416 continue
c Seventh Circle
do 1417 j=189,191
site(i,j)=128
1417 continue
c Eight Circle
```

```
do 1418 j=219,221
site(i,j)=128
1418 continue
1410 continue
c Sixth row
do 1420 i=167,167
c First Circle
do 1421 j=9,11
site(i,j)=128
1421  continue
c Second Circle
do 1422 j=39,41
site(i,j)=128
1422 continue
c Third Circle
do 1423 j=69,71
site(i,j)=128
1423 continue
c Fourth Circle
do 1424 j=99,101
site(i,j)=128
1424 continue
c Fifth Circle
do 1425 j=129,131
site(i,j)=128
1425 continue
c Sixth Circle
do 1426 j=159,161
site(i,j)=128
1426 continue
c Seventh Circle
do 1427 j=189,191
```

```
site(i,j)=128
1427 continue
c Eight Circle
do 1428 j=219,221
site(i,j)=128
1428 continue
1420 continue
c Seventh row
do 1430 i=197,197
c First Circle
do 1431 j=9,11
site(i,j)=128
1431  continue
c Second Circle
do 1432 j=39,41
site(i,j)=128
1432 continue
c Third Circle
do 1433 j=69,71
site(i,j)=128
1433 continue
c Fourth Circle
do 1434 j=99,101
site(i,j)=128
1434 continue
c Fifth Circle
do 1435 j=129,131
site(i,j)=128
1435 continue
c Sixth Circle
do 1436 j=159,161
site(i,j)=128
```

```
1436 continue
c Seventh Circle
do 1437 j=189,191
site(i,j)=128
1437 continue
c Eight Circle
do 1438 j=219,221
site(i,j)=128
1438 continue
1430 continue
c Eight row
do 2430 i=227,227
c First Circle
do 2431 j=9,11
site(i,j)=128
2431  continue
c Second Circle
do 2432 j=39,41
site(i,j)=128
2432 continue
c Third Circle
do 2433 j=69,71
site(i,j)=128
2433 continue
c Fourth Circle
do 2434 j=99,101
site(i,j)=128
2434 continue
c Fifth Circle
do 2435 j=129,131
site(i,j)=128
2435 continue
```

```
c Sixth Circle
do 2436 j=159,161
site(i,j)=128
2436 continue
c Seventh Circle
do 2437 j=189,191
site(i,j)=128
2437 continue
c Eight Circle
do 2438 j=219,221
site(i,j)=128
2438 continue
2430 continue
c ===============
c = Sisi Atas 1 =
c ===============
c First Row
do 1580 i=6,14
c First Circle
do 1581 j=4,4
site(i,j)=128
1581  continue
c Second Circle
do 1582 j=34,34
site(i,j)=128
1581 continue
c Third Circle
do 1583 j=64,64
site(i,j)=128
1583 continue
c Fourth Circle
do 1584 j=94,94
```

```
site(i,j)=128
1584 continue
c Fifth Circle
do 1585 j=124,124
site(i,j)=128
1585 continue
c Sixth Circle
do 1586 j=154,154
site(i,j)=128
1586 continue
c Seventh Circle
do 1587 j=184,184
site(i,j)=128
1587 continue
c Eight Circle
do 1588 j=214,214
site(i,j)=128
1588 continue
1580 continue
c Second Row
do 1590 i=36,44
c First Circle do 1591 j=4,4
site(i,j)=128
1591  continue
c Second Circle
do 1592 j=34,34
site(i,j)=128
1592 continue
c Third Circle
do 1593 j=64,64
site(i,j)=128
1593 continue
```

```
c Fourth Circle
do 1594 j=94,94
site(i,j)=128
1594 continue
c Fifth Circle
do 1595 j=124,124
site(i,j)=128
1595 continue
c Sixth Circle
do 1596 j=154,154
site(i,j)=128
1596 continue
c Seventh Circle
do 1597 j=184,184
site(i,j)=128
1597 continue
c Eight Circle
do 1598 j=214,214
site(i,j)=128
1598 continue
1590 continue
c Third Row
do 1600 i=66,74
c First Circle
do 1601 j=4,4
site(i,j)=128
1601  continue
c Second Circle
do 1602 j=34,34
site(i,j)=128
1602 continue
c Third Circle
```

```
do 1603 j=64,64
site(i,j)=128
1603 continue
c Fourth Circle
do 1604 j=94,94
site(i,j)=128
1604 continue
c Fifth Circle
do 1605 j=124,124
site(i,j)=128
1605 continue
c Sixth Circle
do 1606 j=154,154
site(i,j)=128
1606 continue
c Seventh Circle
do 1607 j=184,184
site(i,j)=128
1607 continue
c Eight Circle
do 1608 j=214,214
site(i,j)=128
1608 continue
1600 continue
c Fourth Row
do 1610 i=96,104
c First Circle
do 1611 j=4,4
site(i,j)=128
1611  continue
c Second Circle
do 1612 j=34,34
```

```
site(i,j)=128
1612 continue
c Third Circle
do 1613 j=64,64
site(i,j)=128
1613 continue
c Fourth Circle do 1614 j=94,94
site(i,j)=128
1614 continue
c Fifth Circle
do 1615 j=124,124
site(i,j)=128
1615 continue
c Sixth Circle
do 1616 j=154,154
site(i,j)=128
1616 continue
c Seventh Circle
do 1617 j=184,184
site(i,j)=128
1617 continue
c Eight Circle
do 1618 j=214,214
site(i,j)=128
1618 continue
1610 continue
c Fifth Row
do 1620 i=126,134
c First Circle
do 1621 j=4,4
site(i,j)=128
1621 continue
```

```
c Second Circle
do 1622 j=34,34
site(i,j)=128
1622 continue
c Third Circle
do 1623 j=64,64
site(i,j)=128
1623 continue
c Fourth Circle
do 1624 j=94,94
site(i,j)=128
1624 continue
c Fifth Circle
do 1625 j=124,124
site(i,j)=128
1625 continue
c Sixth Circle
do 1626 j=154,154
site(i,j)=128
1626 continue
c Seventh Circle
do 1627 j=184,184
site(i,j)=128
1627 continue
c Eight Circle
do 1628 j=214,214
site(i,j)=128
1628 continue
1620 continue
c Sixth Row
do 1630 i=156,164
c First Circle
```

```
do 1631 j=4,4
site(i,j)=128
1631  continue
c Second Circle
do 1632 j=34,34
site(i,j)=128
1632 continue
c Third Circle
do 1633 j=64,64
site(i,j)=128
1633 continue
c Fourth Circle
do 1634 j=94,94
site(i,j)=128
1634 continue
c Fifth Circle
do 1635 j=124,124
site(i,j)=128
1635 continue
c Sixth Circle
do 1636 j=154,154
site(i,j)=128
1636 continue
c Seventh Circle
do 1637 j=184,184
site(i,j)=128
1637 continue
c Eight Circle
do 1638 j=214,214
site(i,j)=128
1638 continue
1630 continue
```

```
c Seventh Row
do 1640 i=186,194
 c First Circle
do 1641 j=4,4
site(i,j)=128
1641  continue
c Second Circle
do 1642 j=34,34
site(i,j)=128
1642 continue
c Third Circle
do 1643 j=64,64
site(i,j)=128
1643 continue
c Fourth Circle
do 1644 j=94,94
site(i,j)=128
1644 continue
c Fifth Circle
do 1645 j=124,124
site(i,j)=128
1645 continue
c Sixth Circle
do 1646 j=154,154
site(i,j)=128
1646 continue
c Seventh Circle
do 1647 j=184,184
site(i,j)=128
1647 continue
c Eight Circle
do 1648 j=214,214
```

```
site(i,j)=128
1648 continue
1640 continue
c Eight Row
do 2640 i=216,224
c First Circle
do 2641 j=4,4
site(i,j)=128
2641  continue
c Second Circle
do 2642 j=34,34
site(i,j)=128
2642 continue
c Third Circle
do 2643 j=64,64
site(i,j)=128
2643 continue
c Fourth Circle
do 2644 j=94,94
site(i,j)=128
2644 continue
c Fifth Circle
do 2645 j=124,124
site(i,j)=128
2645 continue
c Sixth Circle
do 2646 j=154,154
site(i,j)=128
2646 continue
c Seventh Circle
do 2647 j=184,184
site(i,j)=128
```

```
2647 continue
c Eight Circle
do 2648 j=214,214
site(i,j)=128
2648 continue
2640 continue
c ================
c = Sisi Bawah 1 =
c ================
c First Row
do 1650 i=6,14
c First Circle
do 1651 j=16,16
site(i,j)=128
1651  continue
c Second Circle
do 1652 j=46,46
site(i,j)=128
1652 continue
c Third Circle
do 1653 j=76,76
site(i,j)=128
1653 continue
c Fourth Circle
do 1654 j=106,106
site(i,j)=128
1654 continue
c Fifth Circle
do 1655 j=136,136
site(i,j)=128
1655 continue
c Sixth Circle
```

```
do 1656 j=166,166
site(i,j)=128
1656 continue
c Seventh Circle
do 1657 j=196,196
site(i,j)=128
1657 continue
c Eight Circle

do 1658 j=226,226
site(i,j)=128
1658 continue
1650 continue
c Second Row
do 1660 i=36,44
c First Circle
do 1661 j=16,16
site(i,j)=128
1661  continue
c Second Circle
do 1662 j=46,46
site(i,j)=128
1662 continue
c Third Circle
do 1663 j=76,76
site(i,j)=128
1663 continue
c Fourth Circle
do 1664 j=106,106
site(i,j)=128
1664 continue
c Fifth Circle
```

```
do 1665 j=136,136
site(i,j)=128
1665 continue
c Sixth Circle
do 1666 j=166,166
site(i,j)=128
1666 continue
c Seventh Circle
do 1667 j=196,196
site(i,j)=128
1667 continue
c Eight Circle
do 1668 j=226,226
site(i,j)=128
1668 continue
1660 continue
c Third Row
do 1670 i=66,74
c First Circle
do 1671 j=16,16
site(i,j)=128
1671  continue
c Second Circle
do 1672 j=46,46
site(i,j)=128
1672 continue
c Third Circle
do 1673 j=76,76
site(i,j)=128
1673 continue
c Fourth Circle
do 1674 j=106,106
```

```
site(i,j)=128
1674 continue
c Fifth Circle
do 1675 j=136,136
site(i,j)=128
1675 continue
c Sixth Circle
do 1676 j=166,166
site(i,j)=128
1676 continue
c Seventh Circle
do 1677 j=196,196
site(i,j)=128
1677 continue
c Eight Circle
do 1678 j=226,226
site(i,j)=128
1678 continue
1670 continue
c Fourth Row
do 1680 i=96,104
c First Circle
do 1681 j=16,16
site(i,j)=128
1681  continue
c Second Circle
do 1682 j=46,46
site(i,j)=128
1682 continue
c Third Circle
do 1683 j=76,76
site(i,j)=128
```

```
1683 continue
c Fourth Circle
do 1684 j=106,106
site(i,j)=128
1684 continue
c Fifth Circle
do 1685 j=136,136
site(i,j)=128
1685 continue
c Sixth Circle
do 1686 j=166,166
site(i,j)=128
1686 continue
c Seventh Circle
do 1687 j=196,196
site(i,j)=128
1687 continue
c Eight Circle
do 1688 j=226,226
site(i,j)=128
1688 continue
1680 continue
c Fifth Row
do 1690 i=126,134
c First Circle
do 1691 j=16,16
site(i,j)=128
1691  continue
c Second Circle
do 1692 j=46,46
site(i,j)=128
1692 continue
```

```
c Third Circle
do 1693 j=76,76
site(i,j)=128
1693 continue
c Fourth Circle
do 1694 j=106,106
site(i,j)=128
1694 continue
c Fifth Circle
do 1695 j=136,136
site(i,j)=128
1695 continue
c Sixth Circle
do 1696 j=166,166
site(i,j)=128
1696 continue
c Seventh Circle
do 1697 j=196,196
site(i,j)=128
1697 continue
c Eight Circle
do 1698 j=226,226
site(i,j)=128
1698 continue
1690 continue
c Sixth Row
do 1700 i=156,164
c First Circle
do 1701 j=16,16
site(i,j)=128
1701  continue
c Second Circle
```

```
do 1702 j=46,46
site(i,j)=128
1702 continue
c Third Circle
do 1703 j=76,76
site(i,j)=128
1703 continue
c Fourth Circle
do 1704 j=106,106
site(i,j)=128
1704 continue
c Fifth Circle
do 1705 j=136,136
site(i,j)=128
1705 continue
c Sixth Circle
do 1706 j=166,166
site(i,j)=128
1706 continue
c Seventh Circle
do 1707 j=196,196
site(i,j)=128
1707 continue
c Eight Circle
do 1708 j=226,226
site(i,j)=128
1708 continue
1700 continue
c Seventh Row
do 1710 i=186,194
c First Circle
do 1711 j=16,16
```

```
site(i,j)=128
1711  continue
c Second Circle
do 1712 j=46,46
site(i,j)=128
1712 continue
c Third Circle
do 1713 j=76,76
site(i,j)=128
1713 continue
c Fourth Circle
do 1714 j=106,106
site(i,j)=128
1714 continue
c Fifth Circle
do 1715 j=136,136
site(i,j)=128
1715 continue
c Sixth Circle
do 1716 j=166,166
site(i,j)=128
1716 continue
c Seventh Circle
do 1717 j=196,196
site(i,j)=128
1717 continue
c Eight Circle
do 1718 j=226,226
site(i,j)=128
1718 continue
1710 continue
c Eight Row
```

```
do 2710 i=216,224
c First Circle
do 2711 j=16,16
site(i,j)=128
2711  continue
c Second Circle
do 2712 j=46,46
site(i,j)=128
2712 continue
c Third Circle
do 2713 j=76,76
site(i,j)=128
2713 continue
c Fourth Circle
do 2714 j=106,106
site(i,j)=128
2714 continue
c Fifth Circle
do 2715 j=136,136
site(i,j)=128
2715 continue
c Sixth Circle
do 2716 j=166,166
site(i,j)=128
2716 continue
c Seventh Circle
do 2717 j=196,196
site(i,j)=128
2717 continue
c Eight Circle
do 2718 j=226,226
site(i,j)=128
```

```
2718 continue
2710 continue
c ===============
c = Sisi Atas 2 =
c ===============
c First Row
do 1720 i=7,13
c First Circle
do 1721 j=3,3
site(i,j)=128
1721  continue
c Second Circle
do 1722 j=33,33
site(i,j)=128
1722 continue
c Third Circle
do 1723 j=63,63
site(i,j)=128
1723 continue
c Fourth Circle
do 1724 j=93,93
site(i,j)=128
1724 continue
c Fifth Circle
do 1725 j=123,123
site(i,j)=128
1725 continue
c Sixth Circle
do 1726 j=153,153
site(i,j)=128
1726 continue
c Seventh Circle
```

```
do 1727 j=183,183
site(i,j)=128
1727 continue
c Eight Circle
do 1728 j=213,213
site(i,j)=128
1728 continue
1720 continue
c Second Row
do 1730 i=37,43
c First Circle do 1731 j=3,3
site(i,j)=128
1731  continue
c Second Circle
do 1732 j=33,33
site(i,j)=128
1732 continue
c Third Circle
do 1733 j=63,63
site(i,j)=128
1733 continue
c Fourth Circle
do 1734 j=93,93
site(i,j)=128
1734 continue
c Fifth Circle
do 1735 j=123,123
site(i,j)=128
1735 continue
c Sixth Circle
do 1736 j=153,153
site(i,j)=128
```

```
1736 continue
c Seventh Circle
do 1737 j=183,183
site(i,j)=128
1737 continue
c Eight Circle
do 1738 j=213,213
site(i,j)=128
1738 continue
1730 continue
c Third Row
do 1740 i=67,73
c First Circle do 1741 j=3,3
site(i,j)=128
1741  continue
c Second Circle
do 1742 j=33,33
site(i,j)=128
1742 continue
c Third Circle
do 1743 j=63,63
site(i,j)=128
1743 continue
c Fourth Circle do 1744 j=93,93
site(i,j)=128
1744 continue
c Fifth Circle
do 1745 j=123,123
site(i,j)=128
1745 continue
c Sixth Circle
do 1746 j=153,153
```

```
site(i,j)=128
1746 continue
c Seventh Circle
do 1747 j=183,183
site(i,j)=128
1747 continue
c Eight Circle
do 1748 j=213,213
site(i,j)=128
1748 continue
1740 continue
 c Fourth Row
do 1750 i=97,103
c First Circle do 1751 j=3,3
site(i,j)=128
1751  continue
c Second Circle
do 1752 j=33,33
site(i,j)=128
1752 continue
c Third Circle
do 1753 j=63,63
site(i,j)=128
1753 continue
c Fourth Circle
do 1754 j=93,93
site(i,j)=128
1754 continue
c Fifth Circle
do 1755 j=123,123
site(i,j)=128
1755 continue
```

```
c Sixth Circle
do 1756 j=153,153
site(i,j)=128
1756 continue
c Seventh Circle
do 1757 j=183,183
site(i,j)=128
1757 continue
c Eight Circle
do 1758 j=213,213
site(i,j)=128
1758 continue
1750 continue
c Fifth Row
do 1760 i=127,133
c First Circle do 1761 j=3,3
site(i,j)=128
1761  continue
c Second Circle
do 1762 j=33,33
site(i,j)=128
1762 continue
c Third Circle
do 1763 j=63,63
site(i,j)=128
1763 continue
c Fourth Circle
do 1764 j=93,93
site(i,j)=128
1764 continue
c Fifth Circle
do 1765 j=123,123
```

```
site(i,j)=128
1765 continue
c Sixth Circle
do 1766 j=153,153
site(i,j)=128
1766 continue
c Seventh Circle
do 1767 j=183,183
site(i,j)=128
1767 continue
c Eight Circle
do 1768 j=213,213
site(i,j)=128
1768 continue
1760 continue
c Sixth Row
do 1770 i=157,163
c First Circle do 1771 j=3,3
site(i,j)=128
1771  continue
c Second Circle
do 1772 j=33,33
site(i,j)=128
1772 continue
c Third Circle
do 1773 j=63,63
site(i,j)=128
1773 continue
c Fourth Circle
do 1774 j=93,93
site(i,j)=128
1774 continue
```

```
c Fifth Circle
do 1775 j=123,123
site(i,j)=128
1775 continue
c Sixth Circle
do 1776 j=153,153
site(i,j)=128
1776 continue
c Seventh Circle
do 1777 j=183,183
site(i,j)=128
1777 continue
c Eight Circle
do 1778 j=213,213
site(i,j)=128
1778 continue
1770 continue
c Seventh Row
do 1780 i=187,193
c First Circle
do 1781 j=3,3
site(i,j)=128
1781  continue
c Second Circle
do 1782 j=33,33
site(i,j)=128
1782 continue
c Third Circle
do 1783 j=63,63
site(i,j)=128
1783 continue
c Fourth Circle
```

```
do 1784 j=93,93
site(i,j)=128
1784 continue
c Fifth Circle
do 1785 j=123,123
site(i,j)=128
1785 continue
c Sixth Circle
do 1786 j=153,153
site(i,j)=128
1786 continue
c Seventh Circle
do 1787 j=183,183
site(i,j)=128
1787 continue
c Eight Circle
do 1788 j=213,213
site(i,j)=128
1788 continue
1780 continue
c Eight Row
do 2780 i=217,223
c First Circle
do 2781 j=3,3
site(i,j)=128
2781  continue
c Second Circle
do 2782 j=33,33
site(i,j)=128
2782 continue
c Third Circle
do 2783 j=63,63
```

```
site(i,j)=128
2783 continue
c Fourth Circle
do 2784 j=93,93
site(i,j)=128
2784 continue
c Fifth Circle
do 2785 j=123,123
site(i,j)=128
2785 continue
c Sixth Circle
do 2786 j=153,153
site(i,j)=128
2786 continue
c Seventh Circle
do 2787 j=183,183
site(i,j)=128
2787 continue
c Eight Circle
do 2788 j=213,213
site(i,j)=128
2788 continue
2780 continue
c ================
c = Sisi Bawah 2 =
c ================
c First Row
do 1790 i=7,13
c First Circle
do 1791 j=17,17
site(i,j)=128
1791 continue
```

```
c Second Circle
do 1792 j=47,47
site(i,j)=128
1792 continue
c Third Circle
do 1793 j=77,77
site(i,j)=128
1793 continue
c Fourth Circle
do 1794 j=107,107
site(i,j)=128
1794 continue
c Fifth Circle
do 1795 j=137,137
site(i,j)=128
1795 continue
c Sixth Circle
do 1796 j=167,167
site(i,j)=128
1796 continue
c Seventh Circle
do 1797 j=197,197
site(i,j)=128
1797 continue
c Eight Circle
do 1798 j=227,227
site(i,j)=128
1798 continue
1790 continue
c Second Row
do 1800 i=37,43
c First Circle
```

```
do 1801 j=17,17
site(i,j)=128
1801  continue
c Second Circle
do 1802 j=47,47
site(i,j)=128
1802 continue
c Third Circle
do 1803 j=77,77
site(i,j)=128
1803 continue
c Fourth Circle
do 1804 j=107,107
site(i,j)=128
1804 continue
c Fifth Circle
do 1805 j=137,137
site(i,j)=128
1805 continue
c Sixth Circle
do 1806 j=167,167
site(i,j)=128
1806 continue
c Seventh Circle
do 1807 j=197,197
site(i,j)=128
1807 continue
c Eight Circle
do 1808 j=227,227
site(i,j)=128
1808 continue
1800 continue
```

```
c Third Row
do 1810 i=67,73
c First Circle
do 1811 j=17,17
site(i,j)=128
1811  continue
c Second Circle
do 1812 j=47,47
site(i,j)=128
1812 continue
c Third Circle
do 1813 j=77,77
site(i,j)=128
1813 continue
c Fourth Circle
do 1814 j=107,107
site(i,j)=128
1814 continue
c Fifth Circle
do 1815 j=137,137
site(i,j)=128
1815 continue
c Sixth Circle
do 1816 j=167,167
site(i,j)=128
1816 continue
c Seventh Circle
do 1817 j=197,197
site(i,j)=128
1817 continue
c Eight Circle
do 1818 j=227,227
```

```
site(i,j)=128
1818 continue
1810 continue
c Fourth Row
do 1820 i=97,103
c First Circle
do 1821 j=17,17
site(i,j)=128
1821  continue
c Second Circle
do 1822 j=47,47
site(i,j)=128
1822 continue
c Third Circle
do 1823 j=77,77
site(i,j)=128
1823 continue
c Fourth Circle
do 1824 j=107,107
site(i,j)=128
1824 continue
c Fifth Circle
do 1825 j=137,137
site(i,j)=128
1825 continue
c Sixth Circle
do 1826 j=167,167
site(i,j)=128
1826 continue
c Seventh Circle
do 1827 j=197,197
site(i,j)=128
```

```
1827 continue
c Eight Circle
do 1828 j=227,227
site(i,j)=128
1828 continue
1820 continue
c Fifth Row
do 1830 i=127,133
c First Circle
do 1831 j=17,17
site(i,j)=128
1831  continue
c Second Circle
do 1832 j=47,47
site(i,j)=128
1832 continue
c Third Circle
do 1833 j=77,77
site(i,j)=128
1833 continue
c Fourth Circle
do 1834 j=107,107
site(i,j)=128
1834 continue
c Fifth Circle
do 1835 j=137,137
site(i,j)=128
1835 continue
c Sixth Circle
do 1836 j=167,167
site(i,j)=128
1836 continue
```

```
c Seventh Circle
do 1837 j=197,197
site(i,j)=128
1837 continue
c Eight Circle
do 1838 j=227,227
site(i,j)=128
1838 continue
1830 continue
c Sixth Row
do 1840 i=157,163
c First Circle
do 1841 j=17,17
site(i,j)=128
1841  continue
c Second Circle
do 1842 j=47,47
site(i,j)=128
1842 continue
c Third Circle
do 1843 j=77,77
site(i,j)=128
1843 continue
c Fourth Circle
do 1844 j=107,107
site(i,j)=128
1844 continue
c Fifth Circle
do 1845 j=137,137
site(i,j)=128
1845 continue
c Sixth Circle
```

```
do 1846 j=167,167
site(i,j)=128
1846 continue
c Seventh Circle
do 1847 j=197,197
site(i,j)=128
1847 continue
c Eight Circle
do 1848 j=227,227
site(i,j)=128
1848 continue
1840 continue
c Seventh Row
do 1850 i=187,193
c First Circle
do 1851 j=17,17
site(i,j)=128
1851  continue
c Second Circle
do 1852 j=47,47
site(i,j)=128
1852 continue
c Third Circle
do 1853 j=77,77
site(i,j)=128
1853 continue
c Fourth Circle
do 1854 j=107,107
site(i,j)=128
1854 continue
c Fifth Circle
do 1855 j=137,137
```

```
site(i,j)=128
1855 continue
c Sixth Circle
do 1856 j=167,167
site(i,j)=128
1856 continue
c Seventh Circle
do 1857 j=197,197
site(i,j)=128
1857 continue
c Eight Circle
do 1858 j=227,227
site(i,j)=128
1858 continue
1850 continue
c Eight Row
do 2850 i=217,223
c First Circle
do 2851 j=17,17
site(i,j)=128
2851  continue
c Second Circle
do 2852 j=47,47
site(i,j)=128
2852 continue
c Third Circle
do 2853 j=77,77
site(i,j)=128
2853 continue
c Fourth Circle
do 2854 j=107,107
site(i,j)=128
```

```
2854 continue
c Fifth Circle
do 2855 j=137,137
site(i,j)=128
2855 continue
c Sixth Circle
do 2856 j=167,167
site(i,j)=128
2856 continue
c Seventh Circle
do 2857 j=197,197
site(i,j)=128
2857 continue
c Eight Circle
do 2858 j=227,227
site(i,j)=128
2858 continue
2850 continue
c ================
c = Sisi Atas 3 =
c ================
c First Row
do 1860 i=8,12
c First Circle
do 1861 j=2,2
site(i,j)=128
1861  continue
c Second Circle
do 1862 j=32,32
site(i,j)=128
1862 continue
c Third Circle
```

```
do 1863 j=62,62
site(i,j)=128
1863 continue
c Fourth Circle
do 1864 j=92,92
site(i,j)=128
1864 continue
c Fifth Circle
do 1865 j=122,122
site(i,j)=128
1865 continue
c Sixth Circle
do 1866 j=152,152
site(i,j)=128
1866 continue
c Seventh Circle
do 1867 j=182,182
site(i,j)=128
1867 continue
c Eight Circle
do 1868 j=212,212
site(i,j)=128
1868 continue
1860 continue
c Second Row
do 1870 i=38,42
c First Circle
do 1871 j=2,2
site(i,j)=128
1871  continue
c Second Circle
do 1872 j=32,32
```

```
site(i,j)=128
1872 continue
c Third Circle
do 1873 j=62,62
site(i,j)=128
1873 continue
c Fourth Circle
do 1874 j=92,92
site(i,j)=128
1874 continue
c Fifth Circle
do 1875 j=122,122
site(i,j)=128
1875 continue
c Sixth Circle
do 1876 j=152,152
site(i,j)=128
1876 continue
c Seventh Circle
do 1877 j=182,182
site(i,j)=128
1877 continue
c Eight Circle
do 1878 j=212,212
site(i,j)=128
1878 continue
1870 continue
c Third Row
do 1880 i=68,72
c First Circle
do 1881 j=2,2
site(i,j)=128
```

```
1881  continue
c Second Circle
do 1882 j=32,32
site(i,j)=128
1882 continue
c Third Circle
do 1883 j=62,62
site(i,j)=128
1883 continue
c Fourth Circle
do 1884 j=92,92
site(i,j)=128
1884 continue
c Fifth Circle
do 1885 j=122,122
site(i,j)=128
1885 continue
c Sixth Circle
do 1886 j=152,152
site(i,j)=128
1886 continue
c Seventh Circle
do 1887 j=182,182
site(i,j)=128
1887 continue
c Eight Circle
do 1888 j=212,212
site(i,j)=128
1888 continue
1880 continue
c Fourth Row
do 1890 i=98,102
```

```
c First Circle
do 1891 j=2,2
site(i,j)=128
1891  continue
c Second Circle
do 1892 j=32,32
site(i,j)=128
1892 continue
c Third Circle
do 1893 j=62,62
site(i,j)=128
1893 continue
c Fourth Circle
do 1894 j=92,92
site(i,j)=128
1894 continue
c Fifth Circle
do 1895 j=122,122
site(i,j)=128
1895 continue
c Sixth Circle
do 1896 j=152,152
site(i,j)=128
1896 continue
c Seventh Circle
do 1897 j=182,182
site(i,j)=128
1897 continue
c Eight Circle
do 1898 j=212,212
site(i,j)=128
1898 continue
```

```
1890 continue
c Fifth Row
do 1900 i=128,132
c First Circle do 1901 j=2,2
site(i,j)=128
1901  continue
c Second Circle
do 1902 j=32,32
site(i,j)=128
1902 continue
c Third Circle
do 1903 j=62,62
site(i,j)=128
1903 continue
c Fourth Circle
do 1904 j=92,92
site(i,j)=128
1904 continue
c Fifth Circle
do 1905 j=122,122
site(i,j)=128
1905 continue
c Sixth Circle
do 1906 j=152,152
site(i,j)=128
1906 continue
c Seventh Circle
do 1907 j=182,182
site(i,j)=128
1907 continue
c Eight Circle
do 1908 j=212,212
```

```
site(i,j)=128
1908 continue
1900 continue
c Sixth Row
do 1910 i=158,162
c First Circle
do 1911 j=2,2
site(i,j)=128
1911  continue
c Second Circle
do 1912 j=32,32
site(i,j)=128
1912 continue
c Third Circle
do 1913 j=62,62
site(i,j)=128
1913 continue
c Fourth Circle
do 1914 j=92,92
site(i,j)=128
1914 continue
c Fifth Circle
do 1915 j=122,122
site(i,j)=128
1915 continue
c Sixth Circle
do 1916 j=152,152
site(i,j)=128
1916 continue
c Seventh Circle
do 1917 j=182,182
site(i,j)=128
```

```
1917 continue
c Eight Circle
do 1918 j=212,212
site(i,j)=128
1918 continue
1910 continue
c Seventh Row
do 1920 i=188,192
c First Circle
do 1921 j=2,2
site(i,j)=128
1921  continue
c Second Circle
do 1922 j=32,32
site(i,j)=128
1922 continue
c Third Circle
do 1923 j=62,62
site(i,j)=128
1923 continue
c Fourth Circle
do 1924 j=92,92
site(i,j)=128
1924 continue
c Fifth Circle
do 1925 j=122,122
site(i,j)=128
1925 continue
c Sixth Circle
do 1926 j=152,152
site(i,j)=128
1926 continue
```

```
c Seventh Circle
do 1927 j=182,182
site(i,j)=128
1927 continue
c Eight Circle
do 1928 j=212,212
site(i,j)=128
1928 continue
1920 continue
c Eight Row
do 2920 i=218,222
c First Circle
do 2921 j=2,2
site(i,j)=128
2921  continue
c Second Circle
do 2922 j=32,32
site(i,j)=128
2922 continue
c Third Circle
do 2923 j=62,62
site(i,j)=128
2923 continue
c Fourth Circle
do 2924 j=92,92
site(i,j)=128
2924 continue
c Fifth Circle
do 2925 j=122,122
site(i,j)=128
2925 continue
c Sixth Circle
```

```
do 2926 j=152,152
site(i,j)=128
2926 continue
c Seventh Circle
do 2927 j=182,182
site(i,j)=128
2927 continue
c Eight Circle
do 2928 j=212,212
site(i,j)=128
2928 continue
2920 continue
c ================
c = Sisi Bawah 3 =
c ================
c First Row
do 1930 i=9,11
c First Circle
do 1931 j=18,18
site(i,j)=128
1931  continue
c Second Circle
do 1932 j=48,48
site(i,j)=128
1932 continue
c Third Circle
do 1933 j=78,78
site(i,j)=128
1933 continue
c Fourth Circle
do 1934 j=108,108
site(i,j)=128
```

```
1934 continue
c Fifth Circle
do 1935 j=138,138
site(i,j)=128
1935 continue
c Sixth Circle
do 1936 j=168,168
site(i,j)=128
1936 continue
c Seventh Circle
do 1937 j=198,198
site(i,j)=128
1937 continue
c Eight Circle
do 1938 j=228,228
site(i,j)=128
1938 continue
1930 continue
c First Row
do 1940 i=39,41
c First Circle
do 1941 j=18,18
site(i,j)=128
1941  continue
c Second Circle
do 1942 j=48,48
site(i,j)=128
1942 continue
c Third Circle
do 1943 j=78,78
site(i,j)=128
1943 continue
```

```
c Fourth Circle
do 1944 j=108,108
site(i,j)=128
1944 continue
c Fifth Circle
do 1945 j=138,138
site(i,j)=128
1945 continue
c Sixth Circle
do 1946 j=168,168
site(i,j)=128
1946 continue
1940 continue
c
c - setting the boundary - c
do 20 i=1,xdir
site(i,1)=256
site(i,ydir)=256
20 continue
do 21 j=1,ydir
site(1,j)=256
site(xdir,j)=256
21 continue
c
c          - Define neighbor sites –
c
do 25 I=1,xdir
do 25 J=2,ydir-1
nbs1(I,J)=site(I+1,J-1)
nbs2(I,J)=site(I-1,J-1)
nbs3(I,J)=site(I-1,J)
nbs4(I,J)=site(I-1,J+1)
```

```
nbs5(I,J)=site(I+1,J+1)
nbs6(I,J)=site(I+1,J)
25 continue
c
c  - Contact surface - c
cs=0
do 30 I=1,xdir
do 30 J=1,ydir
if(site(I,J).ne.128) goto 30
if((nbs1(I,J).LT.128).OR.(nbs2(I,J).LT.128).OR.(nbs3(I,J).LT.128)
+.OR.(nbs4(I,J).LT.128).OR.(nbs5(I,J).LT.128).OR.
+(nbs6(I,J).LT.128)) cs = cs + 1
30 continue
c
c - setting the open sites –
c
void = 0
kosong = 0
do 50 I=1,xdir
do 40 J=1,ydir
if(site(I,J).ne.128)void=void+1
40 continue
kosong = kosong + void void = 0
50 continue
c
c - calculating porosity –
c
total = xdir*ydir porosity = kosong/total
c
c - Distributing oil particles for given density and calculating oil mass –
c
do 70 I=1,xdir
```

```
do 70 J=1,ydir
if(site(I,J).eq.128) goto 7171
z=mod(a*z,m)
zr=z/zm  g=nint(zr*4.)
if(g.eq.0)site(1,J)=tyoo
if(g.eq.1)site(1,J)=tyop
if(g.eq.2)site(1,J)=tyoq
if(g.eq.3)site(1,J)=tyor
7171 ssss=0
70 continue
c
c - Calculating oil mass –
c
masstot=0
do 80 I=1,xdir
do 80 J=1,ydir
if ((site(I,J).eq.128).or.(site(I,J).eq.192)) goto 80
if (site(I,J).eq.256) goto 80
if(mod(site(I,J),2).eq.1)masstot=masstot+1
if(mod((site(I,J)/2),2).eq.1)masstot=masstot+1 if(mod((site(I,J)/4),2).eq.1)
masstot=masstot+1 if(mod((site(I,J)/8),2).eq.1)masstot=masstot+1 if(-
mod((site(I,J)/16),2).eq.1)masstot=masstot+1 if(mod((site(I,J)/32),2).eq.1)
masstot=masstot+1
if(site(I,J).ge.64)masstot=masstot+1
80 continue  denc=masstot/kosong
c
c          - Calculating intial oil and polymer saturation - c
print *,"Porosity(fraction)=",porosity
write (5,*)"Porosity(fraction)=",porosity
print *,"Surface length(cm)=",cs/100
write (5,*)"Surface length(cm)=",cs/100
print *,"T(sec),Number of Adsorbed-Particles"
write (5,*)"T(sec),Number of Adsorbed-Particles"
```

```
c
c - Main program –
c
do 90 t=1,ts
c
c - Input the particles along the left boundary - c
do 95 j=1,ydir
z=mod(a*z,m)
zr=z/zm g=nint(zr*4.)
c Second run
if(g.eq.0)site(0,J)=2
if(g.eq.1)site(0,J)=1
if(g.eq.2)site(0,J)=2
if(g.eq.3)site(0,J)=4
95 continue
c
c - Closing the boundaries -
do 22 i=1,xdir
site(i,1)=256
site(i,ydir)=256
22 continue
do 23 j=1,ydir
site(1,j)=256
site(xdir,j)=256
23 continue
c
c          - Periodic boundary –
c
do 110 J=1,ydir
if(mod((site(0,J)/32),2).eq.1)site(xdir,ydir+1-J)=32
if(mod((site(0,J)/16),2).eq.1)site(xdir,ydir+1-J)=16
if(mod((site(0,J)/8),2).eq.1)site(xdir,ydir+1-J)=8 if((mod((site(0,J)/32),2).
```

```
eq.1).and.(mod((site(0,J)/16),2).eq.1
+))site(xdir,ydir+1-J)=48 if((mod((site(0,J)/32),2).eq.1).and.
(mod((site(0,J)/8),2).eq.1)
+)site(xdir,ydir+1-J)=40 if((mod((site(0,J)/16),2).eq.1).and.
(mod((site(0,J)/8),2).eq.1)
+)site(xdir,ydir+1-J)=24 if((mod((site(0,J)/32),2).eq.1).and.
(mod((site(0,J)/16),2).eq.1
+).and.(mod((site(xdir,J)/8),2).eq.1))site(xdir,ydir+1-J)=56
c
if(mod(site(xdir,J),2).eq.1)site(0,ydir+1-J)=1
if(mod((site(xdir,J)/2),2).eq.1)site(0,ydir+1-J)=2
if(mod((site(xdir,J)/4),2).eq.1)site(0,ydir+1-J)=4 if((mod(site(xdir,J),2).
eq.1).and.(mod((site(xdir,J)/2),2).eq.1))
+site(0,ydir+1-J)=3
if((mod(site(xdir,J),2).eq.1).and.(mod((site(xdir,J)/4),2).eq.1))
+site(0,ydir+1-J)=5
if((mod((site(xdir,J)/2),2).eq.1).and.(mod((site(xdir,J)/4),2)
+.eq.1)) site(0,ydir+1-J)=6
if((mod(site(xdir,J),2).eq.1).and.(mod((site(xdir,J)/2),2).eq.1)
+.and.(mod((site(xdir,J)/4),2).eq.1))site(0,ydir+1-J)=7
110 continue
c
c - Define neighbor sites –
c
do 120 I=1,xdir
do 120 J=2,ydir-1
nbs1(I,J)=site(I+1,J-1)
nbs2(I,J)=site(I-1,J-1)
nbs3(I,J)=site(I-1,J)
nbs4(I,J)=site(I-1,J+1)
nbs5(I,J)=site(I+1,J+1)
nbs6(I,J)=site(I+1,J)
120 continue
```

```
c
c - Translation procedure -
c Reset newsite(I,J)
do 150 I = 1,xdir
do 150 J = 1,ydir
newsite(I,J)=0
150 continue
c
c - Define added particles from neighbor sites after particle collisions –
c
do 130 K=1,128
c Reset added particle from neighbor sites
aps(K,1)=0
aps(K,2)=0
aps(K,3)=0
aps(K,4)=0
aps(K,5)=0
aps(K,6)=0
c Reset mass and momentum at neighbor sites
mass(K)=0
momx(K)=0 momy(K)=0
130 continue
do 140 K=0,128
c Added particles to site(I,J) from the first nighbor site
if(mod((K/8),2).eq.1)aps(K,1)=8
c Added particles to site(I,J) from the second nighbor site
if(mod((K/4),2).eq.1)aps(K,2)=4
c Added particles to site(I,J) from the third nighbor site
if(mod((K/2),2).eq.1)aps(K,3)=2
c Added particles to site(I,J) from the fourth nighbor site
if(mod(K,2).eq.1)aps(K,4)=1
c Added particles to site(I,J) from the fifth nighbor site
```

```
if(mod((K/32),2).eq.1)aps(K,5)=32
c Added particles to site(I,J) from the sixth nighbor site
if(mod((K/16),2).eq.1)aps(K,6)=16
c Define mass and momentum of particle moving toward the first nighbor site
if(mod(K,2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)+0.5
momy(K)=momy(K)+((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the second nighbor site
if(mod((K/32),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-0.5
momy(K)=momy(K)+((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the third nighbor site
if(mod((K/16),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-1
momy(K)=0
endif
c Define mass and momentum of particle moving toward the fourth nighbor site
if(mod((K/8),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-0.5
momy(K)=momy(K)-((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the fifth nighbor site
```

```
if(mod((K/4),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)+0.5
momy(K)=momy(K)-((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the sixth nighbor
site
if(mod((K/2),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)+1
momy(K)=0
endif
if(K.ge.64) mass(K)=mass(K)+1
140 continue
c
c - Polymer adsorption process - c
dddd = 0.000092592592593 * xn
do 410 I=1,xdir
do 410 J=1,ydir
z=mod(a*z,m)
zr=z/zm
gg=nint(zr/dddd)
aa=0
if(Tol.gt.1) goto 143
c Monolayer (Langmuir) Type c To the first nighbor site
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/32),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/4),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+0.866
c To the second nighbor site
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if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/16),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/2),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+0.866
c To the third nighbor site
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/8),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-1
if((mod(site(I,J),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+0.866
c To the fourth nighbor site
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/4),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/32),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+0.866
c To the fifth nighbor site
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/2),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+0.866
if((mod(site(I,J),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/16),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+0.866
c To the sixth nighbor site
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+1
if((mod(site(I,J),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-1
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if((mod((site(I,J)/8),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+0.866
goto 147
143 zzzzz=0
c Multilayer Type
c To the first nighbor site
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/32),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/4),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs1(I,J).eq.128))aa=aa+0.866
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/32),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/4),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs1(I,J).eq.192))aa=aa+0.866
c To the second nighbor site
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/16),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/2),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs2(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/16),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/2),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs2(I,J).eq.192))aa=aa+0.866
c To the third nighbor site
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if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/8),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-1
if((mod(site(I,J),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs3(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/8),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa-1
if((mod(site(I,J),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs3(I,J).eq.192))aa=aa+0.866
c To the fourth nighbor site
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/4),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/32),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs4(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/4),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa-0.866
if((mod(site(I,J),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/32),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs4(I,J).eq.192))aa=aa+0.866
c To the fifth nighbor site
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+1
if((mod((site(I,J)/2),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+0.866
if((mod(site(I,J),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/16),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs5(I,J).eq.128))aa=aa+0.866
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if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa+1
if((mod((site(I,J)/2),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa+0.866
if((mod(site(I,J),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/16),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs5(I,J).eq.192))aa=aa+0.866
c To the sixth nighbor site
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+1
if((mod(site(I,J),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-1
if((mod((site(I,J)/8),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs6(I,J).eq.128))aa=aa+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa+1
if((mod(site(I,J),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa-1
if((mod((site(I,J)/8),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs6(I,J).eq.192))aa=aa+0.866 147
zzzzz=0
if((site(I,J).eq.128).or.(site(I,J).eq.0).or.(site(I,J).eq.64)
+.or.(site(I,J).eq.192)) goto 410
if((gg.gt.0).or.(aa.le.0)) goto 410
if((aa.gt.0).and.(gg.eq.0)) bb = mass(site(I,J))
if((aa.gt.0).and.(gg.eq.0)) site(I,J) = 192 cc = cc + bb
newsite(I,J)=192 site(I,J)=192
410 continue
c
c - Translation procedure –
c
c Translation scheme
do 160 I=1,xdir
```

```
do 160 J=1,ydir
c Collision rule between fluid and solid particle if((site(I,j).eq.0).or.(site(I,j).
eq.64).or.(site(i,j).eq.128)
+.or.(site(i,j).eq.192).or.(site(i,j).eq.256))goto  160
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.128))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.128))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.128))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.128))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.128))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.128))nbs6(I,J)=16
c Collision rule between fluid and adsorbed polymer particle
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.192))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.192))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.192))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.192))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.192))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.192))nbs6(I,J)=16
c Collision rule between fluid and gelled polymer particle
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.256))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.256))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.256))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.256))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.256))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.256))nbs6(I,J)=16
160 continue
c
c - New configuration of particles in site(I,J) –
c
do 165 i=1,xdir
do  165  j=1,ydir
if(site(i,j).ge.64)
newsite(i,j)=64
```

```
newsite(I,J)=newsite(I,J)+aps(nbs1(I,J),1)
newsite(I,J)=newsite(I,J)+aps(nbs2(I,J),2)
newsite(I,J)=newsite(I,J)+aps(nbs3(I,J),3)
newsite(I,J)=newsite(I,J)+aps(nbs4(I,J),4)
newsite(I,J)=newsite(I,J)+aps(nbs5(I,J),5)
newsite(I,J)=newsite(I,J)+aps(nbs6(I,J),6)
if(site(I,J).eq.128)newsite(I,J)=128
if(site(I,J).eq.192)newsite(I,J)=192
if(site(I,J).eq.256)newsite(I,J)=256
165 continue
do 167 i=1,xdir
do 167 j=1,ydir
nbs1(I,J)=0
nbs2(I,J)=0
nbs3(I,J)=0
nbs4(I,J)=0
nbs5(I,J)=0
nbs6(I,J)=0
167 continue
c
c - Updating site(I,J) –
c
do 170 I=1,xdir
do 170 J=1,ydir
site(I,J)=newsite(I,J)
if(newsite(I,J).eq.128)site(I,J)=128
if(newsite(I,J).eq.192)site(I,J)=192
if(newsite(I,J).eq.256)site(I,J)=256
170 continue
c
c - Rotation rule –
c
```

```
do 180 I=1,xdir
do 180 J=1,ydir
if(site(I,J).eq.0)newsite(I,J)=0
if(site(I,J).eq.1)newsite(I,J)=1
if(site(I,J).eq.2)newsite(I,J)=2
if(site(I,J).eq.3)newsite(I,J)=3
if(site(I,J).eq.4)newsite(I,J)=4
if(site(I,J).eq.6)newsite(I,J)=6
if(site(I,J).eq.7)newsite(I,J)=7
if(site(I,J).eq.8)newsite(I,J)=8
if(site(I,J).eq.12)newsite(I,J)=12
if(site(I,J).eq.14)newsite(I,J)=14
if(site(I,J).eq.15)newsite(I,J)=15
if(site(I,J).eq.16)newsite(I,J)=16
if(site(I,J).eq.24)newsite(I,J)=24
if(site(I,J).eq.28)newsite(I,J)=28
if(site(I,J).eq.30)newsite(I,J)=30
if(site(I,J).eq.32)newsite(I,J)=32
if(site(I,J).eq.33)newsite(I,J)=33
if(site(I,J).eq.35)newsite(I,J)=35
if(site(I,J).eq.39)newsite(I,J)=39
if(site(I,J).eq.48)newsite(I,J)=48
if(site(I,J).eq.49)newsite(I,J)=49
if(site(I,J).eq.51)newsite(I,J)=51
if(site(I,J).eq.56)newsite(I,J)=56
if(site(I,J).eq.57)newsite(I,J)=57
if(site(I,J).eq.60)newsite(I,J)=60
if(site(I,J).eq.63)newsite(I,J)=63
if(site(I,J).eq.64)newsite(I,J)=64
if(site(I,J).eq.67)newsite(I,J)=67
if(site(I,J).eq.70)newsite(I,J)=70
if(site(I,J).eq.71)newsite(I,J)=71
```

```
if(site(I,J).eq.76)newsite(I,J)=76
if(site(I,J).eq.78)newsite(I,J)=78
if(site(I,J).eq.79)newsite(I,J)=79
if(site(I,J).eq.88)newsite(I,J)=88
if(site(I,J).eq.92)newsite(I,J)=92
if(site(I,J).eq.94)newsite(I,J)=94
if(site(I,J).eq.95)newsite(I,J)=95
if(site(I,J).eq.97)newsite(I,J)=97
if(site(I,J).eq.99)newsite(I,J)=99
if(site(I,J).eq.103)newsite(I,J)=103
if(site(I,J).eq.111)newsite(I,J)=111
if(site(I,J).eq.112)newsite(I,J)=112
if(site(I,J).eq.113)newsite(I,J)=113
if(site(I,J).eq.115)newsite(I,J)=115
if(site(I,J).eq.119)newsite(I,J)=119
if(site(I,J).eq.120)newsite(I,J)=120
if(site(I,J).eq.121)newsite(I,J)=121
if(site(I,J).eq.123)newsite(I,J)=123
if(site(I,J).eq.124)newsite(I,J)=124
if(site(I,J).eq.125)newsite(I,J)=125
if(site(I,J).eq.126)newsite(I,J)=126
if(site(I,J).eq.127)newsite(I,J)=127
c
if(site(I,J).eq.5)newsite(I,J)=66
if(site(I,J).eq.10)newsite(I,J)=68
if(site(I,J).eq.17)newsite(I,J)=96
if(site(I,J).eq.20)newsite(I,J)=72
if(site(I,J).eq.21)newsite(I,J)=42
if(site(I,J).eq.31)newsite(I,J)=110
if(site(I,J).eq.34)newsite(I,J)=65
if(site(I,J).eq.40)newsite(I,J)=80
if(site(I,J).eq.42)newsite(I,J)=21
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```
if(site(I,J).eq.47)newsite(I,J)=87
if(site(I,J).eq.55)newsite(I,J)=107
if(site(I,J).eq.59)newsite(I,J)=117
if(site(I,J).eq.61)newsite(I,J)=122
if(site(I,J).eq.62)newsite(I,J)=93
if(site(I,J).eq.65)newsite(I,J)=34
if(site(I,J).eq.66)newsite(I,J)=5
if(site(I,J).eq.68)newsite(I,J)=10
if(site(I,J).eq.72)newsite(I,J)=20
if(site(I,J).eq.80)newsite(I,J)=40
if(site(I,J).eq.85)newsite(I,J)=106
if(site(I,J).eq.87)newsite(I,J)=47
if(site(I,J).eq.93)newsite(I,J)=62
if(site(I,J).eq.96)newsite(I,J)=17
if(site(I,J).eq.106)newsite(I,J)=85
if(site(I,J).eq.107)newsite(I,J)=55
if(site(I,J).eq.110)newsite(I,J)=31
if(site(I,J).eq.117)newsite(I,J)=59
if(site(I,J).eq.122)newsite(I,J)=61
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.9).and.(g.eq.0))newsite(I,J)=36
if((site(I,J).eq.9).and.(g.eq.1))newsite(I,J)=18
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.11).and.(g.eq.0))newsite(I,J)=38
if((site(I,J).eq.11).and.(g.eq.1))newsite(I,J)=69
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
```

```
if((site(I,J).eq.13).and.(g.eq.0))newsite(I,J)=74
if((site(I,J).eq.13).and.(g.eq.1))newsite(I,J)=22
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.18).and.(g.eq.0))newsite(I,J)=9
if((site(I,J).eq.18).and.(g.eq.1))newsite(I,J)=36
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.19).and.(g.eq.0))newsite(I,J)=98
if((site(I,J).eq.19).and.(g.eq.1))newsite(I,J)=37
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.22).and.(g.eq.0))newsite(I,J)=13
if((site(I,J).eq.22).and.(g.eq.1))newsite(I,J)=74
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.23).and.(g.eq.0))newsite(I,J)=102
if((site(I,J).eq.23).and.(g.eq.1))newsite(I,J)=75
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.25).and.(g.eq.0))newsite(I,J)=52
if((site(I,J).eq.25).and.(g.eq.1))newsite(I,J)=104
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.26).and.(g.eq.0))newsite(I,J)=84
if((site(I,J).eq.26).and.(g.eq.1))newsite(I,J)=44
 z=mod(a*z,m)
```

```
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.27).and.(g.eq.0))newsite(I,J)=45
if((site(I,J).eq.27).and.(g.eq.1))newsite(I,J)=54
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.29).and.(g.eq.0))newsite(I,J)=90
if((site(I,J).eq.29).and.(g.eq.1))newsite(I,J)=108
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.36).and.(g.eq.0))newsite(I,J)=18
if((site(I,J).eq.36).and.(g.eq.1))newsite(I,J)=9
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.37).and.(g.eq.0))newsite(I,J)=19
if((site(I,J).eq.37).and.(g.eq.1))newsite(I,J)=98
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.38).and.(g.eq.0))newsite(I,J)=69
if((site(I,J).eq.38).and.(g.eq.1))newsite(I,J)=11
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.41).and.(g.eq.0))newsite(I,J)=81
if((site(I,J).eq.41).and.(g.eq.1))newsite(I,J)=50
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
```

```
if((site(I,J).eq.43).and.(g.eq.0))newsite(I,J)=83
if((site(I,J).eq.43).and.(g.eq.1))newsite(I,J)=101
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.44).and.(g.eq.0))newsite(I,J)=26
if((site(I,J).eq.44).and.(g.eq.1))newsite(I,J)=84
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.45).and.(g.eq.0))newsite(I,J)=54
if((site(I,J).eq.45).and.(g.eq.1))newsite(I,J)=27
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.46).and.(g.eq.0))newsite(I,J)=77
if((site(I,J).eq.46).and.(g.eq.1))newsite(I,J)=86
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.50).and.(g.eq.0))newsite(I,J)=41
if((site(I,J).eq.50).and.(g.eq.1))newsite(I,J)=81
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.52).and.(g.eq.0))newsite(I,J)=104
if((site(I,J).eq.52).and.(g.eq.1))newsite(I,J)=25
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.53).and.(g.eq.0))newsite(I,J)=105
if((site(I,J).eq.53).and.(g.eq.1))newsite(I,J)=114
```

```
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.54).and.(g.eq.0))newsite(I,J)=27
if((site(I,J).eq.54).and.(g.eq.1))newsite(I,J)=45
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.58).and.(g.eq.0))newsite(I,J)=116
if((site(I,J).eq.58).and.(g.eq.1))newsite(I,J)=89
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.69).and.(g.eq.0))newsite(I,J)=11
if((site(I,J).eq.69).and.(g.eq.1))newsite(I,J)=38
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.73).and.(g.eq.0))newsite(I,J)=100
if((site(I,J).eq.73).and.(g.eq.1))newsite(I,J)=82
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.74).and.(g.eq.0))newsite(I,J)=22
if((site(I,J).eq.74).and.(g.eq.1))newsite(I,J)=13
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.75).and.(g.eq.0))newsite(I,J)=23
if((site(I,J).eq.75).and.(g.eq.1))newsite(I,J)=102
z=mod(a*z,m)
zr=z/zm
```

```
g=nint(zr*1.)
if((site(I,J).eq.77).and.(g.eq.0))newsite(I,J)=86
if((site(I,J).eq.77).and.(g.eq.1))newsite(I,J)=46
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.81).and.(g.eq.0))newsite(I,J)=50
if((site(I,J).eq.81).and.(g.eq.1))newsite(I,J)=41
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.82).and.(g.eq.0))newsite(I,J)=73
if((site(I,J).eq.82).and.(g.eq.1))newsite(I,J)=100
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.83).and.(g.eq.0))newsite(I,J)=101
if((site(I,J).eq.83).and.(g.eq.1))newsite(I,J)=43
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.84).and.(g.eq.0))newsite(I,J)=44
if((site(I,J).eq.84).and.(g.eq.1))newsite(I,J)=26
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.86).and.(g.eq.0))newsite(I,J)=46
if((site(I,J).eq.86).and.(g.eq.1))newsite(I,J)=77
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.89).and.(g.eq.0))newsite(I,J)=58
if((site(I,J).eq.89).and.(g.eq.1))newsite(I,J)=116
```

```
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.90).and.(g.eq.0))newsite(I,J)=108
if((site(I,J).eq.90).and.(g.eq.1))newsite(I,J)=29
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.91).and.(g.eq.0))newsite(I,J)=109
if((site(I,J).eq.91).and.(g.eq.1))newsite(I,J)=118
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.98).and.(g.eq.0))newsite(I,J)=37
if((site(I,J).eq.98).and.(g.eq.1))newsite(I,J)=19
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.100).and.(g.eq.0))newsite(I,J)=82
if((site(I,J).eq.100).and.(g.eq.1))newsite(I,J)=73
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.101).and.(g.eq.0))newsite(I,J)=43
if((site(I,J).eq.101).and.(g.eq.1))newsite(I,J)=83
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.102).and.(g.eq.0))newsite(I,J)=75
if((site(I,J).eq.102).and.(g.eq.1))newsite(I,J)=23
z=mod(a*z,m)
zr=z/zm
```

```
g=nint(zr*1.)
if((site(I,J).eq.104).and.(g.eq.0))newsite(I,J)=25
if((site(I,J).eq.104).and.(g.eq.1))newsite(I,J)=52
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.105).and.(g.eq.0))newsite(I,J)=114
if((site(I,J).eq.105).and.(g.eq.1))newsite(I,J)=53
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.108).and.(g.eq.0))newsite(I,J)=29
if((site(I,J).eq.108).and.(g.eq.1))newsite(I,J)=90
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.109).and.(g.eq.0))newsite(I,J)=118
if((site(I,J).eq.109).and.(g.eq.1))newsite(I,J)=91
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.114).and.(g.eq.0))newsite(I,J)=53
if((site(I,J).eq.114).and.(g.eq.1))newsite(I,J)=105
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(I,J).eq.116).and.(g.eq.0))newsite(I,J)=89
if((site(I,J).eq.116).and.(g.eq.1))newsite(I,J)=58
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.118).and.(g.eq.0))newsite(I,J)=91
if((site(I,J).eq.118).and.(g.eq.1))newsite(I,J)=109
```

```
if(site(I,J).eq.128)newsite(I,J)=128
if(site(I,J).eq.192)newsite(I,J)=192
if(site(I,J).eq.256)newsite(I,J)=256
if(site(I,J).eq.0)newsite(I,J)=0
site(I,J) = newsite(I,J)
180 continue
if(t.eq.1)goto 222
if(t.eq.ts)goto 222
if(mod(t,100).ne.0) goto 90
c
c - Calculating the number of adsorbed polymer particles –
c
222
yyyy=0
dd = cc
c
c - Print on screen and write on file –
c
print *,t,cc write (5,*)t,cc
90 continue
2222 end
```

BAB 4

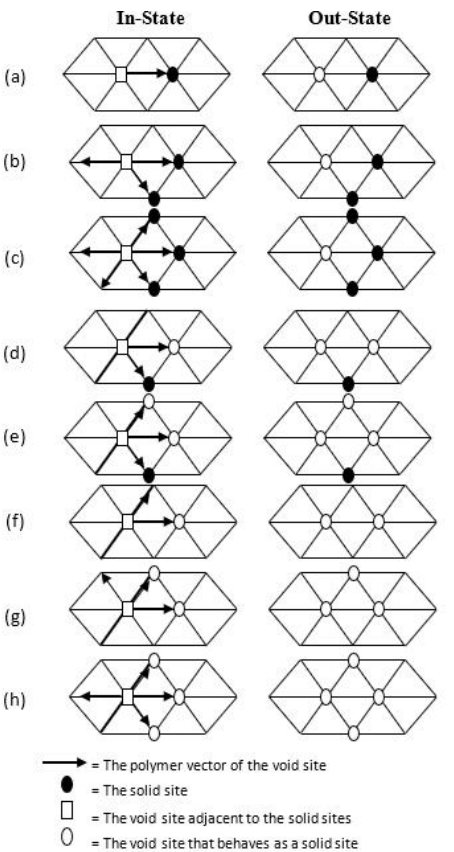
Pemodelan dan Simulasi Proses Gelasi

Dalam bab ini dibahas pengembangan metode lattice gas automata (LGA) untuk proses pembentukan gel dari polimer (gelasi). Pengembangan tersebut dilakukan dengan penambahan pemodelan gelasi pada model LGA. Model gelasi yang diusulkan berupa aturan tumbukan yang merupakan interaksi antara partikel polimer dan partikel padatan (batuan) dan antara partikel polimer dengan partikel polimer yang telah berubah menjadi gel. Di samping itu diberikan pemrograman komputer untuk simulasi gelasi.

4.1 Pemodelan Proses Gelasi

Lapisan gel terjadi dalam proses berurutan. Prosesnya dimulai dengan adsorpsi polimer pada permukaan batuan, yang membentuk lapisan dasar untuk pembentukan struktur. Struktur dikembangkan ketika kation multivalen berinteraksi dengan polimer teradsorpsi. Selanjutnya, ion-ion tersebut akan mengikat molekul polimer berikutnya yang disuntikkan untuk membentuk lapisan polimer kedua (Thomas, 1976; Parmeswar dan Willhite, 1985; Ghazali dan Willhite, 1985; Lake, 1989).

Untuk mensimulasikan fenomena gelasi polimer dalam model LGA, aturan tumbukan baru diperkenalkan seperti yang diilustrasikan pada Gambar 4.1 (Fathaddin, 2006). Aturan tumbukan dikelompokkan menjadi proses penempelan (Gambar 4.1a hingga 4.1e) dan proses akumulasi (Gambar 4.1f hingga 4.1h). Untuk proses penempelan, situs rongga (situs pori-pori), yang merupakan tetangga situs padat, mungkin akan berperilaku sebagai situs padat jika resultan vektor akibat tumbukan partikel-partikel fluida mengarah ke situs padat (batuan) atau ke situs rongga yang telah menjadi padat (gel) pada proses sebelumnya. Untuk proses akumulasi, situs rongga, yang berdekatan dari situs rongga yang telah berubah menjadi padat (gel) akan berperilaku sebagai situs padat baru jika resultan vektor tumbukan partikel-partikel fluidanya mengarah ke situs gel yang telah terbentuk sebelumnya.



Gambar 4.1 Aturan tumbukan untuk proses gelasi polimer (Fathaddin, 2006)

Aturan tumbukan dapat memungkinkan proses akumulasi berlanjut sampai ruang pori terisi gel. Namun, proses pelekatan gel pada permukaan padat harus mendahului proses akumulasi gel. Hasil yang diperoleh (*out-state*) pada Gambar 4.1 menunjukkan bahwa penutupan permukaan padat diakibatkan dari tumbukan antara partikel-partikel fluida pada situs rongga (pori) dan situs padat (batuan). Sedangkan penumpukan gel dihasilkan dari tumbukan antara partikel fluida situs rongga (pori) dengan di situs rongga yang telah menjadi padat (gel).

Jenis batuan dan larutan pengikat silang (cross-linker) dan polimer menentukan tingkat proses gelasi polimer dalam media berpori. Karena media berpori terdiri dari beberapa jenis batuan, maka proses penempelan dan penumpukan partikel gel tidak sama di setiap bagian ruang pori. Untuk memenuhi kondisi tersebut, faktor probabilitas terjadinya gelasi polimer digunakan. Faktor ini diketahui terkait dengan aturan tumbukan. Faktor probabilitas gelasi (Ppg) didefinisikan sebagai berikut:

$$p_{pg} = f(C) \tag{4.1}$$

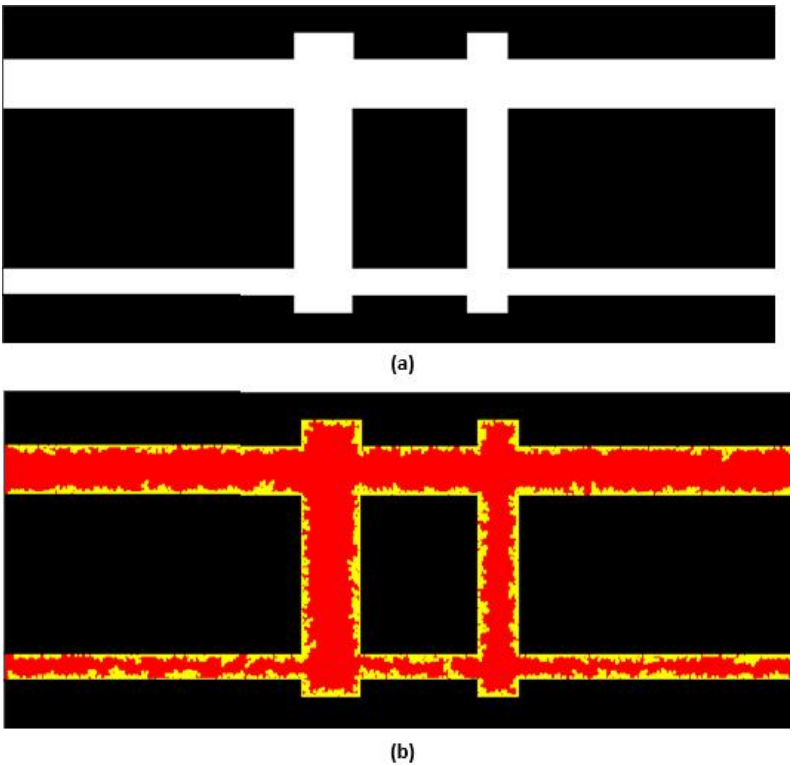
di mana C adalah konsentrasi polimer dalam larutan (ppm).

4.2 Simulasi Proses Gelasi

Simulasi gelasi dilakukan dengan prosedur sebagai berikut (Fathaddin, 2006):

1. Buat sebuah media berpori LGA yang mewakili mewakili media berpori (sampel core atau sandpack) seperti yang diperlihatkan pada Gambar 4.2. Porositas medium LGA harus sama dengan media berpori.
2. Partikel air dimasukkan dari sisi kiri media LGA. Setelah mencapai kondisi stabil (*steady state*), permeabilitas awal dihitung menggunakan Persamaan (1.15) (Rothman, 1988). Permeabilitas awal media LGA harus sama dengan media berpori. Jika permeabilitas media berpori LGA berbeda maka kembali ke langkah pertama.
3. Setelah itu, faktor probabilitas (Ppg) diasumsikan dan aturan tumbukan untuk proses gelasi polimer (Gambar 4.1) diterapkan untuk mengaktifhan proses.

4. Jika injeksi larutan polimer telah melewati media berpori dan diteruskan dengan injeksi air, maka penerapan aturan tumbukan untuk proses gelasi dihentikan.
5. Permeabilitas setelah gelasi dapat dihitung menggunakan Persamaan (1.15) (Rothman, 1988).



Gambar 4.2 Gelasi polimer dalam media berpori. (a) Kondisi awal media berpori. (b) Proses gelasi telah terjadi. Area hitam mewakili padatan, area merah mewakili larutan polimer, dan area kuning mewakili gel (Fathaddin, 2006)

4.3 Program Simulasi Proses Gelasi

Program komputer dibuat untuk mensimulasikan proses gelasi polimer yang terjadi akibat interaksi antara polimer dan batuan berpori dan antara polimer dengan gel selama penginjeksian polimer. Program kom-

puter dibuat dalam Bahasa FORTRAN sebagai berikut:

```
c SIMULATOR for validation
Integer I,J,K,xdir,ydir,g, ee, ff, hh, kk
real tyop,t
Integer site(2330,520), newsite(2330,520)
Integer nbs1(2330,520),nbs2(2330,520),nbs3(2330,520)
Integer nbs4(2330,520),nbs5(2330,520),nbs6(2330,520)
Integer aps(256,6),mass(256), cs
real*4 zr, denc, kosong
real*4 momx(256),momy(256),d,kinevis,dynavis
real*4 flow
real*4 velx,press
real*4 pressgrad
c kkcc
Integer a,seed, ts
Data a,m,seed/1027,1048576,1/
c
c - Calling data file and output file –
c
OPEN(UNIT=5,FILE='C:\Simulatb.OUT',
+STATUS = 'old')
z=seed zm=m
c --------
c - data -
c --------
c Number of sites in x direction
xdir = 2323
c Number of sites in y direction
ydir = 516
c time step
ts = 14320
c Existing fluid particle (codes = 0 - 127)
```

```
tyok = 1
tyol = 2
tyom = 4
tyon = 2
c Injecting fluid particle (codes = 0 - 7)
tyoo = 1
tyop = 2
tyoq = 4
tyor = 2
c Polymer concentration (ppm)
c Polyacrylamide
pa = 0.0
c Xanthan
xn = 5000
c The beginning of Gelation (seconds)
bg=5000
c The end of Gelation (seconds)
eg=9320
c Begin to close (second)
bc=5000
c End of closing (second)
ec=9320
c
c - setting the obstacles –
c
do 10 i=1,xdir
do 10 j=1,ydir
site(i,j)=128
newsite(i,j)=128
10 continue
c ==============
c = First Part=
```

```
c ============
c Cluster1
c The main channel1a
do 990 i=380,840
do 990 j=2,17
site(i,j)=0
990 continue
do 992 i=1180,1640
do 992 j=2,17
site(i,j)=0
992 continue
do 994 i=1975,xdir
do 994 j=2,17
site(i,j)=0
994 continue
c The main channel1anew
do 996 i=380,840
do 996 j=55,70
site(i,j)=0
996 continue
do 997 i=1180,1640
do 997 j=55,70
site(i,j)=0
997 continue
do 998 i=1975,xdir
do 998 j=55,70
site(i,j)=0
998 continue
C The main channel2a
do 1000 i=1,440
do 1000 j=25,40
site(i,j)=0
```

```
1000 continue
do 1001 i=780,1240
do 1001 j=25,40
site(i,j)=0
1001 continue
do 1002 i=1580,2040
do 1002 j=25,40
site(i,j)=0
1002 continue
c The main channel2a
do 1003 i=1,440
do 1003 j=85,100
site(i,j)=0
1003 continue
do 1004 i=780,1240
do 1004 j=85,100
site(i,j)=0
1004 continue
do 1005 i=1580,2040
do 1005 j=85,100
site(i,j)=0
1005 continue
c The main channel2b
do 1006 i=380,840
do 1006 j=110,125
site(i,j)=0
1006 continue
do 1007 i=1180,1640
do 1007 j=110,125
site(i,j)=0
1007 continue
do 1008 i=1975,xdir
```

```
do 1008 j=110,125
site(i,j)=0
1008 continue
c Cluster1
c Branch1
do 1010 i=50,70
do 1010 j=30,100
site(i,j)=0
1010 continue
c Branch2
do 1015 i=100,120
do 1015 j=30,100
site(i,j)=0
1015 continue
c Branch3
do 1020 i=150,170
do 1020 j=30,100
site(i,j)=0
1020 continue
c Branch4
do 1025 i=200,220
do 1025 j=30,100
site(i,j)=0
1025 continue
c Branch5
do 1030 i=250,270
do 1030 j=30,100
site(i,j)=0
1030 continue
c Branch6
do 1035 i=300,320
do 1035 j=30,100
```

```
site(i,j)=0
1035 continue
c Branch7
do 1040 i=350,370
do 1040 j=30,100
site(i,j)=0
1040 continue
c Cluster2
c Branch1
do 1045 i=400,420
do 1045 j=5,450
site(i,j)=0
1045 continue
c Branch2
do 1050 i=450,470
do 1050 j=5,125
site(i,j)=0
1050 continue
c Branch3
do 1055 i=500,520
do 1055 j=5,125
site(i,j)=0
1055 continue
c Branch4
do 1060 i=550,570
do 1060 j=5,125
site(i,j)=0
1060 continue
c Branch5
do 1065 i=600,620
do 1065 j=5,125
site(i,j)=0
```

```
1065 continue
c Branch6
do 1070 i=650,670
do 1070 j=5,125
site(i,j)=0
1070 continue
c Branch7
do 1080 i=700,720
do 1080 j=5,125
site(i,j)=0
1080 continue
c Branch8
do 1090 i=750,770
do 1090 j=5,125
site(i,j)=0
1090 continue
c Branch9
do 1095 i=790,810
do 1095 j=5,470
site(i,j)=0
1095 continue
c Cluster3
c Branch1
do 1100 i=850,870
do 1100 j=30,100
site(i,j)=0
1100 continue
c Branch2
do 1102 i=900,920
do 1102 j=30,100
site(i,j)=0
1102 continue
```

```
c Branch3
do 1104 i=950,970
do 1104 j=30,100
site(i,j)=0
1104 continue
c Branch4
do 1105 i=1000,1020
do 1105 j=30,100
site(i,j)=0
1105 continue
c Branch5
do 1110 i=1050,1070
do 1110 j=30,100
site(i,j)=0
1110 continue
c Branch6
do 1115 i=1100,1120
do 1115 j=30,100
site(i,j)=0
1115 continue
c Branch7
do 1120 i=1150,1170
do 1120 j=30,100
site(i,j)=0
1120 continue
c Cluster4
c Branch1
do 1125 i=1200,1220
do 1125 j=5,470
site(i,j)=0
1125 continue
c Branch2
```

```
do 1130 i=1250,1270
do 1130 j=5,125
site(i,j)=0
1130 continue
c Branch3
do 1135 i=1300,1320
do 1135 j=5,125
site(i,j)=0
1135 continue
c Branch4
do 1137 i=1350,1370
do 1137 j=5,125
site(i,j)=0
1137 continue
c Branch5
do 1140 i=1400,1420
do 1140 j=5,125
site(i,j)=0
1140 continue
c Branch6
do 1145 i=1450,1470
do 1145 j=5,125
site(i,j)=0
1145 continue
c Branch7
do 1150 i=1500,1520
do 1150 j=5,125
site(i,j)=0
1150 continue
c Branch8
do 1155 i=1550,1570
do 1155 j=5,125
```

```
site(i,j)=0
1155 continue
c Branch9
do 1157 i=1600,1620
do 1157 j=5,470
site(i,j)=0
1157 continue
c Cluster5
c Branch1
do 1160 i=1650,1670
do 1160 j=30,100
site(i,j)=0
1160 continue
c Branch2
do 1165 i=1700,1720
do 1165 j=30,100
site(i,j)=0
1165 continue
c Branch3
do 1170 i=1750,1770
do 1170 j=30,100
site(i,j)=0
1170 continue
c Branch4
do 1175 i=1800,1820
do 1175 j=30,100
site(i,j)=0
1175 continue
c Branch5
do 1180 i=1850,1870
do 1180 j=30,100
site(i,j)=0
```

```
1180 continue
c Branch6
do 1185 i=1900,1920
do 1185 j=30,100
site(i,j)=0
1185 continue
c Branch7
do 1190 i=1950,1970
do 1190 j=30,100
site(i,j)=0
1190 continue
c Cluster6
c Branch1
do 1200 i=2000,2020
do 1200 j=5,470
site(i,j)=0
1200 continue
c Branch2
do 1210 i=2050,2070
do 1210 j=5,125
site(i,j)=0
1210 continue
c Branch3
do 1220 i=2100,2120
do 1220 j=5,125
site(i,j)=0
1220 continue
c Branch4
do 1230 i=2150,2170
do 1230 j=5,125
site(i,j)=0
1230 continue
```

```
c Branch5
do 1240 i=2200,2220
do 1240 j=5,125
site(i,j)=0
1240 continue
c Branch6
do 1250 i=2250,2270
do 1250 j=5,125
site(i,j)=0
1250 continue
c Branch7
do 1260 i=2300,2320
do 1260 j=5,125
site(i,j)=0
1260 continue
c ==============
c = Second Part=
c ==============
c Cluster1
c The main channel1a
do 91 i=400,810
do 91 j=131,148
site(i,j)=0
91 continue
do 92 i=1200,1620
do 92 j=131,148
site(i,j)=0
92 continue
do 94 i=2000,xdir
do 94 j=131,148
site(i,j)=0
94 continue
```

```
c The main channel1anew
do 96 i=400,810
do 96 j=182,199
site(i,j)=0
96 continue
do 97 i=1200,1620
do 97 j=182,199
site(i,j)=0 97 continue
do 98 i=2000,xdir
do 98 j=182,199
site(i,j)=0 98 continue
c The main channel2a
do 99 i=1,440
do 99 j=154,171
site(i,j)=0 99 continue
do 101 i=780,1245
do 101 j=154,171
site(i,j)=0
101 continue
do 102 i=1580,2045
do 102 j=154,171
site(i,j)=0
102 continue
c The main channel2a
do 103 i=1,440
do 103 j=212,229
site(i,j)=0
103 continue
do 104 i=780,1245
do 104 j=212,229
site(i,j)=0
104 continue
```

```
do 105 i=1580,2045
do 105 j=212,229
site(i,j)=0
105 continue
c The main channel2b
do 106 i=400,810
do 106 j=239,256
site(i,j)=0
106 continue
do 107 i=1200,1620
do 107 j=239,256
site(i,j)=0
107 continue
do 108 i=2000,xdir
do 108 j=239,256
site(i,j)=0
108 continue
c Cluster1
c Branch1
do 109 i=50,70
do 109 j=159,229
site(i,j)=0
109 continue
c Branch2
do 115 i=100,120
do 115 j=159,229
site(i,j)=0
115 continue
c Branch3
do 122 i=150,170
do 122 j=159,229
site(i,j)=0
```

```
122 continue
c Branch4
do 125 i=200,220
do 125 j=159,229
site(i,j)=0
125 continue
c Branch5
do 132 i=250,270
do 132 j=159,229
site(i,j)=0
132 continue
c Branch6
do 135 i=300,320
do 135 j=159,229
site(i,j)=0
135 continue
c Branch7
do 141 i=350,370
do 141 j=159,229
site(i,j)=0
141 continue
c Cluster2
c Branch1
do 145 i=400,420
do 145 j=134,254
site(i,j)=0
145 continue
c Branch2
do 152 i=450,470
do 152 j=134,254
site(i,j)=0
152 continue
```

```
c Branch3
do 155 i=500,520
do 155 j=134,254
site(i,j)=0
155 continue
c Branch4
do 161 i=550,570
do 161 j=134,254
site(i,j)=0
161 continue
c Branch5
do 166 i=600,620
do 166 j=134,254
site(i,j)=0
166 continue
c Branch6
do 171 i=650,670
do 171 j=134,254
site(i,j)=0
171 continue
c Branch7
do 181 i=700,720
do 181 j=134,254
site(i,j)=0
181 continue
c Branch8
do 191 i=750,770
do 191 j=134,254
site(i,j)=0
191 continue
c Branch9
do 195 i=790,810
```

```
do 195 j=134,254
site(i,j)=0
195 continue
c Cluster3
c Branch1
do 197 i=850,870
do 197 j=159,229
site(i,j)=0
197 continue
c Branch2
do 112 i=900,920
do 112 j=159,229
site(i,j)=0
112 continue
c Branch3
do 114 i=950,970
do 114 j=159,229
site(i,j)=0
114 continue
c Branch4
do 113 i=1000,1020
do 113 j=159,229
site(i,j)=0
113 continue
c Branch5
do 116 i=1050,1070
do 116 j=159,229
site(i,j)=0
116 continue
c Branch6
do 117 i=1100,1120
do 117 j=159,229
```

```
site(i,j)=0
117 continue
c Branch7
do 121 i=1150,1170
do 121 j=159,229
site(i,j)=0
121 continue
c Cluster4
c Branch1
do 126 i=1200,1220
do 126 j=134,254
site(i,j)=0
126 continue
c Branch2
do 131 i=1250,1270
do 131 j=134,254
site(i,j)=0
131 continue
c Branch3
do 136 i=1300,1320
do 136 j=134,254
site(i,j)=0
136 continue
c Branch4
do 137 i=1350,1370
do 137 j=134,254
site(i,j)=0
137 continue
c Branch5
do 142 i=1400,1420
do 142 j=134,254
site(i,j)=0
```

```
142 continue
c Branch6
do 146 i=1450,1470
do 146 j=134,254
site(i,j)=0
146 continue
c Branch7
do 151 i=1500,1520
do 151 j=134,254
site(i,j)=0
151 continue
c Branch8
do 153 i=1550,1570
do 153 j=134,254
site(i,j)=0
153 continue
c Branch9
do 157 i=1600,1620
do 157 j=134,254
site(i,j)=0
157 continue
c Cluster5
c Branch1
do 162 i=1650,1670
do 162 j=159,229
site(i,j)=0
162 continue
c Branch2
do 168 i=1700,1720
do 168 j=159,229
site(i,j)=0
168 continue
```

```
c Branch3
do 172 i=1750,1770
do 172 j=159,229
site(i,j)=0
172 continue
c Branch4
do 176 i=1800,1820
do 176 j=159,229
site(i,j)=0
176 continue
c Branch5
do 182 i=1850,1870
do 182 j=159,229
site(i,j)=0
182 continue
c Branch6
do 186 i=1900,1920
do 186 j=159,229
site(i,j)=0
186 continue
c Branch7
do 192 i=1950,1970
do 192 j=159,229
site(i,j)=0
192 continue
c Cluster6
c Branch1
do 201 i=2000,2020
do 201 j=134,254
site(i,j)=0
201 continue
c Branch2
```

```
do 202 i=2050,2070
do 202 j=134,254
site(i,j)=0
202 continue
c Branch3
do 203 i=2100,2120
do 203 j=134,254
site(i,j)=0
203 continue
c Branch4
do 204 i=2150,2170
do 204 j=134,254
site(i,j)=0
204 continue
c Branch5
do 241 i=2200,2220
do 241 j=134,254
site(i,j)=0
241 continue
c Branch6
do 251 i=2250,2270
do 251 j=134,254
site(i,j)=0
251 continue
c ==============
c = Third Part=
c ==============
c Cluster1
c The main channel1a
do 790 i=400,810
do 790 j=282,299
site(i,j)=0
```

```
790 continue
do 792 i=1200,1620
do 792 j=282,299
site(i,j)=0
792 continue
do 794 i=2000,xdir
do 794 j=282,299
site(i,j)=0
794 continue
c The main channel1anew
do 796 i=400,810
do 796 j=312,329
site(i,j)=0
796 continue
do 797 i=1200,1620
do 797 j=312,329
site(i,j)=0
797 continue
do 798 i=2000,xdir
do 798 j=312,329
site(i,j)=0
798 continue
c The main channel2a
do 802 i=1,420
do 802 j=260,277
site(i,j)=0
802 continue
do 801 i=790,1220
do 801 j=260,277
site(I,j)=0
801 continue
do 809 i=1600,2020
```

```
do 809 j=260,277
site(i,j)=0
809 continue
c The main channel2a
do 803 i=1,420
do 803 j=342,360
site(i,j)=0
803 continue
do 804 i=790,1220
do 804 j=342,360
site(i,j)=0
804 continue
do 805 i=1600,2020
do 805 j=342,360
site(i,j)=0
805 continue
c The main channel2b
do 806 i=400,810
do 806 j=365,383
site(i,j)=0
806 continue
do 807 i=1200,1620
do 807 j=365,383
site(i,j)=0
807 continue
do 808 i=2000,xdir
do 808 j=365,383
site(i,j)=0
808 continue
c Cluster1
c Branch1
do 811 i=50,70
```

```
do 811 j=263,358
site(i,j)=0
811 continue
c Branch2
do 813 i=100,120
do 813 j=263,358
site(i,j)=0
813 continue
c Branch3
do 814 i=150,170
do 814 j=263,358
site(i,j)=0
814 continue
c Branch4
do 816 i=200,220
do 816 j=263,358
site(i,j)=0
816 continue
c Branch5
do 817 i=250,270
do 817 j=263,358
site(i,j)=0
817 continue
c Branch6
do 818 i=300,320
do 818 j=263,358
site(i,j)=0
818 continue
c Branch7
do 819 i=350,370
do 819 j=263,358
site(i,j)=0
```

```
819 continue
c Cluster2
c Branch1
do 821 i=400,420
do 821 j=263,358
site(i,j)=0
821 continue
c Branch2
do 822 i=450,470
do 822 j=288,383
site(i,j)=0
822 continue
c Branch3
do 823 i=500,520
do 823 j=288,383
site(i,j)=0
823 continue
c Branch4
do 824 i=550,570
do 824 j=288,383
site(i,j)=0
824 continue
c Branch5
do 826 i=600,620
do 826 j=288,383
site(i,j)=0
826 continue
c Branch6
do 827 i=650,670
do 827 j=288,383
site(i,j)=0
827 continue
```

```
c Branch7
do 828 i=700,720
do 828 j=288,383
site(i,j)=0
828 continue
c Branch8
do 829 i=750,770
do 829 j=288,383
site(i,j)=0
829 continue
c Branch9
do 831 i=790,810
do 831 j=263,383
site(i,j)=0
831 continue
c Cluster3
c Branch1
do 832 i=850,870
do 832 j=263,358
site(i,j)=0
832 continue
c Branch2
do 833 i=900,920
do 833 j=263,358
site(i,j)=0
833 continue
c Branch3
do 834 i=950,970
do 834 j=263,358
site(i,j)=0
834 continue
c Branch4
```

```
do 836 i=1000,1020
do 836 j=263,358
site(i,j)=0
836 continue
c Branch5
do 837 i=1050,1070
do 837 j=263,358
site(i,j)=0
837 continue
c Branch6
do 838 i=1100,1120
do 838 j=263,358
site(i,j)=0
838 continue
c Branch7
do 839 i=1150,1170
do 839 j=263,358
site(i,j)=0
839 continue
c Cluster4
c Branch1
do 841 i=1200,1220
do 841 j=263,383
site(i,j)=0
841 continue
c Branch2
do 842 i=1250,1270
do 842 j=288,383
site(i,j)=0
842 continue
c Branch3
do 843 i=1300,1320
```

```
do 843 j=288,383
site(i,j)=0
843 continue
c Branch4
do 844 i=1350,1370
do 844 j=288,383
site(i,j)=0
844 continue
c Branch5
do 846 i=1400,1420
do 846 j=288,383
site(i,j)=0
846 continue
c Branch6
do 847 i=1450,1470
do 847 j=288,383
site(i,j)=0
847 continue
c Branch7
do 848 i=1500,1520
do 848 j=288,383
site(i,j)=0
848 continue
c Branch8
do 849 i=1550,1570
do 849 j=288,383
site(i,j)=0
849 continue
c Branch9
do 851 i=1600,1620
do 851 j=263,383
site(i,j)=0
```

```
851 continue
c Cluster5
c Branch1
do 852 i=1650,1670
do 852 j=263,358
site(i,j)=0
852 continue
c Branch2

do 853 i=1700,1720
do 853 j=263,358
site(i,j)=0
853 continue
c Branch3
do 859 i=1750,1770
do 859 j=263,358
site(i,j)=0 859 continue
c Branch4
do 854 i=1800,1820
do 854 j=263,358
site(i,j)=0
854 continue
c Branch5
do 856 i=1850,1870
do 856 j=263,358
site(i,j)=0
856 continue
c Branch6
do 857 i=1900,1920
do 857 j=263,358
site(i,j)=0
857 continue
```

```
c Branch7
do 858 i=1950,1970
do 858 j=263,358
site(i,j)=0
858 continue
c Cluster6
c Branch1
do 8591 i=2000,2020
do 8591 j=263,383
site(i,j)=0
8591 continue
c Branch2
do 861 i=2050,2070
do 861 j=288,383
site(i,j)=0
861 continue
c Branch3
do 862 i=2100,2120
do 862 j=288,383
site(i,j)=0
862 continue
c Branch4
do 863 i=2150,2170
do 863 j=288,383
site(i,j)=0
863 continue
c Branch5
do 864 i=2200,2220
do 864 j=288,383
site(i,j)=0
864 continue
c Branch6
```

```
do 866 i=2250,2270
do 866 j=288,383
site(i,j)=0
866 continue
c Branch7
do 867 i=2300,2320
do 867 j=288,383
site(i,j)=0
867 continue
c ==============
c = Fourth Part=
c ==============
c Cluster1
c The main channel1a
do 690 i=400,810
do 690 j=412,429
site(i,j)=0
690 continue
do 692 i=1200,1620
do 692 j=412,429
site(i,j)=0
692 continue
do 694 i=2000,xdir
do 694 j=412,429
site(i,j)=0
694 continue
c The main channel1anew
do 696 i=400,810
do 696 j=440,457
site(i,j)=0
696 continue
do 697 i=1200,1620
```

```
do 697 j=440,457
site(i,j)=0
697 continue
do 698 i=2000,xdir
do 698 j=440,457
site(i,j)=0
698 continue
c The main channel2a
do 699 i=1,428
do 699 j=389,406
site(i,j)=0
699 continue
do 701 i=782,1228
do 701 j=389,406
site(I,j)=0
701 continue
do 702 i=1592,2028
do 702 j=389,406
site(i,j)=0
702 continue
c The main channel2a
do 703 i=1,428
do 703 j=497,514
site(i,j)=0
703 continue
do 704 i=782,1228
do 704 j=497,514
site(i,j)=0
704 continue
do 709 i=1592,2028
do 709 j=497,514
site(i,j)=0
```

```
709 continue
c The main channel2b
do 706 i=400,810
do 706 j=470,487
site(i,j)=0
706 continue
do 707 i=1200,1620
do 707 j=470,487
site(i,j)=0
707 continue
do 708 i=2000,xdir
do 708 j=470,487
site(i,j)=0
708 continue
c Cluster1
c Branch1
do 611 i=50,70
do 611 j=392,512
site(i,j)=0
611 continue
c Branch2
do 612 i=100,120
do 612 j=392,512
site(i,j)=0
612 continue
c Branch3
do 613 i=150,170
do 613 j=392,512
site(i,j)=0
613 continue
c Branch4
do 614 i=200,220
```

```
do 614 j=392,512
site(i,j)=0
614 continue
c Branch5
do 616 i=250,270
do 616 j=392,512
site(i,j)=0
616 continue
c Branch6
do 617 i=300,320
do 617 j=392,512
site(i,j)=0
617 continue
c Branch7
do 618 i=350,370
do 618 j=392,512
site(i,j)=0
618 continue
c Cluster2
c Branch1
do 619 i=400,420
do 619 j=392,512
site(i,j)=0
619 continue
c Branch2
do 621 i=450,470
do 621 j=417,487
site(i,j)=0
621 continue
c Branch3
do 622 i=500,520
do 622 j=417,487
```

```
site(i,j)=0
622 continue
c Branch4
do 623 i=550,570
do 623 j=417,487
site(i,j)=0
623 continue
c Branch5
do 624 i=600,620
do 624 j=417,487
site(i,j)=0
624 continue
c Branch6
do 626 i=650,670
do 626 j=417,487
site(i,j)=0
626 continue
c Branch7
do 627 i=700,720
do 627 j=417,487
site(i,j)=0
627 continue
c Branch8
do 628 i=750,770
do 628 j=417,487
site(i,j)=0
628 continue
c Branch9
do 629 i=790,810
do 629 j=392,512
site(i,j)=0
629 continue
```

```
c Cluster3
c Branch1
do 631 i=850,870
do 631 j=392,512
site(i,j)=0
631 continue
c Branch2
do 632 i=900,920
do 632 j=392,512
site(i,j)=0
632 continue
c Branch3
do 633 i=950,970
do 633 j=392,512
site(i,j)=0
633 continue
c Branch4
do 634 i=1000,1020
do 634 j=392,512
site(i,j)=0
634 continue
c Branch5
do 636 i=1050,1070
do 636 j=392,512
site(i,j)=0
636 continue
c Branch6
do 637 i=1100,1120
do 637 j=392,512
site(i,j)=0
637 continue
c Branch7
```

```
do 638 i=1150,1170
do 638 j=392,512
site(i,j)=0
638 continue
c Cluster4
c Branch1
do 639 i=1200,1220
do 639 j=392,512
site(i,j)=0
639 continue
c Branch2
do 641 i=1250,1270
do 641 j=417,487
site(i,j)=0
641 continue
c Branch3
do 642 i=1300,1320
do 642 j=417,487
site(i,j)=0
642 continue
c Branch4
do 643 i=1350,1370
do 643 j=417,487
site(i,j)=0
643 continue
c Branch5
do 644 i=1400,1420
do 644 j=417,487
site(i,j)=0
644 continue
c Branch6
do 646 i=1450,1470
```

```
do 646 j=417,487
site(i,j)=0
646 continue
c Branch7
do 647 i=1500,1520
do 647 j=417,487
site(i,j)=0
647 continue
c Branch8
do 648 i=1550,1570
do 648 j=417,487
site(i,j)=0
648 continue
c Branch9
do 649 i=1600,1620
do 649 j=392,512
site(i,j)=0
649 continue
c Cluster5
c Branch1
do 651 i=1650,1670
do 651 j=392,512
site(i,j)=0
651 continue
c Branch2
do 652 i=1700,1720
do 652 j=392,512
site(i,j)=0
652 continue
c Branch3
do 653 i=1750,1770
do 653 j=392,512
```

```
site(i,j)=0
653 continue
c Branch4
do 654 i=1800,1820
do 654 j=392,512
site(i,j)=0
654 continue
c Branch5
do 656 i=1850,1870
do 656 j=392,512
site(i,j)=0
656 continue
c Branch6
do 657 i=1900,1920
do 657 j=392,512
site(i,j)=0
657 continue
c Branch7
do 658 i=1950,1970
do 658 j=392,512
site(i,j)=0
658 continue
c Cluster6
c Branch1
do 659 i=2000,2020
do 659 j=392,512
site(i,j)=0
659 continue
c Branch2
do 661 i=2050,2070
do 661 j=417,487
site(i,j)=0
```

```
661 continue
c Branch3
do 662 i=2100,2120
do 662 j=417,487
site(i,j)=0
662 continue
c Branch4
do 663 i=2150,2170
do 663 j=417,487
site(i,j)=0
663 continue
c Branch5
do 664 i=2200,2220
do 664 j=417,487
site(i,j)=0
664 continue
c Branch6
do 666 i=2250,2270
do 666 j=417,487
site(i,j)=0
666 continue
cc
cc - setting the boundary –
cc
do 20 i=1,xdir
site(i,1)=128
newsite(i,1)=128
site(i,ydir)=128
newsite(i,ydir)=128
20 continue
c
c - Define neighbor sites –
```

```
c
do 25 I=1,xdir
do 25 J=2,ydir-1
nbs1(I,J)=site(I+1,J-1)
nbs2(I,J)=site(I-1,J-1)
nbs3(I,J)=site(I-1,J)
nbs4(I,J)=site(I-1,J+1)
nbs5(I,J)=site(I+1,J+1)
nbs6(I,J)=site(I+1,J)
25 continue
c
c - Contact surface –
c
cs=0
do 30 I=1,xdir
do 30 J=1,ydir
if(site(I,J).ne.128) goto 30
if((nbs1(I,J).LT.128).OR.(nbs2(I,J).LT.128).OR.(nbs3(I,J).LT.128)
+.OR.(nbs4(I,J).LT.128).OR.(nbs5(I,J).LT.128).OR.
+(nbs6(I,J).LT.128)) cs = cs + 1
30 continue
c
c - setting the open sites –
c
void = 0
kosong = 0
do 50 I=1,xdir
do 40 J=1,ydir
if(site(I,J).ne.128)void=void+1
40 continue
kosong = kosong + void void = 0
50 continue
```

```
c
c - calculating porosity –
c
total = xdir*ydir
porosity = kosong/total
c
c - Distributing fluid particles for given density and calculating oil mass –
c
do 70 I=1,xdir
do 70 J=1,ydir
if(site(I,J).eq.128) goto 7171
z=mod(a*z,m)
zr=z/zm g=nint(zr*4.)
if(g.eq.0)site(1,J)=tyok
if(g.eq.1)site(1,J)=tyol
if(g.eq.2)site(1,J)=tyom
if(g.eq.3)site(1,J)=tyon
7171 ssss=0
70 continue
c
c - Calculating fluid mass –
c
masstot=0
do 80 I=1,xdir
do 80 J=1,ydir
if ((site(I,J).eq.128).or.(site(I,J).eq.192)) goto 80
if (site(I,J).eq.256) goto 80
if(mod(site(I,J),2).eq.1)masstot=masstot+1 if(mod((site(I,J)/2),2).eq.1)
masstot=masstot+1 if(mod((site(I,J)/4),2).eq.1)masstot=masstot+1 if(-
mod((site(I,J)/8),2).eq.1)masstot=masstot+1 if(mod((site(I,J)/16),2).eq.1)
masstot=masstot+1 if(mod((site(I,J)/32),2).eq.1)masstot=masstot+1 if-
(site(I,J).ge.64)masstot=masstot+1
80 continue denc=masstot/kosong
```

```
c
c - Calculating intial oil and polymer saturation –
c
print *,”Porosity(fraction)=”,porosity
write (5,*)”Porosity(fraction)=”,porosity
print *,”Surface length(cm)=”,cs/100
write (5,*)”Surface length(cm)=”,cs/100
print *,”T(sec),Vel(cm/sec),K(Darcy),Number of Gel-Particles”
write (5,*)”T(sec),Vel(cm/sec),K(Darcy),Number of Gel-Particles”
c
c - Main program –
c
do 90 t=1,ts
z=mod(a*z,m)
zr=z/zm g=nint(zr*4.)
c
c -Closing the boundaries during gelation –
c
do 22 j=1,ydir
if((t.le.bc).or.(t.gt.ec)) goto 2424
site(1,j)=192
site(xdir,j)=192
2424
ggggg=0
22 continue
c
c -Reopening the boundaries during gelation –
c
do 62 j=1,ydir
if(t.ne.ec) goto 2425
site(1,j)=0
site(xdir,j)=0
```

```
2425
ggggg=0
62 continue
c
c - Input the particles along the left boundary –
c
do 95 j=1,ydir
if(g.eq.0)site(0,J)=tyoo
if(g.eq.1)site(0,J)=tyop
if(g.eq.2)site(0,J)=tyoq
if(g.eq.3)site(0,J)=tyor
95 continue
c
c - Periodic boundary - c
do 110 J=1,ydir
if(mod((site(0,J)/32),2).eq.1)site(xdir,ydir+1-J)=32
if(mod((site(0,J)/16),2).eq.1)site(xdir,ydir+1-J)=16
if(mod((site(0,J)/8),2).eq.1)site(xdir,ydir+1-J)=8 if((mod((site(0,J)/32),2).
eq.1).and.(mod((site(0,J)/16),2).eq.1
+))site(xdir,ydir+1-J)=48 if((mod((site(0,J)/32),2).eq.1).and.
(mod((site(0,J)/8),2).eq.1)
+)site(xdir,ydir+1-J)=40 if((mod((site(0,J)/16),2).eq.1).and.
(mod((site(0,J)/8),2).eq.1)
+)site(xdir,ydir+1-J)=24 if((mod((site(0,J)/32),2).eq.1).and.
(mod((site(0,J)/16),2).eq.1
+).and.(mod((site(xdir,J)/8),2).eq.1))site(xdir,ydir+1-J)=56
c
if(mod(site(xdir,J),2).eq.1)site(0,ydir+1-J)=1
if(mod((site(xdir,J)/2),2).eq.1)site(0,ydir+1-J)=2
if(mod((site(xdir,J)/4),2).eq.1)site(0,ydir+1-J)=4
if((mod(site(xdir,J),2).eq.1).and.(mod((site(xdir,J)/2),2).eq.1))
+site(0,ydir+1-J)=3 if((mod(site(xdir,J),2).eq.1).and.(mod((site(x-
dir,J)/4),2).eq.1))
```

```
+site(0,ydir+1-J)=5 if((mod((site(xdir,J)/2),2).eq.1).and.(mod((site(x-
dir,J)/4),2)
+.eq.1)) site(0,ydir+1-J)=6
if((mod(site(xdir,J),2).eq.1).and.(mod((site(xdir,J)/2),2).eq.1)
+.and.(mod((site(xdir,J)/4),2).eq.1))site(0,ydir+1-J)=7
110 continue
c
c - Forcing rules along the left boundary –
c
do 100 J=1,ydir
if(mod((site(0,J)/32),2).eq.1)site(0,J)=1
if(mod((site(0,J)/16),2).eq.1)site(0,J)=2
if(mod((site(0,J)/8),2).eq.1)site(0,J)=4 if((mod((site(0,J)/32),2).eq.1).and.
(mod((site(0,J)/16),2).eq.1
+))site(0,J)=3
if((mod((site(0,J)/32),2).eq.1).and.(mod((site(0,J)/8),2).eq.1)
+)site(0,J)=5 if((mod((site(0,J)/16),2).eq.1).and.(mod((site(0,J)/8),2).eq.1)
+)site(0,J)=6 if((mod((site(0,J)/32),2).eq.1).and.(mod((site(0,J)/16),2).eq.1
+).and.(mod((site(xdir,J)/8),2).eq.1))site(0,J)=7
100 continue
c
c - Define neighbor sites –
c
do 120 I=1,xdir
do 120 J=2,ydir-1
nbs1(I,J)=site(I+1,J-1)
nbs2(I,J)=site(I-1,J-1)
nbs3(I,J)=site(I-1,J)
nbs4(I,J)=site(I-1,J+1)
nbs5(I,J)=site(I+1,J+1)
nbs6(I,J)=site(I+1,J)
120 continue
```

```
c
c - Translation procedure - c
c Reset newsite(I,J)
do 150 I = 1,xdir
do 150 J = 1,ydir
newsite(I,J)=0
150 continue
c
c - Define added particles from neighbor sites after particle collisions - c

do 130 K=1,128
c Reset added particle from neighbor sites
aps(K,1)=0
aps(K,2)=0
aps(K,3)=0
aps(K,4)=0
aps(K,5)=0
aps(K,6)=0
c Reset mass and momentum at neighbor sites
mass(K)=0
momx(K)=0
momy(K)=0
130 continue
do 140 K=0,128
c Added particles to site(I,J) from the first nighbor site
if(mod((K/8),2).eq.1)aps(K,1)=8
c Added particles to site(I,J) from the second nighbor site
if(mod((K/4),2).eq.1)aps(K,2)=4
c Added particles to site(I,J) from the third nighbor site
if(mod((K/2),2).eq.1)aps(K,3)=2
c Added particles to site(I,J) from the fourth nighbor site
if(mod(K,2).eq.1)aps(K,4)=1
```

```
c Added particles to site(I,J) from the fifth nighbor site
if(mod((K/32),2).eq.1)aps(K,5)=32
c Added particles to site(I,J) from the sixth nighbor site
if(mod((K/16),2).eq.1)aps(K,6)=16
c Define mass and momentum of particle moving toward the first nighbor
site
if(mod(K,2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)+0.5
momy(K)=momy(K)+((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the second nigh-
bor site
if(mod((K/32),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-0.5
momy(K)=momy(K)+((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the third nighbor
site
if(mod((K/16),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-1
momy(K)=0
endif
c Define mass and momentum of particle moving toward the fourth nigh-
bor site
if(mod((K/8),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)-0.5
momy(K)=momy(K)-((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the fifth nighbor
```

```
site
if(mod((K/4),2).eq.1) then
mass(K)=mass(K)+1

momx(K)=momx(K)+0.5
momy(K)=momy(K)-((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the sixth nighbor
site
if(mod((K/2),2).eq.1) then
mass(K)=mass(K)+1
momx(K)=momx(K)+1
momy(K)=0
endif
if(K.ge.64) mass(K)=mass(K)+1
140 continue
c
c - Gelling process - c
c Polyacrylamide
cccc = 0.000000000942279*pa**2-0.0000020608621*pa
c Xanthan
dddd = 0.0000000038*xn**2+0.0000039311*xn If(xn .eq. 0) Then dddd =
cccc
do 415 I=1,xdir
do 415 J=1,ydir
if(t.le.bg) goto 415
if(t.gt.eg) goto 415
z=mod(a*z,m)
zr=z/zm
kk=nint(zr/dddd)
ll=0
c To the first nighbor site
```

```
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.128))ll=ll+1
if((mod((site(I,J)/32),2).eq.1).and.(nbs1(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs1(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs1(I,J).eq.128))ll=ll-1
if((mod((site(I,J)/4),2).eq.1).and.(nbs1(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs1(I,J).eq.128))ll=ll+0.866
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.256))ll=ll+1
if((mod((site(I,J)/32),2).eq.1).and.(nbs1(I,J).eq.256))ll=ll+0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs1(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs1(I,J).eq.256))ll=ll-1
if((mod((site(I,J)/4),2).eq.1).and.(nbs1(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs1(I,J).eq.256))ll=ll+0.866
c To the second nighbor site
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.128))ll=ll+1
if((mod((site(I,J)/16),2).eq.1).and.(nbs2(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs2(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs2(I,J).eq.128))ll=ll-1
if((mod((site(I,J)/2),2).eq.1).and.(nbs2(I,J).eq.128))ll=ll-0.866
if((mod(site(I,J),2).eq.1).and.(nbs2(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.256))ll=ll+1
if((mod((site(I,J)/16),2).eq.1).and.(nbs2(I,J).eq.256))ll=ll+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs2(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs2(I,J).eq.256))ll=ll-1
if((mod((site(I,J)/2),2).eq.1).and.(nbs2(I,J).eq.256))ll=ll-0.866
if((mod(site(I,J),2).eq.1).and.(nbs2(I,J).eq.256))ll=ll+0.866
c To the third nighbor site
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.128))ll=ll+1
if((mod((site(I,J)/8),2).eq.1).and.(nbs3(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs3(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs3(I,J).eq.128))ll=ll-1
if((mod(site(I,J),2).eq.1).and.(nbs3(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs3(I,J).eq.128))ll=ll+0.866
```

```
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.256))ll=ll+1
if((mod((site(I,J)/8),2).eq.1).and.(nbs3(I,J).eq.256))ll=ll+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs3(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs3(I,J).eq.256))ll=ll-1
if((mod(site(I,J),2).eq.1).and.(nbs3(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs3(I,J).eq.256))ll=ll+0.866
c To the fourth nighbor site
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.128))ll=ll+1
if((mod((site(I,J)/4),2).eq.1).and.(nbs4(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs4(I,J).eq.128))ll=ll-0.866
if((mod(site(I,J),2).eq.1).and.(nbs4(I,J).eq.128))ll=ll-1
if((mod((site(I,J)/32),2).eq.1).and.(nbs4(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs4(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.256))ll=ll+1
if((mod((site(I,J)/4),2).eq.1).and.(nbs4(I,J).eq.256))ll=ll+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs4(I,J).eq.256))ll=ll-0.866
if((mod(site(I,J),2).eq.1).and.(nbs4(I,J).eq.256))ll=ll-1
if((mod((site(I,J)/32),2).eq.1).and.(nbs4(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs4(I,J).eq.256))ll=ll+0.866
c To the fifth nighbor site
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.128))ll=ll+1
if((mod((site(I,J)/2),2).eq.1).and.(nbs5(I,J).eq.128))ll=ll+0.866
if((mod(site(I,J),2).eq.1).and.(nbs5(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs5(I,J).eq.128))ll=ll-1
if((mod((site(I,J)/16),2).eq.1).and.(nbs5(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs5(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.256))ll=ll+1
if((mod((site(I,J)/2),2).eq.1).and.(nbs5(I,J).eq.256))ll=ll+0.866
if((mod(site(I,J),2).eq.1).and.(nbs5(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs5(I,J).eq.256))ll=ll-1
if((mod((site(I,J)/16),2).eq.1).and.(nbs5(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/8),2).eq.1).and.(nbs5(I,J).eq.256))ll=ll+0.866
```

```
c To the sixth nighbor site
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.128))ll=ll+1
if((mod(site(I,J),2).eq.1).and.(nbs6(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs6(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs6(I,J).eq.128))ll=ll-1
if((mod((site(I,J)/8),2).eq.1).and.(nbs6(I,J).eq.128))ll=ll-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs6(I,J).eq.128))ll=ll+0.866
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.256))ll=ll+1
if((mod(site(I,J),2).eq.1).and.(nbs6(I,J).eq.256))ll=ll+0.866
if((mod((site(I,J)/32),2).eq.1).and.(nbs6(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/16),2).eq.1).and.(nbs6(I,J).eq.256))ll=ll-1
if((mod((site(I,J)/8),2).eq.1).and.(nbs6(I,J).eq.256))ll=ll-0.866
if((mod((site(I,J)/4),2).eq.1).and.(nbs6(I,J).eq.256))ll=ll+0.866
c
if((site(I,J).eq.128).or.(site(I,J).eq.0).or.(site(I,J).eq.64)
+.or.(site(I,J).eq.192).or.(site(I,J).eq.256)) goto 415
if((kk.gt.0).or.(ll.le.0)) goto 415
if((ll.gt.0).and.(kk.eq.0)) ee = mass(site(I,J))
if((ll.gt.0).and.(kk.eq.0)) site(I,J) = 256
ff = ff + ee
newsite(I,J)=256
site(I,J)=256
415 continue
c
c - Translation procedure –
c
c Translation scheme
do 160 I=1,xdir
do 160 J=1,ydir
c Collision rule between fluid and solid particle
if((site(I,j).eq.0).or.(site(I,j).eq.64).or.(site(i,j).eq.128)
+.or.(site(i,j).eq.192).or.(site(i,j).eq.256))goto 160
```

```
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.128))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.128))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.128))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.128))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.128))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.128))nbs6(I,J)=16
c Collision rule between fluid and adsorbed polymer particle
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.192))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.192))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.192))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.192))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.192))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.192))nbs6(I,J)=16
c Collision rule between fluid and gelled polymer particle
if((mod(site(I,J),2).eq.1).and.(nbs1(I,J).eq.256))nbs1(I,J)=8
if((mod((site(I,J)/32),2).eq.1).and.(nbs2(I,J).eq.256))nbs2(I,J)=4
if((mod((site(I,J)/16),2).eq.1).and.(nbs3(I,J).eq.256))nbs3(I,J)=2
if((mod((site(I,J)/8),2).eq.1).and.(nbs4(I,J).eq.256))nbs4(I,J)=1
if((mod((site(I,J)/4),2).eq.1).and.(nbs5(I,J).eq.256))nbs5(I,J)=32
if((mod((site(I,J)/2),2).eq.1).and.(nbs6(I,J).eq.256))nbs6(I,J)=16
160 continue
c
c - New configuration of particles in site(I,J) –
c
do 165 i=1,xdir
do 165 j=1,ydir
if(site(i,j).ge.64)newsite(i,j)=64
newsite(I,J)=newsite(I,J)+aps(nbs1(I,J),1)
newsite(I,J)=newsite(I,J)+aps(nbs2(I,J),2)
newsite(I,J)=newsite(I,J)+aps(nbs3(I,J),3)
newsite(I,J)=newsite(I,J)+aps(nbs4(I,J),4)
newsite(I,J)=newsite(I,J)+aps(nbs5(I,J),5)
```

```
newsite(I,J)=newsite(I,J)+aps(nbs6(I,J),6)
if(site(I,J).eq.128)newsite(I,J)=128
if(site(I,J).eq.192)newsite(I,J)=192
if(site(I,J).eq.256)newsite(I,J)=256
165 continue
do 167 i=1,xdir
do 167 j=1,ydir
nbs1(I,J)=0
nbs2(I,J)=0
nbs3(I,J)=0
nbs4(I,J)=0
nbs5(I,J)=0
nbs6(I,J)=0
167 continue
c
c - Updating site(I,J) –
c
do 170 I=1,xdir
do 170 J=1,ydir
site(I,J)=newsite(I,J)
if(newsite(I,J).eq.128)site(I,J)=128
if(newsite(I,J).eq.192)site(I,J)=192
if(newsite(I,J).eq.256)site(I,J)=256
170 continue
c
c - Rotation rule –
c
do 180 I=1,xdir
do 180 J=1,ydir
if(site(I,J).eq.0)newsite(I,J)=0
if(site(I,J).eq.1)newsite(I,J)=1
if(site(I,J).eq.2)newsite(I,J)=2
```

```
if(site(I,J).eq.3)newsite(I,J)=3
if(site(I,J).eq.4)newsite(I,J)=4
if(site(I,J).eq.6)newsite(I,J)=6
if(site(I,J).eq.7)newsite(I,J)=7
if(site(I,J).eq.8)newsite(I,J)=8
if(site(I,J).eq.12)newsite(I,J)=12
if(site(I,J).eq.14)newsite(I,J)=14
if(site(I,J).eq.15)newsite(I,J)=15
if(site(I,J).eq.16)newsite(I,J)=16
if(site(I,J).eq.24)newsite(I,J)=24
if(site(I,J).eq.28)newsite(I,J)=28
if(site(I,J).eq.30)newsite(I,J)=30
if(site(I,J).eq.32)newsite(I,J)=32
if(site(I,J).eq.33)newsite(I,J)=33
if(site(I,J).eq.35)newsite(I,J)=35
if(site(I,J).eq.39)newsite(I,J)=39
if(site(I,J).eq.48)newsite(I,J)=48
if(site(I,J).eq.49)newsite(I,J)=49
if(site(I,J).eq.51)newsite(I,J)=51
if(site(I,J).eq.56)newsite(I,J)=56
if(site(I,J).eq.57)newsite(I,J)=57
if(site(I,J).eq.60)newsite(I,J)=60
if(site(I,J).eq.63)newsite(I,J)=63
if(site(I,J).eq.64)newsite(I,J)=64
if(site(I,J).eq.67)newsite(I,J)=67
if(site(I,J).eq.70)newsite(I,J)=70
if(site(I,J).eq.71)newsite(I,J)=71
if(site(I,J).eq.76)newsite(I,J)=76
if(site(I,J).eq.78)newsite(I,J)=78
if(site(I,J).eq.79)newsite(I,J)=79
if(site(I,J).eq.88)newsite(I,J)=88
if(site(I,J).eq.92)newsite(I,J)=92
```

```
if(site(I,J).eq.94)newsite(I,J)=94
if(site(I,J).eq.95)newsite(I,J)=95
if(site(I,J).eq.97)newsite(I,J)=97
if(site(I,J).eq.99)newsite(I,J)=99
if(site(I,J).eq.103)newsite(I,J)=103
if(site(I,J).eq.111)newsite(I,J)=111
if(site(I,J).eq.112)newsite(I,J)=112
if(site(I,J).eq.113)newsite(I,J)=113
if(site(I,J).eq.115)newsite(I,J)=115
if(site(I,J).eq.119)newsite(I,J)=119
if(site(I,J).eq.120)newsite(I,J)=120
if(site(I,J).eq.121)newsite(I,J)=121
if(site(I,J).eq.123)newsite(I,J)=123
if(site(I,J).eq.124)newsite(I,J)=124
if(site(I,J).eq.125)newsite(I,J)=125
if(site(I,J).eq.126)newsite(I,J)=126
if(site(I,J).eq.127)newsite(I,J)=127
c
if(site(I,J).eq.5)newsite(I,J)=66
if(site(I,J).eq.10)newsite(I,J)=68
if(site(I,J).eq.17)newsite(I,J)=96
if(site(I,J).eq.20)newsite(I,J)=72
if(site(I,J).eq.21)newsite(I,J)=42
if(site(I,J).eq.31)newsite(I,J)=110
if(site(I,J).eq.34)newsite(I,J)=65
if(site(I,J).eq.40)newsite(I,J)=80
if(site(I,J).eq.42)newsite(I,J)=21
if(site(I,J).eq.47)newsite(I,J)=87
if(site(I,J).eq.55)newsite(I,J)=107
if(site(I,J).eq.59)newsite(I,J)=117
if(site(I,J).eq.61)newsite(I,J)=122
if(site(I,J).eq.62)newsite(I,J)=93
```

```
if(site(I,J).eq.65)newsite(I,J)=34
if(site(I,J).eq.66)newsite(I,J)=5
if(site(I,J).eq.68)newsite(I,J)=10
if(site(I,J).eq.72)newsite(I,J)=20
if(site(I,J).eq.80)newsite(I,J)=40
if(site(I,J).eq.85)newsite(I,J)=106
if(site(I,J).eq.87)newsite(I,J)=47
if(site(I,J).eq.93)newsite(I,J)=62
if(site(I,J).eq.96)newsite(I,J)=17
if(site(I,J).eq.106)newsite(I,J)=85
if(site(I,J).eq.107)newsite(I,J)=55
if(site(I,J).eq.110)newsite(I,J)=31
if(site(I,J).eq.117)newsite(I,J)=59
if(site(I,J).eq.122)newsite(I,J)=61
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.9).and.(g.eq.0))newsite(I,J)=36
if((site(I,J).eq.9).and.(g.eq.1))newsite(I,J)=18
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.11).and.(g.eq.0))newsite(I,J)=38
if((site(I,J).eq.11).and.(g.eq.1))newsite(I,J)=69
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.13).and.(g.eq.0))newsite(I,J)=74
if((site(I,J).eq.13).and.(g.eq.1))newsite(I,J)=22
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.18).and.(g.eq.0))newsite(I,J)=9
if((site(I,J).eq.18).and.(g.eq.1))newsite(I,J)=36
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
```

```
if((site(I,J).eq.19).and.(g.eq.0))newsite(I,J)=98
if((site(I,J).eq.19).and.(g.eq.1))newsite(I,J)=37
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.22).and.(g.eq.0))newsite(I,J)=13
if((site(I,J).eq.22).and.(g.eq.1))newsite(I,J)=74
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.23).and.(g.eq.0))newsite(I,J)=102
if((site(I,J).eq.23).and.(g.eq.1))newsite(I,J)=75
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.25).and.(g.eq.0))newsite(I,J)=52
if((site(I,J).eq.25).and.(g.eq.1))newsite(I,J)=104
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.26).and.(g.eq.0))newsite(I,J)=84
if((site(I,J).eq.26).and.(g.eq.1))newsite(I,J)=44
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.27).and.(g.eq.0))newsite(I,J)=45
if((site(I,J).eq.27).and.(g.eq.1))newsite(I,J)=54
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.29).and.(g.eq.0))newsite(I,J)=90
if((site(I,J).eq.29).and.(g.eq.1))newsite(I,J)=108
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.36).and.(g.eq.0))newsite(I,J)=18
if((site(I,J).eq.36).and.(g.eq.1))newsite(I,J)=9
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
```

```
if((site(I,J).eq.37).and.(g.eq.0))newsite(I,J)=19
if((site(I,J).eq.37).and.(g.eq.1))newsite(I,J)=98
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.38).and.(g.eq.0))newsite(I,J)=69
if((site(I,J).eq.38).and.(g.eq.1))newsite(I,J)=11
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.41).and.(g.eq.0))newsite(I,J)=81
if((site(I,J).eq.41).and.(g.eq.1))newsite(I,J)=50
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.43).and.(g.eq.0))newsite(I,J)=83
if((site(I,J).eq.43).and.(g.eq.1))newsite(I,J)=101
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.44).and.(g.eq.0))newsite(I,J)=26
if((site(I,J).eq.44).and.(g.eq.1))newsite(I,J)=84
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.45).and.(g.eq.0))newsite(I,J)=54
if((site(I,J).eq.45).and.(g.eq.1))newsite(I,J)=27
z=mod(a*z,m) zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.46).and.(g.eq.0))newsite(I,J)=77
if((site(I,J).eq.46).and.(g.eq.1))newsite(I,J)=86
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.50).and.(g.eq.0))newsite(I,J)=41
if((site(I,J).eq.50).and.(g.eq.1))newsite(I,J)=81
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.52).and.(g.eq.0))newsite(I,J)=104
```

```
if((site(I,J).eq.52).and.(g.eq.1))newsite(I,J)=25
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.53).and.(g.eq.0))newsite(I,J)=105
if((site(I,J).eq.53).and.(g.eq.1))newsite(I,J)=114
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.54).and.(g.eq.0))newsite(I,J)=27
if((site(I,J).eq.54).and.(g.eq.1))newsite(I,J)=45
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.58).and.(g.eq.0))newsite(I,J)=116
if((site(I,J).eq.58).and.(g.eq.1))newsite(I,J)=89
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.69).and.(g.eq.0))newsite(I,J)=11
if((site(I,J).eq.69).and.(g.eq.1))newsite(I,J)=38
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.73).and.(g.eq.0))newsite(I,J)=100
if((site(I,J).eq.73).and.(g.eq.1))newsite(I,J)=82
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.74).and.(g.eq.0))newsite(I,J)=22
if((site(I,J).eq.74).and.(g.eq.1))newsite(I,J)=13
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.75).and.(g.eq.0))newsite(I,J)=23
if((site(I,J).eq.75).and.(g.eq.1))newsite(I,J)=102
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.77).and.(g.eq.0))newsite(I,J)=86
```

```
if((site(I,J).eq.77).and.(g.eq.1))newsite(I,J)=46
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.81).and.(g.eq.0))newsite(I,J)=50
if((site(I,J).eq.81).and.(g.eq.1))newsite(I,J)=41
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.82).and.(g.eq.0))newsite(I,J)=73
if((site(I,J).eq.82).and.(g.eq.1))newsite(I,J)=100
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.83).and.(g.eq.0))newsite(I,J)=101
if((site(I,J).eq.83).and.(g.eq.1))newsite(I,J)=43
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.84).and.(g.eq.0))newsite(I,J)=44
if((site(I,J).eq.84).and.(g.eq.1))newsite(I,J)=26
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.86).and.(g.eq.0))newsite(I,J)=46
if((site(I,J).eq.86).and.(g.eq.1))newsite(I,J)=77
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.89).and.(g.eq.0))newsite(I,J)=58
if((site(I,J).eq.89).and.(g.eq.1))newsite(I,J)=116
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.90).and.(g.eq.0))newsite(I,J)=108
if((site(I,J).eq.90).and.(g.eq.1))newsite(I,J)=29
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.91).and.(g.eq.0))newsite(I,J)=109
```

```
if((site(I,J).eq.91).and.(g.eq.1))newsite(I,J)=118
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.98).and.(g.eq.0))newsite(I,J)=37
if((site(I,J).eq.98).and.(g.eq.1))newsite(I,J)=19
z=mod(a*z,m)
zr=z/zm

g=nint(zr*1.)   if((site(I,J).eq.100).and.(g.eq.0))newsite(I,J)=82
if((site(I,J).eq.100).and.(g.eq.1))newsite(I,J)=73
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.101).and.(g.eq.0))newsite(I,J)=43
if((site(I,J).eq.101).and.(g.eq.1))newsite(I,J)=83
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.102).and.(g.eq.0))newsite(I,J)=75
if((site(I,J).eq.102).and.(g.eq.1))newsite(I,J)=23
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.104).and.(g.eq.0))newsite(I,J)=25
if((site(I,J).eq.104).and.(g.eq.1))newsite(I,J)=52
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.105).and.(g.eq.0))newsite(I,J)=114
if((site(I,J).eq.105).and.(g.eq.1))newsite(I,J)=53
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.108).and.(g.eq.0))newsite(I,J)=29
if((site(I,J).eq.108).and.(g.eq.1))newsite(I,J)=90
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
```

```
if((site(I,J).eq.109).and.(g.eq.0))newsite(I,J)=118
if((site(I,J).eq.109).and.(g.eq.1))newsite(I,J)=91
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.114).and.(g.eq.0))newsite(I,J)=53
if((site(I,J).eq.114).and.(g.eq.1))newsite(I,J)=105
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.116).and.(g.eq.0))newsite(I,J)=89
if((site(I,J).eq.116).and.(g.eq.1))newsite(I,J)=58
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
if((site(I,J).eq.118).and.(g.eq.0))newsite(I,J)=91
if((site(I,J).eq.118).and.(g.eq.1))newsite(I,J)=109
if(site(I,J).eq.128)newsite(I,J)=128
if(site(I,J).eq.192)newsite(I,J)=192
if(site(I,J).eq.256)newsite(I,J)=256
if(site(I,J).eq.0)newsite(I,J)=0 site(I,J) = newsite(I,J)
180 continue
if(t.eq.1)goto 222
if(t.eq.ts)goto 222
if((t.le.5000).or.(t.gt.9320)) goto 111
if(mod(t,200).ne.0) goto 90
c
c - Recalculating porosity in iteration –
c
111 ddddd=0
if(mod(t,200).ne.0) goto 90
222 ddddd=0
void = 0
voida = 0
kosong = 0
```

```
kosonga = 0
do 4209 I = 1, xdir
do 4309 J = 1, ydir
if(site(I,J).ne.128) void = void + 1
if((site(I,J).ne.128).and.(site(I,J).ne.192).and.(site(I,J).ne.
+256))voida = voida + 1
4309 continue
kosong = kosong + void
kosonga = kosonga + voida
void = 0
voida = 0
4209 continue
total = xdir * ydir
porosity = kosong/total
c -
c - Calculating the number of gelled polymer particles –
c -
hh = ff
c
c - Calculated variables –
c
masstot = 0
vxt = 0
mxt = 0
do 4409 I = 1, xdir
do 4409 J = 1, ydir
if(site(I,J).eq.128) goto 4409
if(site(I,J).eq.192) goto 4409
if(site(I,J).eq.256) goto 4409
if(site(I,J).eq.0) goto 4409
if(mod(site(I,J),2).eq.1)masstot=masstot+1 if(mod((site(I,J)/2),2).eq.1)
masstot=masstot+1 if(mod((site(I,J)/4),2).eq.1)masstot=masstot+1 if(-
```

```
mod((site(I,J)/8),2).eq.1)masstot=masstot+1 if(mod((site(I,J)/16),2).eq.1)
masstot=masstot+1
if(mod((site(I,J)/32),2).eq.1)masstot=masstot+1 if(site(I,J).ge.64)massto-
t=masstot+1
4409 continue
do 4509 I = 1, xdir
do 4509 J = 1, ydir
masite = 0
if(site(I,J).eq.128) goto 4709
if(site(I,J).eq.192) goto 4709
if(site(I,J).eq.256) goto 4709
if(site(I,J).eq.0) goto 4709
if(mod(site(I,J),2).eq.1)masite=masite+1 if(mod((site(I,J)/2),2).eq.1)
masite=masite+1 if(mod((site(I,J)/4),2).eq.1)masite=masite+1 if(-
mod((site(I,J)/8),2).eq.1)masite=masite+1 if(mod((site(I,J)/16),2).eq.1)
masite=masite+1 if(mod((site(I,J)/32),2).eq.1)masite=masite+1
if(site(I,J).ge.64)masite=masite+1
4709 zzzzz=0
if(site(I,J).eq.64) goto 4509
if((site(I,J).gt.0).and.(site(I,J).lt.128))vxt=vxt +
+(momx(site(I,J)))/masite if((site(I,J).gt.0).and.(site(I,J).lt.128))mxt=mxt +
+momx(site(I,J)) 4509 continue
c
c - Density -
c
denc = masstot/kosong
c
c - Kinematic viscosity –
c
d=denc/7
kinevis=(1.0/28/(d*(1-d))/(1-8*d*(1-d)/7))-(1/8)
c
c - Dynamic viscosity –
```

```
c
dynavis = denc * kinevis
c
c - Velocity –
c
velx = vxt / kosong
c
c - Flow rate –
c
flow = velx * porosity
c
c - Calculate momentum at left boundary –
c
wx = 0
void = 0
do 4809 J = 1, ydir

if((site(0,J).eq.0).or.(site(0,J).eq.64)) goto 4809
if((site(0,J).eq.128).or.(site(0,J).eq.192)) goto 4809
if(site(0,J).eq.256) goto 4809
if((site(0,J).gt.0).and.(site(0,J).lt.128)) wx=wx+momx(site(0,J))
4809 continue
c
c - Pressure –
c
press = wx/(ydir*0.8660254)
c
c - Pressure gradient –
c
pressgrad =  wx/(ydir*0.8660254)/xdir
c
c - Permeability –
```

```
c
permeability = (vxt/kosong*porosity)*dynavis/pressgrad
c
c - Print on screen and write on file –
c
print *,t,velx,permeability,ff
write (5,*)t,velx,permeability,ff
90 continue
2222 end
```

BAB 5

Pemodelan dan Simulasi Pendesakan Minyak

Dalam bab ini dibahas mengenai model injeksi polimer dengan metode lattice gas automata (LGA). Pada kasus ini polimer diinjeksikan untuk mendesak minyak. Prosedur untuk simulasi injeksi polimer diterapkan dengan menggunakan model multifasa dan aturan tumbukan untuk adsorpsi polimer. Pada bagian akhir diberikan pemrograman komputer untuk simulasi injeksi polimer.

5.1 Pemodelan Proses Pendesakan Minyak

Untuk system media berpori yang dijenuhi oleh minyak dan air untuk model LGA, saturasi minyak dapat didefinisikan sebagai jumlah total partikel minyak (jumlah situs yang ditempati minyak) dibagi dengan jumlah total partikel minyak (jumlah situs yang ditempati minyak) dan jumlah total partikel air (jumlah situs yang ditempati air). Dalam bentuk persamaan matematika dapat dinyatakan sebagai berikut (Fathaddin, 2006).

$$S_o = \frac{1}{n}\sum_{r=1}^{n} \frac{\sum_i N_{oi}(r,t)}{\sum_i N_{oi}(r,t) + \sum_i N_{wi}(r,t)} \tag{5.1}$$

Dan

$$S_w = \frac{1}{n}\sum_{r=1}^{n} \frac{\sum_i N_{wi}(r,t)}{\sum_i N_{oi}(r,t) + \sum_i N_{wi}(r,t)} \tag{5.2}$$

Saturasi minyak mula-mula dan saturasi minyak sisa berturut-turut dapat dinyatakan dengan persamaan-persamaan berikut:

$$S_o = \frac{1}{n}\sum_{r=1}^{n} \frac{\sum_i N_{oi}(r,0)}{\sum_i N_{oi}(r,0) + \sum_i N_{wi}(r,0)} \tag{5.3}$$

dan

$$S_{or} = \frac{1}{n}\sum_{r=1}^{n} \frac{\sum_i N_{oi}(r,t_{dis})}{\sum_i N_{oi}(r,t_{dis}) + \sum_i N_{wi}(r,t_{dis})} \tag{5.4}$$

Sehingga faktor perolehan dapat dinyatakan dengan persamaan berikut (Fathaddin dkk., 2005; Fathaddin, 2006):

$$RF = 1 - \frac{\frac{1}{n}\sum_{r=1}^{n} \frac{\sum_i N_{oi}(r,t_{dis})}{\sum_i N_{oi}(r,t_{dis}) + \sum_i N_{wi}(r,t_{dis})}}{\frac{1}{n}\sum_{r=1}^{n} \frac{\sum_i N_{oi}(r,0)}{\sum_i N_{oi}(r,0) + \sum_i N_{wi}(r,0)}} \tag{5.5}$$

Dan efisiensi pendesakan (Fathaddin dan Awang, 2005; Fathaddin, 2006):

$$D_{eff} = \frac{1}{n}\sum_{r=1}^{n} \frac{\sum_i N_{oi}(r,0) - \sum_i N_{oi}(r,t_{dis})}{\sum_i N_{oi}(r,0)} \tag{5.6}$$

Konsep permeabilitas relatif minyak dan air dapat diaplikasikan untuk model LGA dengan bentuk persamaan berikut (Fathaddin dan Awang, 2005; Fathaddin, 2006):

$$k_{rw} = k_{rw}^{o}\left(\frac{1}{n}\sum_{r=1}^{n}\frac{\frac{\sum_i N_{wi(r,t)}}{\sum_i N_{oi(r,t)}+\sum_i N_{wi(r,t)}}-\frac{\sum_i N_{wi(r,0)}}{\sum_i N_{oi(r,0)}+\sum_i N_{wi(r,0)}}}{1-\frac{\sum_i N_{oi(r,t_{dis})}}{\sum_i N_{oi(r,t_{dis})}+\sum_i N_{wi(r,t_{dis})}}-\frac{\sum_i N_{wi(r,0)}}{\sum_i N_{oi(r,0)}+\sum_i N_{wi(r,0)}}}\right)^{n_w} \quad (5.7)$$

dan

$$k_{ro} = k_{ro}^{o}\left(\frac{1}{n}\sum_{r=1}^{n}\frac{1-\frac{\sum_i N_{wi(r,t)}}{\sum_i N_{oi(r,t)}+\sum_i N_{wi(r,t)}}-\frac{\sum_i N_{oi(r,t_{dis})}}{\sum_i N_{oi(r,t_{dis})}+\sum_i N_{wi(r,t_{dis})}}}{1-\frac{\sum_i N_{oi(r,t_{dis})}}{\sum_i N_{oi(r,t_{dis})}+\sum_i N_{wi(r,t_{dis})}}-\frac{\sum_i N_{wi(r,0)}}{\sum_i N_{oi(r,0)}+\sum_i N_{wi(r,0)}}}\right)^{n_w} \quad (5.8)$$

Untuk simulasi perpindahan polimer, ada beberapa hal yang dipertimbangkan dalam pemodelan LGA yaitu sebagai berikut:

1. Ada tiga jenis cairan yang terlibat dalam pendesakan minyak yaitu minyak, air dan polimer. Di sini, model fluida biner (Rothman dan Keller, 1988) diterapkan untuk menentukan aturan tumbukan antara dua cairan yang tidak dapat bercampur yaitu antara partikel minyak dan air dan antara partikel minyak dan polimer.
2. Tumbukan antar partikel cairan yang sejenis yaitu antar partikel minyak, antar partikel air atau antar partikel polimer ditentukan oleh aturan tumbukan FHP III (Buick, 1997). Aturan tumbukan juga digunakan untuk tumbukan antara dua cairan yang bercampur yaitu antara air dan polimer.
3. Tumbukan antara partikel cair dan padat diwakili oleh kondisi batas tidak licin karena dalam mekanika fluida pada umumnya dan aliran berpori pada khususnya, kecepatan cairan kental pada batas padat biasanya diasumsikan nol (Rothman, 1988).
4. Proses adsorpsi polimer antara polimer dan permukaan padat diwakili oleh aturan tumbukan untuk proses adsorpsi polimer seperti yang diberikan pada Gambar 2.1 (Fathaddin dan Awang, 2004; Fathaddin, 2006).

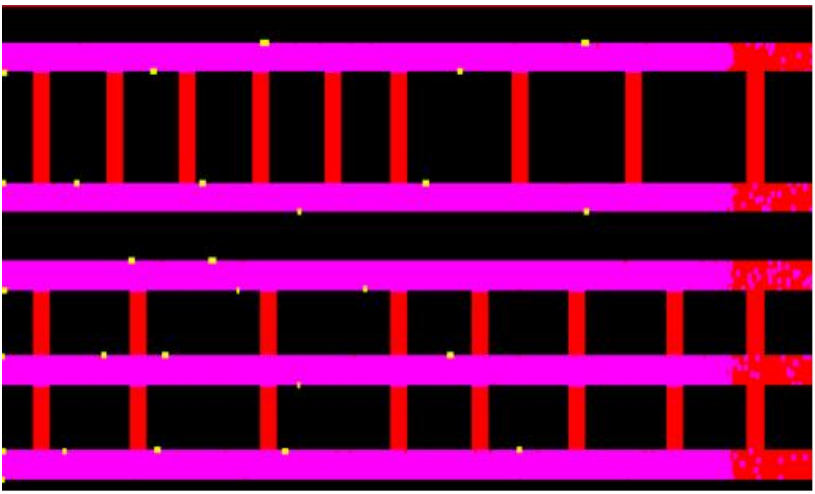
5.2 Simulasi Proses Pendesakan Minyak

Gambar 5.1 dan 5.2 memperlihatkan hasil simulasi pendesakan minyak. Simulator LGA untuk aliran dua fasa dibangun berdasarkan apa yang diuraikan di atas. Prosedur yang digunakan untuk simulasi pendesakan minyak dengan menginjeksikan larutan polimer diberikan sebagai berikut ((Fathaddin dkk., 2005; Fathaddin, 2006):

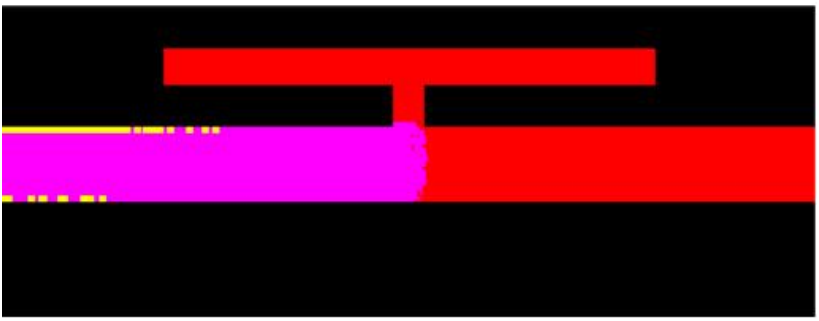
1. Media LGA yang mewakili media berpori (sampel core atau sandpack) dibuat dan diatur dengan memperhatikan ukuran, porositas, dan batas-batas kisi dan posisi rintangan.
2. Saturasi awal dan densitas partikel minyak dan air serta konsentrasi polimer yang diinjeksikan ditetapkan.
3. Durasi simulasi (langkah waktu) ditentukan.
4. Partikel larutan polimer di sepanjang batas hulu dimasukkan ke dalam media LGA. Nomor acak dihasilkan untuk mengatur arah aliran polimer.
5. Partikel fluida bergerak ke situs terdekat.
6. Posisi partikel fluida diperbarui.
7. Aturan tumbukan di seluruh kisi diterapkan. Aturan tersebut meliputi tumbukan antar partikel minyak dan tumbukan antar partikel polimer (aturan tumbukan FHP-III), tumbukan antara minyak dan partikel polimer (model fluida biner), tumbukan antara minyak dan partikel padat (*no slip boundary condition*), dan tumbukan antara polimer larutan dan partikel padat (aturan tumbukan adsorpsi polimer).
8. Uji apakah langkah waktu lebih besar dari durasi simulasi yang diberikan kemudian lanjutkan ke langkah berikutnya, jika tidak lanjutkan ke langkah 4.
9. Densitas, momentum dan kecepatan partikel minyak dan polimer pada setiap node dihitung. Proses perata-rataan parameter kecepatan (*coarse graining process*).
11. Gradien tekanan, saturasi, laju aliran, viskositas, permeabilitas relatif, aliran fraksional, dan faktor perolehan minyak dihitung.
12. Hasilnya ditampilkan dan simulasi selesai.

5.3 Program Simulasi Proses Pendesakan Minyak

Program komputer dibuat untuk mensimulasikan injeksi polimer untuk pendesakan minyak. Program komputer dibuat dalam Bahasa FORTRAN sebagai berikut:



Gambar 5.1 Simulasi injeksi polimer untuk pendesakan minyak pada media berpori 5 cm kali 2 cm setelah 200 detik. Area hitam mewakili padatan, area merah mewakili minyak, area ungu mewakili larutan polimer, titik ungu mewakili air, dan titik kuning adalah polimer teradsorpsi (Fathaddin, 2006)



Gambar 5.2 Simulasi injeksi polimer untuk pendesakan minyak volume pori pada media berpori dengan volume pori buntu. Posisi leher pori buntu berada di tengah media berpori (Fathaddin dkk., 2009)

```
Integer I,J,K,xdir,ydir,g, gg, bb, cc, dd real Tol
Integer tyop, tyoo, tyoq, recov, pecov, qecov
Integer t, poil, ppol, above, below, left
real site(550,450,5), newsite(550,450,5)
real  C(550,450),f(550,450),nbs0(550,450,5)
real nbs1(550,450,5),nbs2(550,450,5),nbs3(550,450,5)
real nbs4(550,450,5),nbs5(550,450,5),nbs6(550,450,5)
real aps(260,10,5),mass(256,5), cs real*4 zr, denco,dencp, kosong
real momx(260,5),momy(260,5),d,kineo,kinep,dynao,dynap
real  W1,W2,W3,W4,W5,W6,P0,P1,P2,P3,P4,P5,P6
real flowo,flowp
real velxo, velxp, pressp real pressgrad, swi
real oilsat,polsat,masstot,mastot Integer a,seed, ts
Data a,m,seed/1027,1048576,1/
c
c -Calling data file).And.(output file –
c
OPEN(UNIT=5,FILE='C:\simulata.OUT',
+STATUS='old')
z=seed zm=m
c       '=========================
c       '= Polymer Displacement =
c       '=========================
c       Note: Porus medium for various mobility ratio
c       Area = 5 cm x 1 cm
c       Mobility ratio= c
c       - data -
c       --------
c       Number of sites in x direction
xdir = 500
c       Number of sites in y direction
ydir = 100
```

```
c          time step
ts= 600
c          Initial water saturation
swi = 0.2
c          Existing oil fluid particle (codes = 0 - 127)
tyoa = 1
tyob = 2
tyoc = 4
tyod = 1
tyoe = 2
tyof = 4
c Existing water fluid particle (codes = 0 - 127)
tyog = 1
tyoh = 2
tyoi = 4
tyoj = 1
tyok = 2
tyol = 4
c Injecting polymer particle (codes = 0 - 7)
tyom = 1
tyon = 3
tyoo = 2
tyop = 4
tyoq = 5
tyor = 7
tyos = 1
tyot = 2
tyou = 6
tyov = 4
c Polymer concentration (ppm)
xn = 5000
c Types of layer (Tol) (Monolayer: Tol = 1 ; Multilayer: Tol = 2)
```

```
Tol = 1
c
c          - setting the obstacles –
c
do 10 i=1,xdir
do 10 j=1,ydir
do 10 k=1,3 site(i,j,k)=128
newsite(i,j,k)=128
10 continue
c          '==========================
c          '= Data of Porous Medium =
c          '==========================
c          Mainchannels c Mainchannel1
do 885 i=1,xdir
do 885 j=10,30
do 885 k= 1,3 site(i,j,k)=0
885 continue
c Mainchannel2
do 886 i=1,xdir
do 886 j=70,90
do 886 k= 1,3
site(i,j,k)=0
886 continue
c Branches
c Branch1
do 911 i=20,40
do 911 j=10,90
do 911 k= 1,3
site(i,j,k)=0
911 continue
c Branch2
do 913 i=60,80
```

```
do 913 j=10,90
do 913 k= 1,3
site(i,j,k)=0
913 continue
c Branch3
do 915 i=100,120
do 915 j=10,90
do 915 k= 1,3
site(i,j,k)=0
915 continue
c Branch4
do 917 i=150,170
do 917 j=10,90
do 917 k= 1,3
site(i,j,k)=0
917 continue
c Branch5
do 918 i=190,210
do 918 j=10,90
do 918 k= 1,3
site(i,j,k)=0
918 continue
c Branch6
do 920 i=240,260
do 920 j=10,90
do 920 k= 1,3
site(i,j,k)=0
920 continue
c Branch7
do 921 i=290,310
do 921 j=10,90
do 921 k= 1,3
```

```
site(i,j,k)=0
921 continue
c Branch8
do 923 i=350,370
do 923 j=10,90
do 923 k= 1,3
site(i,j,k)=0
923 continue
c Branch9
do 925 i=390,410
do 925 j=10,90
do 925 k= 1,3
site(i,j,k)=0
925 continue
c Branch10
do 927 i=460,480
do 927 j=10,90
do 927 k= 1,3
site(i,j,k)=0
927 continue
c
c - Define neighbor sites –
c
do 25 I=1,xdir
do 25 J=2,ydir-1
do 25 K=1,3
nbs0(I,J,K)=site(I,J,K)
nbs1(I,J,K)=site(I+1,J-1,K)
nbs2(I,J,K)=site(I-1,J-1,K)
nbs3(I,J,K)=site(I-1,J,K)
nbs4(I,J,K)=site(I-1,J+1,K)
nbs5(I,J,K)=site(I+1,J+1,K)
```

```
nbs6(I,J,K)=site(I+1,J,K)
25 continue
c
c   - Contact surface –
c
cs=0
do 30 I=1,xdir
do 30 J=1,ydir
If(site(I,J,1).LT.128) goto 30
If((nbs1(I,J,1).LT.128).OR.(nbs2(I,J,1).LT.128).
+OR.(nbs3(I,J,1).LT.128).OR.(nbs4(I,J,1).LT.128).
+OR.(nbs5(I,J,1).LT.128).OR.(nbs6(I,J,1).LT.128)) cs=cs+1
30 continue
c
c           - setting the open sites –
c
void=0
kosong=0
do 50 I=1,xdir
do 40 J=1,ydir
If(site(I,J,1).lt.128)void=void+1
40 continue
kosong=kosong+void
void=0
50 continue
c
c - calculating porosity –
c
total=xdir*ydir
porosity=kosong/total
c
c - Distributing oil and polymer particles –
```

```
c
do 70 I=1,xdir
do 70 J=1,ydir
If(site(i,j,1).ge.128) goto 70
If(site(i,j,2).ge.128) goto 70
If(site(i,j,3).ge.128) goto 70
z=mod(a*z,m)
zr=z/zm gg=nint(zr*99.)
swii=swi*100
if (gg.lt.swii) goto 71
c
c           - Oil particle –
c
z=mod(a*z,m)
zr=z/zm
ff=nint(zr*5.)
if(ff.eq.0)site(i,j,2)=Tyoa
if(ff.eq.1)site(i,j,2)=Tyob
if(ff.eq.2)site(i,j,2)=Tyoc
if(ff.eq.3)site(i,j,2)=Tyod
if(ff.eq.4)site(i,j,2)=Tyoe
if(ff.eq.5)site(i,j,2)=Tyof
goto 70
c
c  - Water particle –
c
71 dddd=0
z=mod(a*z,m)
zr=z/zm
ff=nint(zr*3.)
if(ff.eq.0)site(i,j,3)=Tyog
if(ff.eq.1)site(i,j,3)=Tyoh
```

```
if(ff.eq.2)site(i,j,3)=Tyoi
if(ff.eq.3)site(i,j,3)=Tyoj
if(ff.eq.4)site(i,j,3)=Tyok
if(ff.eq.5)site(i,j,3)=Tyol
70 continue
c
c  - Calculating oil & polymer mass –
c
massto=0
masstp=0
do 80 I=1,xdir
do 80 J=1,ydir
If ((site(I,J,2).eq.128).or.(site(I,J,2).eq.192)) goto 85
If  ((site(I,J,2).eq.256).or.(site(I,J,2).eq.0))  goto  85  If(mod(site(I,J,2),2).
eq.1)massto=massto+1      If(mod((site(I,J,2)/2),2).eq.1)massto=massto+1
If(mod((site(I,J,2)/4),2).eq.1)massto=massto+1    If(mod((site(I,J,2)/8),2).
eq.1)massto=massto+1    If(mod((site(I,J,2)/16),2).eq.1)massto=massto+1
If(mod((site(I,J,2)/32),2).eq.1)massto=massto+1  If(site(I,J,2).ge.64)mass-
to=massto+1
85 aaaa=0
If ((site(I,J,3).eq.128).or.(site(I,J,3).eq.192)) goto 80
If  ((site(I,J,3).eq.256).or.(site(I,J,3).eq.0))  goto  80  If(mod(site(I,J,3),2).
eq.1)masstp=masstp+1      If(mod((site(I,J,3)/2),2).eq.1)masstp=masstp+1
If(mod((site(I,J,3)/4),2).eq.1)masstp=masstp+1    If(mod((site(I,J,3)/8),2).
eq.1)masstp=masstp+1    If(mod((site(I,J,3)/16),2).eq.1)masstp=masstp+1
If(mod((site(I,J,3)/32),2).eq.1)masstp=masstp+1  If(site(I,J,3).ge.64)masst-
p=masstp+1
80 continue
denco=massto/kosong
dencp=masstp/kosong
masstot=massto+masstp
poil=massto
ppol=masstp
c
```

```
c - Calculating intial oil and polymer saturation –
c
oilsat=massto/masstot
polsat=masstp/masstot
swi=polsat
print *,”Porosity=”,porosity
write (5,*)”Porosity=”,porosity
print *,”Surface Length (cm)=”,cs/100
write (5,*)”Surface Length (cm)=”,cs/100
print *,”Initial oilsat=”,oilsat
write (5,*)”Initial oilsat=”,oilsat
print *,”Initial watsat=”,polsat
write (5,*)”Initial watsat=”,polsat
print *,”Tsec,Oilsat,Polsat,Oilvis,Polvis,Producedoilparticles”
write (5,*)”Tsec,Oilsat,Polsat,Oilvis,Polvis,Producedoilparticles”
c
c          - Main program –
c
do 90 t=1,ts
c
c          - Input the polymer particles along the left boundary –
c
do 95 j=1,ydir
z=mod(a*z,m)
zr=z/zm
g=nint(zr*9.)
If(g.eq.0)site(0,J,3)=tyom
If(g.eq.1)site(0,J,3)=tyon
If(g.eq.2)site(0,J,3)=tyoo
If(g.eq.3)site(0,J,3)=tyop
If(g.eq.4)site(0,J,3)=tyoq
If(g.eq.5)site(0,J,3)=tyor
```

```
If(g.eq.6)site(0,J,3)=tyos
If(g.eq.7)site(0,J,3)=tyot
If(g.eq.8)site(0,J,3)=tyou
If(g.eq.9)site(0,J,3)=tyov
If(g.eq.0)site(1,J,3)=tyom
If(g.eq.1)site(1,J,3)=tyon
If(g.eq.2)site(1,J,3)=tyoo
If(g.eq.3)site(1,J,3)=tyop
If(g.eq.4)site(1,J,3)=tyoq
If(g.eq.5)site(1,J,3)=tyor
If(g.eq.6)site(1,J,3)=tyos
If(g.eq.7)site(1,J,3)=tyot
If(g.eq.8)site(1,J,3)=tyou
If(g.eq.9)site(1,J,3)=tyov
site(0,J,2)=128
site(1,J,2)=128
95 continue
c
c          - Define neighbor sites –
c
do 120 I=1,xdir
do 120 J=2,ydir-1
do 120 K=1,3
nbs0(I,J,K)=site(I,J,K)
nbs1(I,J,K)=site(I+1,J-1,K)
nbs2(I,J,K)=site(I-1,J-1,K)
nbs3(I,J,K)=site(I-1,J,K)
nbs4(I,J,K)=site(I-1,J+1,K)
nbs5(I,J,K)=site(I+1,J+1,K)
nbs6(I,J,K)=site(I+1,J,K)
120 continue
c
```

```
c -Translation procedure –
c
c Reset newsite(I,J)
do 150 I=1,xdir
do 150 J=1,ydir
do 150 K=1,3
newsite(I,J,K)=0
150 continue
c
c -Define added particles from neighbor sites after particle collisions –
c
do 130 I=1,128
do 130 K=1,3
c Reset added particle from neighbor sites
aps(I,0,K)=0
aps(I,1,K)=0
aps(I,2,K)=0
aps(I,3,K)=0
aps(I,4,K)=0
aps(I,5,K)=0
aps(I,6,K)=0
c Reset mass).And.(momentum at neighbor sites
mass(I,K)=0
momx(I,K)=0
momy(I,K)=0
130 continue
do 140 I=0,128
do 140 K=1,3
c Added particles to site(I,J,K) from the site
If (I.ge.64)aps(I,0,K)=64
c Added particles to site(I,J,K) from the first nighbor site
If(mod((I/8),2).eq.1)aps(I,1,K)=8
```

```
c Added particles to site(I,J,K) from the second nighbor site
If(mod((I/4),2).eq.1)aps(I,2,K)=4
c Added particles to site(I,J,K) from the third nighbor site
If(mod((I/2),2).eq.1)aps(I,3,K)=2
c Added particles to site(I,J) from the fourth nighbor site
If(mod(I,2).eq.1)aps(I,4,K)=1
c Added particles to site(I,J,K) from the fifth nighbor site
If(mod((I/32),2).eq.1)aps(I,5,K)=32
c Added particles to site(I,J,K) from the sixth nighbor site
If(mod((I/16),2).eq.1)aps(I,6,K)=16
c Define mass).And.(momentum of particle moving toward the first nighbor site
If(mod(I,2).eq.1) then
mass(I,K)=mass(I,K)+1
momx(I,K)=momx(I,K)+0.5
momy(I,K)=momy(I,K)+((sqrt(3.0))/2.0)
endif
c Define mass).And.(momentum of particle moving toward the second nighbor site
If(mod((I/32),2).eq.1) then
mass(I,K)=mass(I,K)+1
momx(I,K)=momx(I,K)-0.5
momy(I,K)=momy(I,K)+((sqrt(3.0))/2.0)
endif
c Define mass).And.(momentum of particle moving toward the third nighbor site
If(mod((I/16),2).eq.1) then
mass(I,K)=mass(I,K)+1
momx(I,K)=momx(I,K)-1
momy(I,K)=0
endif
c Define mass).And.(momentum of particle moving toward the fourth nighbor site
```

```
If(mod((I/8),2).eq.1) then
mass(I,K)=mass(I,K)+1
momx(I,K)=momx(I,K)-0.5
momy(I,K)=momy(I,K)-((sqrt(3.0))/2.0)
endif
c Define mass).And.(momentum of particle moving toward the fifth neighbor site
If(mod((I/4),2).eq.1) then
mass(I,K)=mass(I,K)+1
momx(I,K)=momx(I,K)+0.5
momy(I,K)=momy(I,K)-((sqrt(3.0))/2.0)
endif
c Define mass).And.(momentum of particle moving toward the sixth neighbor site
If(mod((I/2),2).eq.1) then
mass(I,K)=mass(I,K)+1
momx(I,K)=momx(I,K)+1
momy(I,K)=0
endif
If(I.ge.64)mass(I,K)=mass(I,K)+1
140 continue
c
c -Polymer adsorption process –
c
dddd = 0.00000464427119*xn**0.706571160678112
do 410 I=1,xdir
do 410 J=1,ydir
if(I.gt.t) goto 410
z=mod(a*z,m)
zr=z/zm
gg=nint(zr/dddd)
v=0
```

```
vv=0.866
If(Tol.gt.1) goto 143
C Monolayer (Langmuir) Type c To the first nighbor site
If((mod(site(I,J,3),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v+vv
c To the second nighbor site
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v-vv
If((mod(site(I,J,3),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v+vv
c To the third nighbor site
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v-1
If((mod(site(I,J,3),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v+vv
c To the fourth nighbor site
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v-vv
If((mod(site(I,J,3),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v+vv
c To the fifth nighbor site
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v+1
```

```
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v+vv
If((mod(site(I,J,3),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v+vv
c To the sixth nighbor site
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v+1
If((mod(site(I,J,3),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v+vv
goto 147
143 zzzzz=0
c Multilayer Type
c To the first nighbor site
If((mod(site(I,J,3),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs1(I,J,3).eq.128))v=v+vv
If((mod(site(I,J,3),2).eq.1).and.(nbs1(I,J,3).eq.192))v=v+1
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs1(I,J,3).eq.192))v=v+vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs1(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs1(I,J,3).eq.192))v=v-1
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs1(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs1(I,J,3).eq.192))v=v+vv
c To the second nighbor site
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v-vv
```

```
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v-vv
If((mod(site(I,J,3),2).eq.1).and.(nbs2(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs2(I,J,3).eq.192))v=v+1
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs2(I,J,3).eq.192))v=v+vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs2(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs2(I,J,3).eq.192))v=v-1
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs2(I,J,3).eq.192))v=v-vv
If((mod(site(I,J,3),2).eq.1).and.(nbs2(I,J,3).eq.192))v=v+vv
c To the third nighbor site
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v-1
If((mod(site(I,J,3),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs3(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs3(I,J,3).eq.192))v=v+1
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs3(I,J,3).eq.192))v=v+vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs3(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs3(I,J,3).eq.192))v=v-1
If((mod(site(I,J,3),2).eq.1).and.(nbs3(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs3(I,J,3).eq.192))v=v+vv
c To the fourth nighbor site
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v-vv
If((mod(site(I,J,3),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs4(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs4(I,J,3).eq.192))v=v+1
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs4(I,J,3).eq.192))v=v+vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs4(I,J,3).eq.192))v=v-vv
```

```
If((mod(site(I,J,3),2).eq.1).and.(nbs4(I,J,3).eq.192))v=v-1
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs4(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs4(I,J,3).eq.192))v=v+vv
c To the fifth nighbor site
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v+1
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v+vv
If((mod(site(I,J,3),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs5(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs5(I,J,3).eq.192))v=v+1
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs5(I,J,3).eq.192))v=v+vv
If((mod(site(I,J,3),2).eq.1).and.(nbs5(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs5(I,J,3).eq.192))v=v-1
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs5(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs5(I,J,3).eq.192))v=v+vv
c To the sixth nighbor site
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v+1
If((mod(site(I,J,3),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v-1
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v-vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs6(I,J,3).eq.128))v=v+vv
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs6(I,J,3).eq.192))v=v+1
If((mod(site(I,J,3),2).eq.1).and.(nbs6(I,J,3).eq.192))v=v+vv
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs6(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs6(I,J,3).eq.192))v=v-1
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs6(I,J,3).eq.192))v=v-vv
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs6(I,J,3).eq.192))v=v+vv
147 zzzzz=0
If((site(I,J,3).eq.128).or.(site(I,J,3).eq.0)
+.or.(site(I,J,3).eq.64).or.(site(I,J,3).eq.192)) goto 410
```

```
If((gg.gt.0).or.(v.le.0)) goto 410
If((v.gt.0).and.(gg.eq.0)) bb=mass(site(I,J,3),3)
If((v.gt.0).and.(gg.eq.0)) site(I,J,3)=192
cc=cc+bb
newsite(I,J,3)=192
site(I,J,3)=192
410 continue
c
c - Translation procedure –
c
c Translation scheme
do 160 I=1,xdir
do 160 J=1,ydir
do 160 K=1,3
If((site(I,J,K).eq.
+128).or.(site(I,J,K).eq.192).or.(site(I,J,K).eq.256))goto 160
c Collision rule between fluid and adsorbed polymer particle
If((mod(site(I,J,3),2).eq.1).and.(nbs1(I,J,3).eq.192))
+nbs1(I,J,3)=8
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs2(I,J,3).eq.192))
+nbs2(I,J,3)=4
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs3(I,J,3).eq.192))
+nbs3(I,J,3)=2
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs4(I,J,3).eq.192))
+nbs4(I,J,3)=1
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs5(I,J,3).eq.192))
+nbs5(I,J,3)=32
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs6(I,J,3).eq.192))
+nbs6(I,J,3)=16
c Collision rule between fluid).And.(gelled polymer particle
If((mod(site(I,J,3),2).eq.1).and.(nbs1(I,J,3).eq.256))
+nbs1(I,J,3)=8
```

```
If((mod((site(I,J,3)/32),2).eq.1).and.(nbs2(I,J,3).eq.256))
+nbs2(I,J,3)=4
If((mod((site(I,J,3)/16),2).eq.1).and.(nbs3(I,J,3).eq.256))
+nbs3(I,J,3)=2
If((mod((site(I,J,3)/8),2).eq.1).and.(nbs4(I,J,3).eq.256))
+nbs4(I,J,3)=1
If((mod((site(I,J,3)/4),2).eq.1).and.(nbs5(I,J,3).eq.256))
+nbs5(I,J,3)=32
If((mod((site(I,J,3)/2),2).eq.1).and.(nbs6(I,J,3).eq.256))
+nbs6(I,J,3)=16
c Collision rule between fluid and solid particle
If((mod(site(I,J,K),2).eq.1).and.(nbs1(I,J,1).eq.128))
+nbs1(I,J,K)=8
If((mod((site(I,J,K)/32),2).eq.1).and.(nbs2(I,J,1).eq.128))
+nbs2(I,J,K)=4
If((mod((site(I,J,K)/16),2).eq.1).and.(nbs3(I,J,1).eq.128))
+nbs3(I,J,K)=2
If((mod((site(I,J,K)/8),2).eq.1).and.(nbs4(I,J,1).eq.128))
+nbs4(I,J,K)=1
If((mod((site(I,J,K)/4),2).eq.1).and.(nbs5(I,J,1).eq.128))
+nbs5(I,J,K)=32
If((mod((site(I,J,K)/2),2).eq.1).and.(nbs6(I,J,1).eq.128))
+nbs6(I,J,K)=16
If((mod(site(I,J,K),2).eq.1).and.(nbs1(I,J,2).eq.128))
+nbs1(I,J,K)=8
If((mod((site(I,J,K)/32),2).eq.1).and.(nbs2(I,J,2).eq.128))
+nbs2(I,J,K)=4
If((mod((site(I,J,K)/16),2).eq.1).and.(nbs3(I,J,2).eq.128))
+nbs3(I,J,K)=2
If((mod((site(I,J,K)/8),2).eq.1).and.(nbs4(I,J,2).eq.128))
+nbs4(I,J,K)=1
If((mod((site(I,J,K)/4),2).eq.1).and.(nbs5(I,J,2).eq.128))
```

```
+nbs5(I,J,K)=32
If((mod((site(I,J,K)/2),2).eq.1).and.(nbs6(I,J,2).eq.128))
+nbs6(I,J,K)=16
If((mod(site(I,J,K),2).eq.1).and.(nbs1(I,J,3).eq.128))
+nbs1(I,J,K)=8
If((mod((site(I,J,K)/32),2).eq.1).and.(nbs2(I,J,3).eq.128))
+nbs2(I,J,K)=4
If((mod((site(I,J,K)/16),2).eq.1).and.(nbs3(I,J,3).eq.128))
+nbs3(I,J,K)=2
If((mod((site(I,J,K)/8),2).eq.1).and.(nbs4(I,J,3).eq.128))
+nbs4(I,J,K)=1
If((mod((site(I,J,K)/4),2).eq.1).and.(nbs5(I,J,3).eq.128))
+nbs5(I,J,K)=32
If((mod((site(I,J,K)/2),2).eq.1).and.(nbs6(I,J,3).eq.128))
+nbs6(I,J,K)=16
160 continue
c
c - Additional Collision Rule –
c
c Translation scheme
do 172 I=1,xdir
do 172 J=1,ydir
c Collision rule between fluid and solid particle If(((mod(site(I,J,2),2).eq.1).
and.(nbs1(I,J,1).eq.128)).or.
+((mod(site(I,J,2),2).eq.1).and.(nbs1(I,J,2).eq.128)).or.
+((mod(site(I,J,2),2).eq.1).and.(nbs1(I,J,3).eq.128)))
+nbs1(I,J,2)=8
If(((mod((site(I,J,2)/32),2).eq.1).and.(nbs2(I,J,1).eq.128)).or.
+((mod((site(I,J,2)/32),2).eq.1).and.(nbs2(I,J,2).eq.128)).or.
+((mod((site(I,J,2)/32),2).eq.1).and.(nbs2(I,J,3).eq.128)))
+nbs2(I,J,2)=4
If(((mod((site(I,J,2)/16),2).eq.1).and.(nbs3(I,J,1).eq.128)).or.
```

```
+((mod((site(I,J,2)/16),2).eq.1).and.(nbs3(I,J,2).eq.128)).or.
+((mod((site(I,J,2)/16),2).eq.1).and.(nbs3(I,J,3).eq.128)))
+nbs3(I,J,2)=2
If(((mod((site(I,J,2)/8),2).eq.1).and.(nbs4(I,J,1).eq.128)).or.
+((mod((site(I,J,2)/8),2).eq.1).and.(nbs4(I,J,2).eq.128)).or.
+((mod((site(I,J,2)/8),2).eq.1).and.(nbs4(I,J,3).eq.128)))
+nbs4(I,J,2)=1
If(((mod((site(I,J,2)/4),2).eq.1).and.(nbs5(I,J,1).eq.128)).or.
+((mod((site(I,J,2)/4),2).eq.1).and.(nbs5(I,J,2).eq.128)).or.
+((mod((site(I,J,2)/4),2).eq.1).and.(nbs5(I,J,3).eq.128)))
+nbs5(I,J,2)=32
If(((mod((site(I,J,2)/2),2).eq.1).and.(nbs6(I,J,1).eq.128)).or.
+((mod((site(I,J,2)/2),2).eq.1).and.(nbs6(I,J,2).eq.128)).or.
+((mod((site(I,J,2)/2),2).eq.1).and.(nbs6(I,J,3).eq.128)))
+nbs6(I,J,2)=16
172       continue
c
c - Additional Collision Rule –
c
c Translation scheme
do 173 I=1,xdir
do 173 J=1,ydir
c Collision rule between fluid and solid particle If(((mod(site(I,J,3),2).eq.1).
and.(nbs1(I,J,1).eq.128)).or.
+((mod(site(I,J,3),2).eq.1).and.(nbs1(I,J,2).eq.128)).or.
+((mod(site(I,J,3),2).eq.1).and.(nbs1(I,J,3).eq.128)))
+nbs1(I,J,3)=8
If(((mod((site(I,J,3)/32),2).eq.1).and.(nbs2(I,J,1).eq.128)).or.
+((mod((site(I,J,3)/32),2).eq.1).and.(nbs2(I,J,2).eq.128)).or.
+((mod((site(I,J,3)/32),2).eq.1).and.(nbs2(I,J,3).eq.128)))
+nbs2(I,J,3)=4
If(((mod((site(I,J,3)/16),2).eq.1).and.(nbs3(I,J,1).eq.128)).or.
```

```
+((mod((site(I,J,3)/16),2).eq.1).and.(nbs3(I,J,2).eq.128)).or.
+((mod((site(I,J,3)/16),2).eq.1).and.(nbs3(I,J,3).eq.128)))
+nbs3(I,J,3)=2
If(((mod((site(I,J,3)/8),2).eq.1).and.(nbs4(I,J,1).eq.128)).or.
+((mod((site(I,J,3)/8),2).eq.1).and.(nbs4(I,J,2).eq.128)).or.
+((mod((site(I,J,3)/8),2).eq.1).and.(nbs4(I,J,3).eq.128)))
+nbs4(I,J,3)=1
If(((mod((site(I,J,3)/4),2).eq.1).and.(nbs5(I,J,1).eq.128)).or.
+((mod((site(I,J,3)/4),2).eq.1).and.(nbs5(I,J,2).eq.128)).or.
+((mod((site(I,J,3)/4),2).eq.1).and.(nbs5(I,J,3).eq.128)))
+nbs5(I,J,3)=32
If(((mod((site(I,J,3)/2),2).eq.1).and.(nbs6(I,J,1).eq.128)).or.
+((mod((site(I,J,3)/2),2).eq.1).and.(nbs6(I,J,2).eq.128)).or.
+((mod((site(I,J,3)/2),2).eq.1).and.(nbs6(I,J,3).eq.128)))
+nbs6(I,J,3)=16
173 continue
c
c - Additional Collision Rule –
c
c Translation scheme
do 174 I=1,xdir
do 174 J=1,ydir
c Collision rule between fluid and solid particle If(((mod(site(I,J,1),2).eq.1).
and.(nbs1(I,J,1).eq.128)).or.
+((mod(site(I,J,1),2).eq.1).and.(nbs1(I,J,2).eq.128)).or.
+((mod(site(I,J,1),2).eq.1).and.(nbs1(I,J,3).eq.128)))
+nbs1(I,J,1)=8
If(((mod((site(I,J,1)/32),2).eq.1).and.(nbs2(I,J,1).eq.128)).or.
+((mod((site(I,J,1)/32),2).eq.1).and.(nbs2(I,J,2).eq.128)).or.
+((mod((site(I,J,1)/32),2).eq.1).and.(nbs2(I,J,3).eq.128)))
+nbs2(I,J,1)=4
If(((mod((site(I,J,1)/16),2).eq.1).and.(nbs3(I,J,1).eq.128)).or.
```

```
+((mod((site(I,J,1)/16),2).eq.1).and.(nbs3(I,J,2).eq.128)).or.
+((mod((site(I,J,1)/16),2).eq.1).and.(nbs3(I,J,3).eq.128)))
+nbs3(I,J,1)=2
If(((mod((site(I,J,1)/8),2).eq.1).and.(nbs4(I,J,1).eq.128)).or.
+((mod((site(I,J,1)/8),2).eq.1).and.(nbs4(I,J,2).eq.128)).or.
+((mod((site(I,J,1)/8),2).eq.1).and.(nbs4(I,J,3).eq.128)))
+nbs4(I,J,1)=1
If(((mod((site(I,J,1)/4),2).eq.1).and.(nbs5(I,J,1).eq.128)).or.
+((mod((site(I,J,1)/4),2).eq.1).and.(nbs5(I,J,2).eq.128)).or.
+((mod((site(I,J,1)/4),2).eq.1).and.(nbs5(I,J,3).eq.128)))
+nbs5(I,J,1)=32
If(((mod((site(I,J,1)/2),2).eq.1).and.(nbs6(I,J,1).eq.128)).or.
+((mod((site(I,J,1)/2),2).eq.1).and.(nbs6(I,J,2).eq.128)).or.
+((mod((site(I,J,1)/2),2).eq.1).and.(nbs6(I,J,3).eq.128)))
+nbs6(I,J,1)=16
174 continue
c
c - New configuration of particles in site(I,J) –
c
c Pilih apakah oil nonwetting, jika ya tetapkan jika > 172 lompati aturan ini
c
c - Binary Fluid Model, Rothman).And.(Keller (1988) –
c
c ‘Check if in a site there are 2 different fluids (oil).And.(polymer)
apsto=0
apstp=0
do 161 i=1,xdir
do 161 j=1,ydir
apsto=aps(nbs1(I,J,2),1,2)+aps(nbs2(I,J,2),2,2)+aps(nbs3(I,J,2),3,
+2)+aps(nbs4(I,J,2),4,2)+aps(nbs5(I,J,2),5,2)+aps(nbs6(I,J,2),6,2)
apstp=aps(nbs1(I,J,3),1,3)+aps(nbs2(I,J,3),2,3)+aps(nbs3(I,J,3),3,
+3)+aps(nbs4(I,J,3),4,3)+aps(nbs5(I,J,3),5,3)+aps(nbs6(I,J,3),6,3)
```

```
If((apstp.gt.0).and.(apsto.gt.0))goto 162
If((apstp.eq.0).and.(apsto.gt.0))goto 163
If((apstp.gt.0).and.(apsto.eq.0))goto 164
c This site(I,J,K) is empty of particle
goto 165
162 aaaa=0
c This site(I,J,K) contains oil and polymer particles
newsite(I,J,1)=newsite(I,J,1)+aps(nbs1(I,J,2),1,2)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs2(I,J,2),2,2)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs3(I,J,2),3,2)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs4(I,J,2),4,2)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs5(I,J,2),5,2)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs6(I,J,2),6,2)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs1(I,J,3),1,3)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs2(I,J,3),2,3)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs3(I,J,3),3,3)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs4(I,J,3),4,3)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs5(I,J,3),5,3)
newsite(I,J,1)=newsite(I,J,1)+aps(nbs6(I,J,3),6,3)
if((site(I,J,2).ge.64).or.(site(I,J,3).ge.64))
+newsite(I,J,1)=newsite(I,J,1)+64 goto 165
163       aaaa=0
c This site(I,J,K) contains oil particles only
newsite(I,J,2)=newsite(I,J,2)+aps(nbs1(I,J,2),1,2)
newsite(I,J,2)=newsite(I,J,2)+aps(nbs2(I,J,2),2,2)
newsite(I,J,2)=newsite(I,J,2)+aps(nbs3(I,J,2),3,2)
newsite(I,J,2)=newsite(I,J,2)+aps(nbs4(I,J,2),4,2)
newsite(I,J,2)=newsite(I,J,2)+aps(nbs5(I,J,2),5,2)
newsite(I,J,2)=newsite(I,J,2)+aps(nbs6(I,J,2),6,2)
if(site(I,J,2).ge.64)newsite(I,J,2)=newsite(I,J,2)+64
goto 165
164 aaaa=0
```

```
c This site(I,J,K) contains polymer particles only newsite(I,J,3)=newsite(I,-
J,3)+aps(nbs1(I,J,3),1,3)
newsite(I,J,3)=newsite(I,J,3)+aps(nbs2(I,J,3),2,3)
newsite(I,J,3)=newsite(I,J,3)+aps(nbs3(I,J,3),3,3)
newsite(I,J,3)=newsite(I,J,3)+aps(nbs4(I,J,3),4,3)
newsite(I,J,3)=newsite(I,J,3)+aps(nbs5(I,J,3),5,3)
newsite(I,J,3)=newsite(I,J,3)+aps(nbs6(I,J,3),6,3)
if(site(I,J,3).ge.64)newsite(I,J,3)=newsite(I,J,3)+64
goto 165
165 aaaa=0
If(site(I,J,1).eq.128)newsite(I,J,1)=128
If(site(I,J,2).eq.128)newsite(I,J,2)=128
If(site(I,J,3).eq.128)newsite(I,J,3)=128
If(site(I,J,3).eq.192)newsite(I,J,3)=192
If(site(I,J,3).eq.256)newsite(I,J,3)=256
c Colour density at site
polymer=newsite(I,J,3)
oil=newsite(I,J,2)
C(I,J)=mass(polymer,3)-mass(oil,2)
161 continue
do 167 I=1,xdir
do 167 J=1,ydir
do 167 K=1,3
nbs0(I,J,K)=0
nbs1(I,J,K)=0
nbs2(I,J,K)=0
nbs3(I,J,K)=0
nbs4(I,J,K)=0
nbs5(I,J,K)=0
nbs6(I,J,K)=0
167 continue
c
```

```
c - Updating site(I,J) –
c
do 170 I=1,xdir
do 170 J=1,ydir
do 170 K=1,3
site(I,J,K)=newsite(I,J,K)
If(newsite(I,J,K).eq.128)site(I,J,K)=128
If(newsite(I,J,3).eq.192)site(I,J,3)=192
If(newsite(I,J,3).eq.256)site(I,J,3)=256
170 continue
c Local colour gradient
do 175 I=1,xdir
do 175 J=1,ydir
f(I,J)=C(I+1,J+1)*(0.5+0.866)+C(I-1,J+1)*(-0.5+0.866)+C(I-1,J)*(-1
++0)+C(I-1,J-1)*(-0.5-0.866)+C(I+1,J-1)*(0.5-0.866)+C(I+1,J)*(1+0)
175 continue
c
c -Collision rule –
c
c This site(I,J,K) contains only oil or polymer particles
do 180 I=1,xdir
do 180 J=1,ydir
do 180 K=2,3
newsite(I,J,K)=site(I,J,K)
If(site(I,J,K).eq.5)newsite(I,J,K)=66
If(site(I,J,K).eq.10)newsite(I,J,K)=68
If(site(I,J,K).eq.17)newsite(I,J,K)=96
If(site(I,J,K).eq.20)newsite(I,J,K)=72
If(site(I,J,K).eq.21)newsite(I,J,K)=42
If(site(I,J,K).eq.31)newsite(I,J,K)=110
If(site(I,J,K).eq.34)newsite(I,J,K)=65
If(site(I,J,K).eq.40)newsite(I,J,K)=80
```

```
If(site(I,J,K).eq.42)newsite(I,J,K)=21
If(site(I,J,K).eq.47)newsite(I,J,K)=87
If(site(I,J,K).eq.55)newsite(I,J,K)=107
If(site(I,J,K).eq.59)newsite(I,J,K)=117
If(site(I,J,K).eq.61)newsite(I,J,K)=122
If(site(I,J,K).eq.62)newsite(I,J,K)=93
If(site(I,J,K).eq.65)newsite(I,J,K)=34
If(site(I,J,K).eq.66)newsite(I,J,K)=5
If(site(I,J,K).eq.68)newsite(I,J,K)=10
If(site(I,J,K).eq.72)newsite(I,J,K)=20
If(site(I,J,K).eq.80)newsite(I,J,K)=40
If(site(I,J,K).eq.85)newsite(I,J,K)=106
If(site(I,J,K).eq.87)newsite(I,J,K)=47
If(site(I,J,K).eq.93)newsite(I,J,K)=62
If(site(I,J,K).eq.96)newsite(I,J,K)=17
If(site(I,J,K).eq.106)newsite(I,J,K)=85
If(site(I,J,K).eq.107)newsite(I,J,K)=55
If(site(I,J,K).eq.110)newsite(I,J,K)=31
If(site(I,J,K).eq.117)newsite(I,J,K)=59
If(site(I,J,K).eq.122)newsite(I,J,K)=61
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.9).and.(g.eq.0))newsite(I,J,K)=36
If((site(I,J,K).eq.9).and.(g.eq.1))newsite(I,J,K)=18
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.11).and.(g.eq.0))newsite(I,J,K)=38
If((site(I,J,K).eq.11).and.(g.eq.1))newsite(I,J,K)=69
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.13).and.(g.eq.0))newsite(I,J,K)=74
If((site(I,J,K).eq.13).and.(g.eq.1))newsite(I,J,K)=22
```

```
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.18).and.(g.eq.0))newsite(I,J,K)=9
If((site(I,J,K).eq.18).and.(g.eq.1))newsite(I,J,K)=36
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.19).and.(g.eq.0))newsite(I,J,K)=98
If((site(I,J,K).eq.19).and.(g.eq.1))newsite(I,J,K)=37
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.22).and.(g.eq.0))newsite(I,J,K)=13
If((site(I,J,K).eq.22).and.(g.eq.1))newsite(I,J,K)=74
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.23).and.(g.eq.0))newsite(I,J,K)=102
If((site(I,J,K).eq.23).and.(g.eq.1))newsite(I,J,K)=75
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.25).and.(g.eq.0))newsite(I,J,K)=52
If((site(I,J,K).eq.25).and.(g.eq.1))newsite(I,J,K)=104
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.26).and.(g.eq.0))newsite(I,J,K)=84
If((site(I,J,K).eq.26).and.(g.eq.1))newsite(I,J,K)=44
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.27).and.(g.eq.0))newsite(I,J,K)=45
If((site(I,J,K).eq.27).and.(g.eq.1))newsite(I,J,K)=54
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.29).and.(g.eq.0))newsite(I,J,K)=90
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If((site(I,J,K).eq.29).and.(g.eq.1))newsite(I,J,K)=108
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.36).and.(g.eq.0))newsite(I,J,K)=18
If((site(I,J,K).eq.36).and.(g.eq.1))newsite(I,J,K)=9
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.37).and.(g.eq.0))newsite(I,J,K)=19
If((site(I,J,K).eq.37).and.(g.eq.1))newsite(I,J,K)=98
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.38).and.(g.eq.0))newsite(I,J,K)=69
If((site(I,J,K).eq.38).and.(g.eq.1))newsite(I,J,K)=11
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.41).and.(g.eq.0))newsite(I,J,K)=81
If((site(I,J,K).eq.41).and.(g.eq.1))newsite(I,J,K)=50
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.43).and.(g.eq.0))newsite(I,J,K)=83
If((site(I,J,K).eq.43).and.(g.eq.1))newsite(I,J,K)=101
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.44).and.(g.eq.0))newsite(I,J,K)=26
If((site(I,J,K).eq.44).and.(g.eq.1))newsite(I,J,K)=84
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.45).and.(g.eq.0))newsite(I,J,K)=54
If((site(I,J,K).eq.45).and.(g.eq.1))newsite(I,J,K)=27
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.46).and.(g.eq.0))newsite(I,J,K)=77
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If((site(I,J,K).eq.46).and.(g.eq.1))newsite(I,J,K)=86
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.50).and.(g.eq.0))newsite(I,J,K)=41
If((site(I,J,K).eq.50).and.(g.eq.1))newsite(I,J,K)=81
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.52).and.(g.eq.0))newsite(I,J,K)=104
If((site(I,J,K).eq.52).and.(g.eq.1))newsite(I,J,K)=25
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.53).and.(g.eq.0))newsite(I,J,K)=105
If((site(I,J,K).eq.53).and.(g.eq.1))newsite(I,J,K)=114
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.54).and.(g.eq.0))newsite(I,J,K)=27
If((site(I,J,K).eq.54).and.(g.eq.1))newsite(I,J,K)=45
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.58).and.(g.eq.0))newsite(I,J,K)=116
If((site(I,J,K).eq.58).and.(g.eq.1))newsite(I,J,K)=89
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.69).and.(g.eq.0))newsite(I,J,K)=11
If((site(I,J,K).eq.69).and.(g.eq.1))newsite(I,J,K)=38
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.73).and.(g.eq.0))newsite(I,J,K)=100
If((site(I,J,K).eq.73).and.(g.eq.1))newsite(I,J,K)=82
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
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```
If((site(I,J,K).eq.74).and.(g.eq.0))newsite(I,J,K)=22
If((site(I,J,K).eq.74).and.(g.eq.1))newsite(I,J,K)=13
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.75).and.(g.eq.0))newsite(I,J,K)=23
If((site(I,J,K).eq.75).and.(g.eq.1))newsite(I,J,K)=102
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.77).and.(g.eq.0))newsite(I,J,K)=86
If((site(I,J,K).eq.77).and.(g.eq.1))newsite(I,J,K)=46
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.81).and.(g.eq.0))newsite(I,J,K)=50
If((site(I,J,K).eq.81).and.(g.eq.1))newsite(I,J,K)=41
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.82).and.(g.eq.0))newsite(I,J,K)=73
If((site(I,J,K).eq.82).and.(g.eq.1))newsite(I,J,K)=100
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
If((site(I,J,K).eq.83).and.(g.eq.0))newsite(I,J,K)=101
If((site(I,J,K).eq.83).and.(g.eq.1))newsite(I,J,K)=43
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.84).and.(g.eq.0))newsite(I,J,K)=44
If((site(I,J,K).eq.84).and.(g.eq.1))newsite(I,J,K)=26
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
```

```
If((site(I,J,K).eq.86).and.(g.eq.0))newsite(I,J,K)=46
If((site(I,J,K).eq.86).and.(g.eq.1))newsite(I,J,K)=77
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.89).and.(g.eq.0))newsite(I,J,K)=58
If((site(I,J,K).eq.89).and.(g.eq.1))newsite(I,J,K)=116
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.90).and.(g.eq.0))newsite(I,J,K)=108
If((site(I,J,K).eq.90).and.(g.eq.1))newsite(I,J,K)=29
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.91).and.(g.eq.0))newsite(I,J,K)=109
If((site(I,J,K).eq.91).and.(g.eq.1))newsite(I,J,K)=118
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.98).and.(g.eq.0))newsite(I,J,K)=37
If((site(I,J,K).eq.98).and.(g.eq.1))newsite(I,J,K)=19
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.100).and.(g.eq.0))newsite(I,J,K)=82
If((site(I,J,K).eq.100).and.(g.eq.1))newsite(I,J,K)=73
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.101).and.(g.eq.0))newsite(I,J,K)=43
If((site(I,J,K).eq.101).and.(g.eq.1))newsite(I,J,K)=83
```

```
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.102).and.(g.eq.0))newsite(I,J,K)=75
If((site(I,J,K).eq.102).and.(g.eq.1))newsite(I,J,K)=23
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.104).and.(g.eq.0))newsite(I,J,K)=25
If((site(I,J,K).eq.104).and.(g.eq.1))newsite(I,J,K)=52
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.105).and.(g.eq.0))newsite(I,J,K)=114
If((site(I,J,K).eq.105).and.(g.eq.1))newsite(I,J,K)=53
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.108).and.(g.eq.0))newsite(I,J,K)=29
If((site(I,J,K).eq.108).and.(g.eq.1))newsite(I,J,K)=90
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.109).and.(g.eq.0))newsite(I,J,K)=118
If((site(I,J,K).eq.109).and.(g.eq.1))newsite(I,J,K)=91
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.114).and.(g.eq.0))newsite(I,J,K)=53
If((site(I,J,K).eq.114).and.(g.eq.1))newsite(I,J,K)=105
z=mod(a*z,m)
zr=z/zm
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g=nint(zr*1.)
If((site(I,J,K).eq.116).and.(g.eq.0))newsite(I,J,K)=89
If((site(I,J,K).eq.116).and.(g.eq.1))newsite(I,J,K)=58
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
If((site(I,J,K).eq.118).and.(g.eq.0))newsite(I,J,K)=91
If((site(I,J,K).eq.118).and.(g.eq.1))newsite(I,J,K)=109 If(site(I,J,K).eq.128)
newsite(I,J,K)=128
If(site(I,J,K).eq.192)newsite(I,J,K)=192
If(site(I,J,K).eq.256)newsite(I,J,K)=256
If(site(I,J,K).eq.0)newsite(I,J,K)=0
site(I,J,K)=newsite(I,J,K)
180 continue
do 190 I=1,xdir
do 190 J=1,ydir
c    ======================================
c =Definisi momentum of every particle =
c ======================================
P0=0.0
P1=1.366025403
P2=0.366025403
P3=-1.0
P4=-1.366025403
P5=-0.366025403
P6=1.0
c    ======================================
c   This site(i,j) contains both oil).And.(polymer particles
c  The local colour density
c C(I,J)=1 artinya perbedaan jumlah polymer dan oil=1
If((site(I,J,1).eq.128))goto 620
If((site(I,J,2).eq.128))goto  620
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If((site(I,J,3).eq.128))goto  620
If((site(I,J,3).eq.192))goto  620
If((site(I,J,3).eq.256))goto  620
If((site(I,J,1).eq.5))goto 700
If((site(I,J,1).eq.10))goto  710
If((site(I,J,1).eq.17))goto  720
If((site(I,J,1).eq.20))goto  730
If((site(I,J,1).eq.21).And.(C(I,J).eq.1))goto  740
If((site(I,J,1).eq.21).And.(C(I,J).eq.-1))goto  750
If((site(I,J,1).eq.34))goto  760
If((site(I,J,1).eq.40))goto  770
If((site(I,J,1).eq.42).And.(C(I,J).eq.1))goto  780
If((site(I,J,1).eq.42).And.(C(I,J).eq.-1))goto  790
If((site(I,J,1).eq.3))goto  1000
If((site(I,J,1).eq.6))goto  1010
If((site(I,J,1).eq.12))goto 1020
If((site(I,J,1).eq.9).And.(g.eq.0))goto  1030
If((site(I,J,1).eq.9).And.(g.eq.1))goto  1035
If((site(I,J,1).eq.18).And.(g.eq.0))goto  1040
If((site(I,J,1).eq.18).And.(g.eq.1))goto  1045
If((site(I,J,1).eq.24))goto  1050
If((site(I,J,1).eq.33))goto  1060
If((site(I,J,1).eq.36).And.(g.eq.0))goto  1070
If((site(I,J,1).eq.36).And.(g.eq.1))goto  1075
If((site(I,J,1).eq.48))goto  1080
If((site(I,J,1).eq.65))goto  1090
If((site(I,J,1).eq.66))goto  1100
If((site(I,J,1).eq.68))goto  1110
If((site(I,J,1).eq.72))goto  1120
If((site(I,J,1).eq.80))goto  1130
If((site(I,J,1).eq.96))goto  1140
If((site(I,J,1).eq.7).And.(C(I,J).eq.1))goto  1150
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If((site(I,J,1).eq.7).And.(C(I,J).eq.-1))goto 1155
If((site(I,J,1).eq.11).And.(C(I,J).eq.1).And.(g.eq.0))goto 1160
If((site(I,J,1).eq.11).And.(C(I,J).eq.-1).And.(g.eq.0))goto 1165
If((site(I,J,1).eq.11).And.(C(I,J).eq.1).And.(g.eq.1))goto 1170
If((site(I,J,1).eq.11).And.(C(I,J).eq.-1).And.(g.eq.1))goto 1175
If((site(I,J,1).eq.13).And.(C(I,J).eq.1).And.(g.eq.0))goto 1180
If((site(I,J,1).eq.13).And.(C(I,J).eq.-1).And.(g.eq.0))goto 1185
If((site(I,J,1).eq.13).And.(C(I,J).eq.1).And.(g.eq.1))goto 1190
If((site(I,J,1).eq.13).And.(C(I,J).eq.-1).And.(g.eq.1))goto 1195
If((site(I,J,1).eq.14).And.(C(I,J).eq.1))goto 1200
If((site(I,J,1).eq.14).And.(C(I,J).eq.-1))goto 1210
If((site(I,J,1).eq.19).And.(C(I,J).eq.1).And.(g.eq.0))goto 1220
If((site(I,J,1).eq.19).And.(C(I,J).eq.-1).And.(g.eq.0))goto 1225
If((site(I,J,1).eq.19).And.(C(I,J).eq.1).And.(g.eq.1))goto 1230
If((site(I,J,1).eq.19).And.(C(I,J).eq.-1).And.(g.eq.1))goto 1235
If((site(I,J,1).eq.22).And.(C(I,J).eq.1).And.(g.eq.0))goto 1240
If((site(I,J,1).eq.22).And.(C(I,J).eq.-1).And.(g.eq.0))goto 1245
If((site(I,J,1).eq.22).And.(C(I,J).eq.1).And.(g.eq.1))goto 1250
If((site(I,J,1).eq.22).And.(C(I,J).eq.-1).And.(g.eq.1))goto 1255
If((site(I,J,1).eq.25).And.(C(I,J).eq.1).And.(g.eq.0))goto 1260
If((site(I,J,1).eq.25).And.(C(I,J).eq.-1).And.(g.eq.0))goto 1265
If((site(I,J,1).eq.25).And.(C(I,J).eq.1).And.(g.eq.1))goto 1270
If((site(I,J,1).eq.25).And.(C(I,J).eq.-1).And.(g.eq.1))goto 1275
If((site(I,J,1).eq.26).And.(C(I,J).eq.1).And.(g.eq.0))goto 1280
If((site(I,J,1).eq.26).And.(C(I,J).eq.-1).And.(g.eq.0))goto 1285
If((site(I,J,1).eq.26).And.(C(I,J).eq.1).And.(g.eq.1))goto 1290
If((site(I,J,1).eq.26).And.(C(I,J).eq.-1).And.(g.eq.1))goto 1295
If((site(I,J,1).eq.28).And.(C(I,J).eq.1))goto 1300
If((site(I,J,1).eq.28).And.(C(I,J).eq.-1))goto 1310
If((site(I,J,1).eq.35).And.(C(I,J).eq.1))goto 1320
If((site(I,J,1).eq.35).And.(C(I,J).eq.-1))goto 1330
If((site(I,J,1).eq.37).And.(C(I,J).eq.1).And.(g.eq.0))goto 1340
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If((site(I,J,1).eq.37).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1345
If((site(I,J,1).eq.37).And.(C(I,J).eq.1).And.(g.eq.1))goto  1350
If((site(I,J,1).eq.37).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1355
If((site(I,J,1).eq.38).And.(C(I,J).eq.1).And.(g.eq.0))goto  1360
If((site(I,J,1).eq.38).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1365
If((site(I,J,1).eq.38).And.(C(I,J).eq.1).And.(g.eq.1))goto  1370
If((site(I,J,1).eq.38).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1375
If((site(I,J,1).eq.41).And.(C(I,J).eq.1).And.(g.eq.0))goto  1380
If((site(I,J,1).eq.41).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1385
If((site(I,J,1).eq.41).And.(C(I,J).eq.1).And.(g.eq.1))goto  1390
If((site(I,J,1).eq.41).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1395
If((site(I,J,1).eq.44).And.(C(I,J).eq.1).And.(g.eq.0))goto  1400
If((site(I,J,1).eq.44).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1405
If((site(I,J,1).eq.44).And.(C(I,J).eq.1).And.(g.eq.1))goto  1410
If((site(I,J,1).eq.44).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1415
If((site(I,J,1).eq.49).And.(C(I,J).eq.1))goto  1420
If((site(I,J,1).eq.49).And.(C(I,J).eq.-1))goto  1430
If((site(I,J,1).eq.50).And.(C(I,J).eq.1).And.(g.eq.0))goto  1440
If((site(I,J,1).eq.50).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1445
If((site(I,J,1).eq.50).And.(C(I,J).eq.1).And.(g.eq.1))goto  1450
If((site(I,J,1).eq.50).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1455
If((site(I,J,1).eq.52).And.(C(I,J).eq.1).And.(g.eq.0))goto  1460
If((site(I,J,1).eq.52).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1465
If((site(I,J,1).eq.52).And.(C(I,J).eq.1).And.(g.eq.1))goto  1470
If((site(I,J,1).eq.52).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1475
If((site(I,J,1).eq.56).And.(C(I,J).eq.1))goto  1480
If((site(I,J,1).eq.56).And.(C(I,J).eq.-1))goto  1490
c Collision 3
If((site(I,J,1).eq.67).And.(C(I,J).eq.1))goto  1500
If((site(I,J,1).eq.67).And.(C(I,J).eq.-1))goto  1510
If((site(I,J,1).eq.69).And.(C(I,J).eq.1).And.(g.eq.0))goto  1520
If((site(I,J,1).eq.69).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1525
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If((site(I,J,1).eq.69).And.(C(I,J).eq.1).And.(g.eq.1))goto  1530
If((site(I,J,1).eq.69).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1535
If((site(I,J,1).eq.70).And.(C(I,J).eq.1))goto  1540
If((site(I,J,1).eq.70).And.(C(I,J).eq.-1))goto  1550
If((site(I,J,1).eq.73).And.(C(I,J).eq.1).And.(g.eq.0))goto  1560
If((site(I,J,1).eq.73).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1565
If((site(I,J,1).eq.73).And.(C(I,J).eq.1).And.(g.eq.1))goto  1570
If((site(I,J,1).eq.73).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1575
If((site(I,J,1).eq.74).And.(C(I,J).eq.1).And.(g.eq.0))goto  1580
If((site(I,J,1).eq.74).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1585
If((site(I,J,1).eq.74).And.(C(I,J).eq.1).And.(g.eq.1))goto  1590
If((site(I,J,1).eq.74).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1595
If((site(I,J,1).eq.76).And.(C(I,J).eq.1))goto  1600
If((site(I,J,1).eq.76).And.(C(I,J).eq.-1))goto  1610
If((site(I,J,1).eq.81).And.(C(I,J).eq.1).And.(g.eq.0))goto  1620
If((site(I,J,1).eq.81).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1625
If((site(I,J,1).eq.81).And.(C(I,J).eq.1).And.(g.eq.1))goto  1630
If((site(I,J,1).eq.81).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1635
If((site(I,J,1).eq.82).And.(C(I,J).eq.1).And.(g.eq.0))goto  1640
If((site(I,J,1).eq.82).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1645
If((site(I,J,1).eq.82).And.(C(I,J).eq.1).And.(g.eq.1))goto  1650
If((site(I,J,1).eq.82).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1655
If((site(I,J,1).eq.84).And.(C(I,J).eq.1).And.(g.eq.0))goto  1660
If((site(I,J,1).eq.84).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1665
If((site(I,J,1).eq.84).And.(C(I,J).eq.1).And.(g.eq.1))goto  1670
If((site(I,J,1).eq.84).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1675
If((site(I,J,1).eq.88).And.(C(I,J).eq.1))goto  1680
If((site(I,J,1).eq.88).And.(C(I,J).eq.-1))goto  1690
If((site(I,J,1).eq.97).And.(C(I,J).eq.1))goto  1700
If((site(I,J,1).eq.97).And.(C(I,J).eq.-1))goto  1710
If((site(I,J,1).eq.98).And.(C(I,J).eq.1).And.(g.eq.0))goto  1720
If((site(I,J,1).eq.98).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1725
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If((site(I,J,1).eq.98).And.(C(I,J).eq.1).And.(g.eq.1))goto  1730
If((site(I,J,1).eq.98).And.(C(I,J).eq.-1).And.(g.eq.1))goto   1735
If((site(I,J,1).eq.100).And.(C(I,J).eq.1).And.(g.eq.0))goto   1740
If((site(I,J,1).eq.100).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1745
If((site(I,J,1).eq.100).And.(C(I,J).eq.1).And.(g.eq.1))goto  1750
If((site(I,J,1).eq.100).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1755
If((site(I,J,1).eq.104).And.(C(I,J).eq.1).And.(g.eq.0))goto  1760
If((site(I,J,1).eq.104).And.(C(I,J).eq.-1).And.(g.eq.0))goto  1765
If((site(I,J,1).eq.104).And.(C(I,J).eq.1).And.(g.eq.1))goto  1770
If((site(I,J,1).eq.104).And.(C(I,J).eq.-1).And.(g.eq.1))goto  1775
If((site(I,J,1).eq.112).And.(C(I,J).eq.1))goto  1780
If((site(I,J,1).eq.112).And.(C(I,J).eq.-1))goto  1790
c ‘Collision rules of 4 particles
If((site(I,J,1).eq.15).And.(C(I,J).eq.2))goto   1800
If((site(I,J,1).eq.15).And.(C(I,J).eq.-2))goto   1803
If((site(I,J,1).eq.15).And.(C(I,J).eq.0))goto  1806
If((site(I,J,1).eq.23).And.(C(I,J).eq.2).And.(g.eq.0))goto  1810
If((site(I,J,1).eq.23).And.(C(I,J).eq.-2).And.(g.eq.0))goto  1813
If((site(I,J,1).eq.23).And.(C(I,J).eq.0).And.(g.eq.0))goto   1816
If((site(I,J,1).eq.23).And.(C(I,J).eq.2).And.(g.eq.1))goto   1820
If((site(I,J,1).eq.23).And.(C(I,J).eq.-2).And.(g.eq.1))goto  1823
If((site(I,J,1).eq.23).And.(C(I,J).eq.0).And.(g.eq.1))goto   1826
If((site(I,J,1).eq.27).And.(C(I,J).eq.2).And.(g.eq.0))goto   1830
If((site(I,J,1).eq.27).And.(C(I,J).eq.-2).And.(g.eq.0))goto  1833
If((site(I,J,1).eq.27).And.(C(I,J).eq.0).And.(g.eq.0))goto   1836
If((site(I,J,1).eq.27).And.(C(I,J).eq.2).And.(g.eq.1))goto   1840
If((site(I,J,1).eq.27).And.(C(I,J).eq.-2).And.(g.eq.1))goto  1843
If((site(I,J,1).eq.27).And.(C(I,J).eq.0).And.(g.eq.1))goto   1846
If((site(I,J,1).eq.29).And.(C(I,J).eq.2).And.(g.eq.0))goto   1850
If((site(I,J,1).eq.29).And.(C(I,J).eq.-2).And.(g.eq.0))goto  1853
If((site(I,J,1).eq.29).And.(C(I,J).eq.0).And.(g.eq.0))goto   1856
If((site(I,J,1).eq.29).And.(C(I,J).eq.2).And.(g.eq.1))goto   1860
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If((site(I,J,1).eq.29).And.(C(I,J).eq.-2).And.(g.eq.1))goto  1863
If((site(I,J,1).eq.29).And.(C(I,J).eq.0).And.(g.eq.1))goto  1866
If((site(I,J,1).eq.30).And.(C(I,J).eq.2))goto  1870
If((site(I,J,1).eq.30).And.(C(I,J).eq.-2))goto  1873
If((site(I,J,1).eq.30).And.(C(I,J).eq.0))goto  1876
If((site(I,J,1).eq.39).And.(C(I,J).eq.2))goto  1880
If((site(I,J,1).eq.39).And.(C(I,J).eq.-2))goto  1883
If((site(I,J,1).eq.39).And.(C(I,J).eq.0))goto  1886
If((site(I,J,1).eq.43).And.(C(I,J).eq.2).And.(g.eq.0))goto  1890
If((site(I,J,1).eq.43).And.(C(I,J).eq.-2).And.(g.eq.0))goto  1893
If((site(I,J,1).eq.43).And.(C(I,J).eq.0).And.(g.eq.0))goto  1896
If((site(I,J,1).eq.43).And.(C(I,J).eq.2).And.(g.eq.1))goto  1900
If((site(I,J,1).eq.43).And.(C(I,J).eq.-2).And.(g.eq.1))goto  1903
If((site(I,J,1).eq.43).And.(C(I,J).eq.0).And.(g.eq.1))goto  1906
goto 620
c Collision5
1900 aaaa=0
c 'For Site(I,J)=43; C(i,j)=2; g=1
W1=-f(I,J)*(P0+P1+P2-P5)
W2=-f(I,J)*(P0+P1-P2+P5)
W3=-f(I,J)*(P0-P1+P2+P5)
W4=-f(I,J)*(-P0+P1+P2+P5)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=97
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=69
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=100

If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=1
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=37
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=64
goto 620
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1903 aaaa=0
c 'For Site(I,J)=43; C(i,j)=-2; g=1
W1=-f(I,J)*(P0-P1-P2-P5)
W2=-f(I,J)*(-P0+P1-P2-P5)
W3=-f(I,J)*(-P0-P1+P2-P5)
W4=-f(I,J)*(-P0-P1-P2+P5)     If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=37
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=100
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=32
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=69
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=4
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=97
goto 620
1906 aaaa=0
c 'For Site(I,J)=43; C(i,j)=0; g=1
W1=-f(I,J)*(P0+P1-P2-P5)
W2=-f(I,J)*(P0-P1+P2-P5)
W3=-f(I,J)*(-P0+P1+P2-P5)
W4=-f(I,J)*(P0-P1-P2+P5)
W5=-f(I,J)*(-P0+P1-P2+P5)
W6=-f(I,J)*(-P0-P1+P2+P5)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=65 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=36 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=96 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=5  If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=33 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
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lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=68 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=68 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=33 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=5  If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=96 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=36 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=65
goto 620
1890 aaaa=0
c 'For Site(I,J)=43; C(i,j)=2; g=0
W1=-f(I,J)*(P0+P1+P3-P6)
W2=-f(I,J)*(P0+P1-P3+P6)
W3=-f(I,J)*(P0-P1+P3+P6)
W4=-f(I,J)*(-P0+P1+P3+P6)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=81
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=67
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=82
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=1
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=19
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=64
goto 620
1893 aaaa=0
c          'For Site(I,J)=43; C(i,j)=-2; g=0
W1=-f(I,J)*(P0-P1-P3-P6)
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W2=-f(I,J)*(-P0+P1-P3-P6)
W3=-f(I,J)*(-P0-P1+P3-P6)
W4=-f(I,J)*(-P0-P1-P3+P6)     If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=19
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=82
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=16
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=67
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=2
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=81
goto 620
1896 aaaa=0
c 'For Site(I,J)=43; C(i,j)=0; g=0
W1=-f(I,J)*(P0+P1-P3-P6)
W2=-f(I,J)*(P0-P1+P3-P6)
W3=-f(I,J)*(-P0+P1+P3-P6)
W4=-f(I,J)*(P0-P1-P3+P6)
W5=-f(I,J)*(-P0+P1-P3+P6)
W6=-f(I,J)*(-P0-P1+P3+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=65 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=18 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=66 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=17 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=3   If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=80
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3).And.(W4.lt.W5).And.
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 +(W4.lt.W6))newsite(I,J,3)=80
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=3  If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=17 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=66 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=18 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=65
goto 620
1880 aaaa=0
c 'For Site(I,J)=39; C(i,j)=2
W1=-f(I,J)*(P1+P2+P5-P6)
W2=-f(I,J)*(P1+P2-P5+P6)
W3=-f(I,J)*(P1-P2+P5+P6)
W4=-f(I,J)*(-P1+P2+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=37
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=35
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=7
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=32
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=38
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=1
goto 620
1883 aaaa=0
c          'For Site(I,J)=39; C(i,j)=-2
W1=-f(I,J)*(P1-P2-P5-P6)
W2=-f(I,J)*(-P1+P2-P5-P6)
W3=-f(I,J)*(-P1-P2+P5-P6)
W4=-f(I,J)*(-P1-P2-P5+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
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lt.W4))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=38
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=7
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=35
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=2
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=37
goto 620
1886 aaaa=0
c 'For Site(I,J)=39; C(i,j)=0
W1=-f(I,J)*(P1+P2-P5-P6)
W2=-f(I,J)*(P1-P2+P5-P6)
W3=-f(I,J)*(-P1+P2+P5-P6)
W4=-f(I,J)*(P1-P2-P5+P6)
W5=-f(I,J)*(-P1+P2-P5+P6)
W6=-f(I,J)*(-P1-P2+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=33 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=6  If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=5  If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=34 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=36 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=3  If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=3  If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=36 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
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lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=34 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=5  If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=6  If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=33 goto 620
1870 aaaa=0
c 'For Site(I,J)=30; C(i,j)=2
W1=-f(I,J)*(P3+P4+P5-P6)
W2=-f(I,J)*(P3+P4-P5+P6)
W3=-f(I,J)*(P3-P4+P5+P6)
W4=-f(I,J)*(-P3+P4+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=28
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=26
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=22
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=8
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=14
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=16
goto 620
1873 aaaa=0
c 'For Site(I,J)=30; C(i,j)=-2
W1=-f(I,J)*(P3-P4-P5-P6)
W2=-f(I,J)*(-P3+P4-P5-P6)
W3=-f(I,J)*(-P3-P4+P5-P6)
W4=-f(I,J)*(-P3-P4-P5+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=16
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=14
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=22
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If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=26
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=2
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=28
goto 620
1876 aaaa=0
c 'For Site(I,J)=30; C(i,j)=0
W1=-f(I,J)*(P3+P4-P5-P6)
W2=-f(I,J)*(P3-P4+P5-P6)
W3=-f(I,J)*(-P3+P4+P5-P6)
W4=-f(I,J)*(P3-P4-P5+P6)
W5=-f(I,J)*(-P3+P4-P5+P6)
W6=-f(I,J)*(-P3-P4+P5+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=24 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=6  If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=20 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=10 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=12 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=18 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=18 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=12 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=10 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=20 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
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+(W6.lt.W5))newsite(I,J,3)=6  If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=24 goto 620
1860 aaaa=0
c 'For Site(I,J)=29; C(i,j)=2; g=1
W1=-f(I,J)*(P0+P2+P4-P5)
W2=-f(I,J)*(P0+P2-P4+P5)
W3=-f(I,J)*(P0-P2+P4+P5)
W4=-f(I,J)*(-P0+P2+P4+P5)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=104
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=100
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=76
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=32
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=44
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=64
goto 620
1863 aaaa=0
c          'For Site(I,J)=29; C(i,j)=-2; g=1
W1=-f(I,J)*(P0-P2-P4-P5)
W2=-f(I,J)*(-P0+P2-P4-P5)
W3=-f(I,J)*(-P0-P2+P4-P5)
W4=-f(I,J)*(-P0-P2-P4+P5)     If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=44
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=76
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=100
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=4
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=104
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goto 620
1866 aaaa=0
c 'For Site(I,J)=29; C(i,j)=0; g=1
W1=-f(I,J)*(P0+P2-P4-P5)
W2=-f(I,J)*(P0-P2+P4-P5)
W3=-f(I,J)*(-P0+P2+P4-P5)
W4=-f(I,J)*(P0-P2-P4+P5)
W5=-f(I,J)*(-P0+P2-P4+P5)
W6=-f(I,J)*(-P0-P2+P4+P5)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=96 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=12 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=72 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=36 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=40 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=68 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=68 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=40 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=36 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=72 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=12 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=96 goto 620
1850 aaaa=0
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c ‘For Site(I,J)=29; C(i,j)=2; g=0
W1=-f(I,J)*(P0+P3+P4-P6)
W2=-f(I,J)*(P0+P3-P4+P6)
W3=-f(I,J)*(P0-P3+P4+P6)
W4=-f(I,J)*(-P0+P3+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=88
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=82
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=74
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=16
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=26
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=64
goto 620
1853 aaaa=0
c ‘For Site(I,J)=29; C(i,j)=-2; g=0
W1=-f(I,J)*(P0-P3-P4-P6)
W2=-f(I,J)*(-P0+P3-P4-P6)
W3=-f(I,J)*(-P0-P3+P4-P6)
W4=-f(I,J)*(-P0-P3-P4+P6)     If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=26
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=74
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=82
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=2
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=88
goto 620
1856 aaaa=0
c ‘For Site(I,J)=29; C(i,j)=0; g=0
W1=-f(I,J)*(P0+P3-P4-P6)
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W2=-f(I,J)*(P0-P3+P4-P6)
W3=-f(I,J)*(-P0+P3+P4-P6)
W4=-f(I,J)*(P0-P3-P4+P6)
W5=-f(I,J)*(-P0+P3-P4+P6)
W6=-f(I,J)*(-P0-P3+P4+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=80 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=10 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=72 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=18 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=24 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=66 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=66 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=24
If((W5.lt.W1).And.(W5.lt.W2).And.(W5.lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=18 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=72 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=10 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=80 goto 620
1840 aaaa=0
c 'For Site(I,J)=27; C(i,j)=2; g=1
W1=-f(I,J)*(P2+P3+P5-P6)
W2=-f(I,J)*(P2+P3-P5+P6)
W3=-f(I,J)*(P2-P3+P5+P6)
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W4=-f(I,J)*(-P2+P3+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=52
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=50
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=38
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=16
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=22
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=32
goto 620
1843 aaaa=0
c 'For Site(I,J)=27; C(i,j)=-2; g=1
W1=-f(I,J)*(P2-P3-P5-P6)
W2=-f(I,J)*(-P2+P3-P5-P6)
W3=-f(I,J)*(-P2-P3+P5-P6)
W4=-f(I,J)*(-P2-P3-P5+P6)     If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=22
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=38
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=50
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=2
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=52
goto 620
1846 aaaa=0
c 'For Site(I,J)=27; C(i,j)=0; g=1
W1=-f(I,J)*(P2+P3-P5-P6)
W2=-f(I,J)*(P2-P3+P5-P6)
W3=-f(I,J)*(-P2+P3+P5-P6)
W4=-f(I,J)*(P2-P3-P5+P6)
W5=-f(I,J)*(-P2+P3-P5+P6)
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W6=-f(I,J)*(-P2-P3+P5+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=48 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=6
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=36 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=18 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=20 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=34 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=34 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=20 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=18 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=36 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=6  If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=48 goto 620
1830 aaaa=0
c 'For Site(I,J)=27; C(i,j)=2; g=0
W1=-f(I,J)*(P1+P2+P4-P5)
W2=-f(I,J)*(P1+P2-P4+P5)
W3=-f(I,J)*(P1-P2+P4+P5)
W4=-f(I,J)*(-P1+P2+P4+P5)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=41
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=37
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If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=13
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=32
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=44
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=1
goto 620
1833 aaaa=0
c 'For Site(I,J)=27; C(i,j)=-2; g=0
W1=-f(I,J)*(P1-P2-P4-P5)
W2=-f(I,J)*(-P1+P2-P4-P5)
W3=-f(I,J)*(-P1-P2+P4-P5)
W4=-f(I,J)*(-P1-P2-P4+P5)     If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=44
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=13
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=37
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=4
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=41
goto 620
1836 aaaa=0
c 'For Site(I,J)=27; C(i,j)=0; g=0
W1=-f(I,J)*(P1+P2-P4-P5)
W2=-f(I,J)*(P1-P2+P4-P5)
W3=-f(I,J)*(-P1+P2+P4-P5)
W4=-f(I,J)*(P1-P2-P4+P5)
W5=-f(I,J)*(-P1+P2-P4+P5)
W6=-f(I,J)*(-P1-P2+P4+P5)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=33 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=12 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
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lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=9  If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=36 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=40 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=5  If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=5  If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=40 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=36 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=9  If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=12 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=33 goto 620
1820 aaaa=0
c 'For Site(I,J)=23; C(i,j)=2; g=1
W1=-f(I,J)*(P0+P1+P4-P6)
W2=-f(I,J)*(P0+P1-P4+P6)
W3=-f(I,J)*(P0-P1+P4+P6)
W4=-f(I,J)*(-P0+P1+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=73
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=67
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=74
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=1
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=11
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=64
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goto 620
1823 aaaa=0
c ‘For Site(I,J)=23; C(i,j)=-2; g=1
W1=-f(I,J)*(P0-P1-P4-P6)
W2=-f(I,J)*(-P0+P1-P4-P6)
W3=-f(I,J)*(-P0-P1+P4-P6)
W4=-f(I,J)*(-P0-P1-P4+P6)     If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=11
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=74
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=67
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=2
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=73
goto 620
1826 aaaa=0
c ‘For Site(I,J)=23; C(i,j)=0; g=1
W1=-f(I,J)*(P0+P1-P4-P6)
W2=-f(I,J)*(P0-P1+P4-P6)
W3=-f(I,J)*(-P0+P1+P4-P6)
W4=-f(I,J)*(P0-P1-P4+P6)
W5=-f(I,J)*(-P0+P1-P4+P6)
W6=-f(I,J)*(-P0-P1+P4+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=65 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=10 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=72 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=3   If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
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+(W3.lt.W6))newsite(I,J,3)=9  If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=66 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=66 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=9  If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=3  If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=72 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=10 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=65 goto 620
1810 aaaa=0
c 'For Site(I,J)=23; C(i,j)=2; g=0
W1=-f(I,J)*(P0+P2+P5-P6)
W2=-f(I,J)*(P0+P2-P5+P6)
W3=-f(I,J)*(P0-P2+P5+P6)
W4=-f(I,J)*(-P0+P2+P5+P6)  If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=100
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=98
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=70
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=32
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=38
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=64
goto 620
1813 aaaa=0
c 'For Site(I,J)=23; C(i,j)=-2; g=0
W1=-f(I,J)*(P0-P2-P5-P6)
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W2=-f(I,J)*(-P0+P2-P5-P6)
W3=-f(I,J)*(-P0-P2+P5-P6)
W4=-f(I,J)*(-P0-P2-P5+P6)     If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=38
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=70
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=98
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=2
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=100
goto 620
1816 aaaa=0
c 'For Site(I,J)=23; C(i,j)=0; g=0
W1=-f(I,J)*(P0+P2-P5-P6)
W2=-f(I,J)*(P0-P2+P5-P6)
W3=-f(I,J)*(-P0+P2+P5-P6)
W4=-f(I,J)*(P0-P2-P5+P6)
W5=-f(I,J)*(-P0+P2-P5+P6)
W6=-f(I,J)*(-P0-P2+P5+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=96 If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=6  If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=68 If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=34 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=36 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=66 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
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+(W4.lt.W6))newsite(I,J,3)=66 If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=36 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=34
If((W5.lt.W1).And.(W5.lt.W2).And.(W5.lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=68 If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=6  If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=96
goto 620
1800 aaaa=0
C 'For Site(I,J)=15; C(i,j)=2
W1=-f(I,J)*(P1+P4+P5-P6)
W2=-f(I,J)*(P1+P4-P5+P6)
W3=-f(I,J)*(P1-P4+P5+P6)
W4=-f(I,J)*(-P1+P4+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,3)=13
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=11
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=7
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=8
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=14
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=1
goto 620
1803 aaaa=0
c 'For Site(I,J)=15; C(i,j)=-2
W1=-f(I,J)*(P1-P4-P5-P6)
W2=-f(I,J)*(-P1+P4-P5-P6)
W3=-f(I,J)*(-P1-P4+P5-P6)
W4=-f(I,J)*(-P1-P4-P5+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
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lt.W4))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3).And.(W1.lt.W4))newsite(I,J,2)=14
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4))newsite(I,J,2)=7
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2).And.(W3.lt.W4))newsite(I,J,2)=11
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,3)=2
If((W4.lt.W1).And.(W4.lt.W2).And.(W4.lt.W3))newsite(I,J,2)=13
goto 620
1806 aaaa=0
c 'For Site(I,J)=15; C(i,j)=0
W1=-f(I,J)*(P1+P4-P5-P6)
W2=-f(I,J)*(P1-P4+P5-P6)
W3=-f(I,J)*(-P1+P4+P5-P6)
W4=-f(I,J)*(P1-P4-P5+P6)
W5=-f(I,J)*(-P1+P4-P5+P6)
W6=-f(I,J)*(-P1-P4+P5+P6)    If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,3)=9  If((W1.lt.W2).And.(W1.lt.W3).And.(W1.
lt.W4).And.(W1.lt.W5).And.
+(W1.lt.W6))newsite(I,J,2)=6  If((W2.lt.W1).And.(W2.lt.W3).And.(W2.
lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,3)=5
If((W2.lt.W1).And.(W2.lt.W3).And.(W2.lt.W4).And.(W2.lt.W5).And.
+(W2.lt.W6))newsite(I,J,2)=10 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,3)=12 If((W3.lt.W1).And.(W3.lt.W2).And.(W3.
lt.W4).And.(W3.lt.W5).And.
+(W3.lt.W6))newsite(I,J,2)=3  If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,3)=3  If((W4.lt.W1).And.(W4.lt.W2).And.(W4.
lt.W3).And.(W4.lt.W5).And.
+(W4.lt.W6))newsite(I,J,2)=12 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
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lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,3)=10 If((W5.lt.W1).And.(W5.lt.W2).And.(W5.
lt.W3).And.(W5.lt.W4).And.
+(W5.lt.W6))newsite(I,J,2)=5  If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,3)=6  If((W6.lt.W1).And.(W6.lt.W2).And.(W6.
lt.W3).And.(W6.lt.W4).And.
+(W6.lt.W5))newsite(I,J,2)=9 goto 620
1780 aaaa=0
c 'For Site(I,J)=112; C(i,j)=1
W1=-f(I,J)*(P0+P2-P3)
W2=-f(I,J)*(P0-P2+P3)
W3=-f(I,J)*(-P0+P2+P3)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=96
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=80
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=48
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64  goto  620
1790 aaaa=0
c 'For Site(I,J)=112; C(i,j)=-1
W1=-f(I,J)*(P0-P2-P3)
W2=-f(I,J)*(-P0+P2-P3)
W3=-f(I,J)*(-P0-P2+P3)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=48
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=80
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=96
goto 620
1770 aaaa=0
c 'For Site(I,J)=104; C(i,j)=1; g=1
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W1=-f(I,J)*(P2+P3-P5)
W2=-f(I,J)*(P2-P3+P5)
W3=-f(I,J)*(-P2+P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=48
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=36
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=20
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
1775 aaaa=0
c 'For Site(I,J)=104; C(i,j)=-1; g=1
W1=-f(I,J)*(P2-P3-P5)
W2=-f(I,J)*(-P2+P3-P5)
W3=-f(I,J)*(-P2-P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=20
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=36
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=48
goto 620
1760 aaaa=0
c 'For Site(I,J)=104; C(i,j)=1; g=0
W1=-f(I,J)*(P1+P3-P4)
W2=-f(I,J)*(P1-P3+P4)
W3=-f(I,J)*(-P1+P3+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=17
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=9
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=24
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If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1765 aaaa=0
c 'For Site(I,J)=104; C(i,j)=-1; g=0
W1=-f(I,J)*(P1-P3-P4)
W2=-f(I,J)*(-P1+P3-P4)
W3=-f(I,J)*(-P1-P3+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=24
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=9
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=17  goto  620
1750 aaaa=0
c 'For Site(I,J)=100; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P1-P4)
W2=-f(I,J)*(P0-P1+P4)
W3=-f(I,J)*(-P0+P1+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=65
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=72
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=9
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1755 aaaa=0
c 'For Site(I,J)=100; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P1-P4)
W2=-f(I,J)*(-P0+P1-P4)
W3=-f(I,J)*(-P0-P1+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=9
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If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=72
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=65
goto 620
1740 aaaa=0
c 'For Site(I,J)=100; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P3-P6)
W2=-f(I,J)*(P0-P3+P6)
W3=-f(I,J)*(-P0+P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=80
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=66
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=18
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1745 aaaa=0
c 'For Site(I,J)=100; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P3-P6)
W2=-f(I,J)*(-P0+P3-P6)
W3=-f(I,J)*(-P0-P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=66
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=80
goto 620
1730 aaaa=0
c 'For Site(I,J)=98; C(i,j)=1; g=1
W1=-f(I,J)*(P1+P3-P6)
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W2=-f(I,J)*(P1-P3+P6)
W3=-f(I,J)*(-P1+P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=17
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=3
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=18
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1735 aaaa=0
c 'For Site(I,J)=98; C(i,j)=-1; g=1
W1=-f(I,J)*(P1-P3-P6)
W2=-f(I,J)*(-P1+P3-P6)
W3=-f(I,J)*(-P1-P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=3
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=17
goto 620
1720 aaaa=0
c 'For Site(I,J)=98; C(i,j)=1; g=0
W1=-f(I,J)*(P1+P2-P5)
W2=-f(I,J)*(P1-P2+P5)
W3=-f(I,J)*(-P1+P2+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=33
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=5
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=36
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
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goto 620
1725 aaaa=0
c 'For Site(I,J)=98; C(i,j)=-1; g=0
W1=-f(I,J)*(P1-P2-P5)
W2=-f(I,J)*(-P1+P2-P5)
W3=-f(I,J)*(-P1-P2+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=36
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=5
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=33
goto 620
1700 aaaa=0
c 'For Site(I,J)=97; C(i,j)=1
W1=-f(I,J)*(P0+P1-P2)
W2=-f(I,J)*(P0-P1+P2)
W3=-f(I,J)*(-P0+P1+P2)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=65
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=96
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=33
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1710 aaaa=0
c 'For Site(I,J)=97; C(i,j)=-1
W1=-f(I,J)*(P0-P1-P2)
W2=-f(I,J)*(-P0+P1-P2)
W3=-f(I,J)*(-P0-P1+P2)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=33
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If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=96
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=65
goto 620
1680 aaaa=0
c 'For Site(I,J)=88; C(i,j)=1
W1=-f(I,J)*(P0+P3-P4)
W2=-f(I,J)*(P0-P3+P4)
W3=-f(I,J)*(-P0+P3+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=80
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=72
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=24
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1690 aaaa=0
c 'For Site(I,J)=88; C(i,j)=-1
W1=-f(I,J)*(P0-P3-P4)
W2=-f(I,J)*(-P0+P3-P4)
W3=-f(I,J)*(-P0-P3+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=24
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=72
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=80
goto 620
1670 aaaa=0
c 'For Site(I,J)=84; C(i,j)=1; g=1
W1=-f(I,J)*(P3+P4-P6)
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W2=-f(I,J)*(P3-P4+P6)
W3=-f(I,J)*(-P3+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=24
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=10
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=16
goto 620
1675 aaaa=0
c 'For Site(I,J)=84; C(i,j)=-1; g=1
W1=-f(I,J)*(P3-P4-P6)
W2=-f(I,J)*(-P3+P4-P6)
W3=-f(I,J)*(-P3-P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=16
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=10
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=18
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=24
goto 620
1660 aaaa=0
c 'For Site(I,J)=84; C(i,j)=1; g=0
W1=-f(I,J)*(P2+P4-P5)
W2=-f(I,J)*(P2-P4+P5)
W3=-f(I,J)*(-P2+P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=40
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=36
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=12
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
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goto 620
1665 aaaa=0
c ‘For Site(I,J)=84; C(i,j)=-1; g=0
W1=-f(I,J)*(P2-P4-P5)
W2=-f(I,J)*(-P2+P4-P5)
W3=-f(I,J)*(-P2-P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=12
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=36
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=40
goto 620
1650 aaaa=0
c ‘For Site(I,J)=82; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P2-P5)
W2=-f(I,J)*(P0-P2+P5)
W3=-f(I,J)*(-P0+P2+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=96
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=68
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=36
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1655 aaaa=0
c ‘For Site(I,J)=82; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P2-P5)
W2=-f(I,J)*(-P0+P2-P5)
W3=-f(I,J)*(-P0-P2+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=36
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If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=68
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=96

goto 620
1640 aaaa=0
c 'For Site(I,J)=82; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P1-P4)
W2=-f(I,J)*(P0-P1+P4)
W3=-f(I,J)*(-P0+P1+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=65
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=72
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=9
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1645 aaaa=0
c 'For Site(I,J)=82; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P1-P4)
W2=-f(I,J)*(-P0+P1-P4)
W3=-f(I,J)*(-P0-P1+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=9
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=72
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=65
goto 620
1630 aaaa=0
c 'For Site(I,J)=81; C(i,j)=1; g=1
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W1=-f(I,J)*(P1+P2-P4)
W2=-f(I,J)*(P1-P2+P4)
W3=-f(I,J)*(-P1+P2+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=33
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=9
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=40
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1635 aaaa=0
c 'For Site(I,J)=81; C(i,j)=-1; g=1
W1=-f(I,J)*(P1-P2-P4)
W2=-f(I,J)*(-P1+P2-P4)
W3=-f(I,J)*(-P1-P2+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=40
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=9
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=33
goto 620
1620 aaaa=0
c 'For Site(I,J)=81; C(i,j)=1; g=0
W1=-f(I,J)*(P2+P3-P6)
W2=-f(I,J)*(P2-P3+P6)
W3=-f(I,J)*(-P2+P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=48
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=34
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=18
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If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
1625 aaaa=0
c 'For Site(I,J)=81; C(i,j)=-1; g=0
W1=-f(I,J)*(P2-P3-P6)
W2=-f(I,J)*(-P2+P3-P6)
W3=-f(I,J)*(-P2-P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=34
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=48
goto 620
1600 aaaa=0
c 'For Site(I,J)=76; C(i,j)=1
W1=-f(I,J)*(P0+P4-P5)
W2=-f(I,J)*(P0-P4+P5)
W3=-f(I,J)*(-P0+P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=72
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=68
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=12
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1610 aaaa=0
c 'For Site(I,J)=76; C(i,j)=-1
W1=-f(I,J)*(P0-P4-P5)
W2=-f(I,J)*(-P0+P4-P5)
W3=-f(I,J)*(-P0-P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
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If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=12
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=68
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=72
goto 620
1590 aaaa=0
c 'For Site(I,J)=74; C(i,j)=1; g=1
W1=-f(I,J)*(P1+P4-P5)
W2=-f(I,J)*(P1-P4+P5)
W3=-f(I,J)*(-P1+P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=9
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=5
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=12
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1595 aaaa=0
c 'For Site(I,J)=74; C(i,j)=-1; g=1
W1=-f(I,J)*(P1-P4-P5)
W2=-f(I,J)*(-P1+P4-P5)
W3=-f(I,J)*(-P1-P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=12
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=5
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=9
goto 620
1580 aaaa=0
c 'For Site(I,J)=74; C(i,j)=1; g=0
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W1=-f(I,J)*(P3+P5-P6)
W2=-f(I,J)*(P3-P5+P6)
W3=-f(I,J)*(-P3+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=20
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=6
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=16
goto 620
1585 aaaa=0
c 'For Site(I,J)=74; C(i,j)=-1; g=0
W1=-f(I,J)*(P3-P5-P6)
W2=-f(I,J)*(-P3+P5-P6)
W3=-f(I,J)*(-P3-P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=16
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=6
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=18
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=20
goto 620
1570 aaaa=0
c 'For Site(I,J)=73; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P3-P6)
W2=-f(I,J)*(P0-P3+P6)
W3=-f(I,J)*(-P0+P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=80
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=66
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=18
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If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1575 aaaa=0
c 'For Site(I,J)=73; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P3-P6)
W2=-f(I,J)*(-P0+P3-P6)
W3=-f(I,J)*(-P0-P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=66
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=80
goto 620
1560 aaaa=0
c 'For Site(I,J)=73; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P2-P5)
W2=-f(I,J)*(P0-P2+P5)
W3=-f(I,J)*(-P0+P2+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=96
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=68
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=36
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1565 aaaa=0
c 'For Site(I,J)=73; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P2-P5)
W2=-f(I,J)*(-P0+P2-P5)
W3=-f(I,J)*(-P0-P2+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
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If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=36
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=68
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=96
goto 620
1540 aaaa=0
c 'For Site(I,J)=70; C(i,j)=1
W1=-f(I,J)*(P0+P5-P6)
W2=-f(I,J)*(P0-P5+P6)
W3=-f(I,J)*(-P0+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=68
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=66
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=6
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1550 aaaa=0
c 'For Site(I,J)=70; C(i,j)=-1
W1=-f(I,J)*(P0-P5-P6)
W2=-f(I,J)*(-P0+P5-P6)
W3=-f(I,J)*(-P0-P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=6
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=66
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=68
goto 620
1530 aaaa=0
c 'For Site(I,J)=69; C(i,j)=1; g=1
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W1=-f(I,J)*(P2+P5-P6)
W2=-f(I,J)*(P2-P5+P6)
W3=-f(I,J)*(-P2+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=36
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=34
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=6
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
1535 aaaa=0
c 'For Site(I,J)=69; C(i,j)=-1; g=1
W1=-f(I,J)*(P2-P5-P6)
W2=-f(I,J)*(-P2+P5-P6)
W3=-f(I,J)*(-P2-P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=6
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=34
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=36
goto 620
1520 aaaa=0
c 'For Site(I,J)=69; C(i,j)=1; g=0
W1=-f(I,J)*(P1+P4-P6)
W2=-f(I,J)*(P1-P4+P6)
W3=-f(I,J)*(-P1+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=9
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=3
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=10
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If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1525 aaaa=0
c 'For Site(I,J)=69; C(i,j)=-1; g=0
W1=-f(I,J)*(P1-P4-P6)
W2=-f(I,J)*(-P1+P4-P6)
W3=-f(I,J)*(-P1-P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=10
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=3
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=9
goto 620
1500 aaaa=0
c 'For Site(I,J)=67; C(i,j)=1
W1=-f(I,J)*(P0+P1-P6)
W2=-f(I,J)*(P0-P1+P6)
W3=-f(I,J)*(-P0+P1+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=65
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=66
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=3
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1510 aaaa=0
c 'For Site(I,J)=67; C(i,j)=-1
W1=-f(I,J)*(P0-P1-P6)
W2=-f(I,J)*(-P0+P1-P6)
W3=-f(I,J)*(-P0-P1+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
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If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=3
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=66
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=65
goto 620
1480 aaaa=0
c 'For Site(I,J)=56; C(i,j)=1
W1=-f(I,J)*(P2+P3-P4)
W2=-f(I,J)*(P2-P3+P4)
W3=-f(I,J)*(-P2+P3+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=48
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=40
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=24
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
1490 aaaa=0
c 'For Site(I,J)=56; C(i,j)=-1
W1=-f(I,J)*(P2-P3-P4)
W2=-f(I,J)*(-P2+P3-P4)
W3=-f(I,J)*(-P2-P3+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=24
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=40
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=48
goto 620
1470 aaaa=0
c 'For Site(I,J)=52; C(i,j)=1; g=1
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W1=-f(I,J)*(P1+P3-P4)
W2=-f(I,J)*(P1-P3+P4)
W3=-f(I,J)*(-P1+P3+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=17
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=9
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=24
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1475 aaaa=0
c 'For Site(I,J)=52; C(i,j)=-1; g=1
W1=-f(I,J)*(P1-P3-P4)
W2=-f(I,J)*(-P1+P3-P4)
W3=-f(I,J)*(-P1-P3+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=24
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=9
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=17
goto 620
1460 aaaa=0
c 'For Site(I,J)=52; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P2-P4)
W2=-f(I,J)*(P0-P2+P4)
W3=-f(I,J)*(-P0+P2+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=96
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=72
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=40
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If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1465 aaaa=0
c 'For Site(I,J)=52; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P2-P4)
W2=-f(I,J)*(-P0+P2-P4)
W3=-f(I,J)*(-P0-P2+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=40
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=72
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=96
goto 620
1450 aaaa=0
c 'For Site(I,J)=50; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P1-P3)
W2=-f(I,J)*(P0-P1+P3)
W3=-f(I,J)*(-P0+P1+P3)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=65
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=80
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=17
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1455 aaaa=0
c 'For Site(I,J)=50; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P1-P3)
W2=-f(I,J)*(-P0+P1-P3)
W3=-f(I,J)*(-P0-P1+P3)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
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If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=17
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=80
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=65
goto 620
1440 aaaa=0
c 'For Site(I,J)=50; C(i,j)=1; g=0
W1=-f(I,J)*(P1+P2-P4)
W2=-f(I,J)*(P1-P2+P4)
W3=-f(I,J)*(-P1+P2+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=33
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=9
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=40
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1445 aaaa=0
c 'For Site(I,J)=50; C(i,j)=-1; g=0
W1=-f(I,J)*(P1-P2-P4)
W2=-f(I,J)*(-P1+P2-P4)
W3=-f(I,J)*(-P1-P2+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=40
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=9
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=33
goto 620
1420 aaaa=0
c 'For Site(I,J)=49; C(i,j)=1
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W1=-f(I,J)*(P1+P2-P3)
W2=-f(I,J)*(P1-P2+P3)
W3=-f(I,J)*(-P1+P2+P3)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=33
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=17
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=48
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1430 aaaa=0
c 'For Site(I,J)=49; C(i,j)=-1
W1=-f(I,J)*(P1-P2-P3)
W2=-f(I,J)*(-P1+P2-P3)
W3=-f(I,J)*(-P1-P2+P3)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=48
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=17
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=33  goto  620
1410 aaaa=0
c 'For Site(I,J)=44; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P3-P5)
W2=-f(I,J)*(P0-P3+P5)
W3=-f(I,J)*(-P0+P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=80
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=68
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=20
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
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goto 620
1415 aaaa=0
c ‘For Site(I,J)=44; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P3-P5)
W2=-f(I,J)*(-P0+P3-P5)
W3=-f(I,J)*(-P0-P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=20
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=68
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=80
goto 620
1400 aaaa=0
c ‘For Site(I,J)=44; C(i,j)=1; g=0
W1=-f(I,J)*(P3+P4-P6)
W2=-f(I,J)*(P3-P4+P6)
W3=-f(I,J)*(-P3+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=24
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=10
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=16
goto 620
1405 aaaa=0
c ‘For Site(I,J)=44; C(i,j)=-1; g=0
W1=-f(I,J)*(P3-P4-P6)
W2=-f(I,J)*(-P3+P4-P6)
W3=-f(I,J)*(-P3-P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=16
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=10
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If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=18
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=24
goto 620
1390 aaaa=0
c 'For Site(I,J)=41; C(i,j)=1; g=1
W1=-f(I,J)*(P2+P3-P6)
W2=-f(I,J)*(P2-P3+P6)
W3=-f(I,J)*(-P2+P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=48
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=34
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=18
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
1395 aaaa=0
c 'For Site(I,J)=41; C(i,j)=-1; g=1
W1=-f(I,J)*(P2-P3-P6)
W2=-f(I,J)*(-P2+P3-P6)
W3=-f(I,J)*(-P2-P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=34
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=48
goto 620
1380 aaaa=0
c 'For Site(I,J)=41; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P1-P3)
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W2=-f(I,J)*(P0-P1+P3)
W3=-f(I,J)*(-P0+P1+P3)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=65
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=80
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=17
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1385 aaaa=0
c 'For Site(I,J)=41; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P1-P3)
W2=-f(I,J)*(-P0+P1-P3)
W3=-f(I,J)*(-P0-P1+P3)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=17
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=80
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=65
goto 620
1370 aaaa=0
c 'For Site(I,J)=38; C(i,j)=1; g=1
W1=-f(I,J)*(P1+P4-P6)
W2=-f(I,J)*(P1-P4+P6)
W3=-f(I,J)*(-P1+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=9
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=3
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=10
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
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goto 620
1375 aaaa=0
c 'For Site(I,J)=38; C(i,j)=-1; g=1
W1=-f(I,J)*(P1-P4-P6)
W2=-f(I,J)*(-P1+P4-P6)
W3=-f(I,J)*(-P1-P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=10
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=3
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=9
goto 620
1360 aaaa=0
c 'For Site(I,J)=38; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P1-P5)
W2=-f(I,J)*(P0-P1+P5)
W3=-f(I,J)*(-P0+P1+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=65
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=68
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=5
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1365 aaaa=0
c 'For Site(I,J)=38; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P1-P5)
W2=-f(I,J)*(-P0+P1-P5)
W3=-f(I,J)*(-P0-P1+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=5
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If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=1
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=68
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=65
goto 620
1350 aaaa=0
c ‘For Site(I,J)=37; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P2-P6)
W2=-f(I,J)*(P0-P2+P6)
W3=-f(I,J)*(-P0+P2+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=96
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=66
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=34
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1355 aaaa=0
c ‘For Site(I,J)=37; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P2-P6)
W2=-f(I,J)*(-P0+P2-P6)
W3=-f(I,J)*(-P0-P2+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=34
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=66
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=96
goto 620
1340 aaaa=0
c ‘For Site(I,J)=37; C(i,j)=1; g=0
W1=-f(I,J)*(P1+P3-P6)
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W2=-f(I,J)*(P1-P3+P6)
W3=-f(I,J)*(-P1+P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=17
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=3
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=18
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1345 aaaa=0
c 'For Site(I,J)=37; C(i,j)=-1; g=0
W1=-f(I,J)*(P1-P3-P6)
W2=-f(I,J)*(-P1+P3-P6)
W3=-f(I,J)*(-P1-P3+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=3
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=17
goto 620
1320 aaaa=0
c 'For Site(I,J)=35; C(i,j)=1
W1=-f(I,J)*(P1+P2-P6)
W2=-f(I,J)*(P1-P2+P6)
W3=-f(I,J)*(-P1+P2+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=33
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=3
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=34
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
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goto 620
1330 aaaa=0
c 'For Site(I,J)=35; C(i,j)=-1
W1=-f(I,J)*(P1-P2-P6)
W2=-f(I,J)*(-P1+P2-P6)
W3=-f(I,J)*(-P1-P2+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=34
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=3
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=33
goto 620
1300 aaaa=0
c 'For Site(I,J)=28; C(i,j)=1
W1=-f(I,J)*(P3+P4-P5)
W2=-f(I,J)*(P3-P4+P5)
W3=-f(I,J)*(-P3+P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=24
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=20
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=12
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=16
goto 620
1310 aaaa=0
c 'For Site(I,J)=28; C(i,j)=-1
W1=-f(I,J)*(P3-P4-P5)
W2=-f(I,J)*(-P3+P4-P5)
W3=-f(I,J)*(-P3-P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=16
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=12
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If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=20
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=24
goto 620
1290 aaaa=0
c 'For Site(I,J)=26; C(i,j)=1; g=1
W1=-f(I,J)*(P2+P4-P5)
W2=-f(I,J)*(P2-P4+P5)
W3=-f(I,J)*(-P2+P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=40
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=36
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=12
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
1295 aaaa=0
c 'For Site(I,J)=26; C(i,j)=-1; g=1
W1=-f(I,J)*(P2-P4-P5)
W2=-f(I,J)*(-P2+P4-P5)
W3=-f(I,J)*(-P2-P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=12
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=36
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=40
goto 620
1280 aaaa=0
c 'For Site(I,J)=26; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P3-P5)
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W2=-f(I,J)*(P0-P3+P5)
W3=-f(I,J)*(-P0+P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=80
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=68
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=20
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1285 aaaa=0
c 'For Site(I,J)=26; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P3-P5)
W2=-f(I,J)*(-P0+P3-P5)
W3=-f(I,J)*(-P0-P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=20
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=68
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=80
goto 620
1270 aaaa=0
c 'For Site(I,J)=25; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P2-P4)
W2=-f(I,J)*(P0-P2+P4)
W3=-f(I,J)*(-P0+P2+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=96
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=72
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=40
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
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goto 620
1275 aaaa=0
c 'For Site(I,J)=25; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P2-P4)
W2=-f(I,J)*(-P0+P2-P4)
W3=-f(I,J)*(-P0-P2+P4)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=40
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=72
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=96
goto 620
1260 aaaa=0
c 'For Site(I,J)=25; C(i,j)=1; g=0
W1=-f(I,J)*(P2+P3-P5)
W2=-f(I,J)*(P2-P3+P5)
W3=-f(I,J)*(-P2+P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=48
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=36
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=20
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
1265 aaaa=0
c 'For Site(I,J)=25; C(i,j)=-1; g=0
W1=-f(I,J)*(P2-P3-P5)
W2=-f(I,J)*(-P2+P3-P5)
W3=-f(I,J)*(-P2-P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=20
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If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=36
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=48
goto 620
1250 aaaa=0
c 'For Site(I,J)=22; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P4-P6)
W2=-f(I,J)*(P0-P4+P6)
W3=-f(I,J)*(-P0+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=72
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=66
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=10
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1255 aaaa=0
c 'For Site(I,J)=22; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P4-P6)
W2=-f(I,J)*(-P0+P4-P6)
W3=-f(I,J)*(-P0-P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=10
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=66
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=72
goto 620
1240 aaaa=0
c 'For Site(I,J)=22; C(i,j)=1; g=0
W1=-f(I,J)*(P1+P4-P5)
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W2=-f(I,J)*(P1-P4+P5)
W3=-f(I,J)*(-P1+P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=9
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=5
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=12
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1245 aaaa=0
c ‘For Site(I,J)=22; C(i,j)=-1; g=0
W1=-f(I,J)*(P1-P4-P5)
W2=-f(I,J)*(-P1+P4-P5)
W3=-f(I,J)*(-P1-P4+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=12
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=5
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=9goto   620
1230 aaaa=0
c ‘For Site(I,J)=19; C(i,j)=1; g=1
W1=-f(I,J)*(P1+P2-P5)
W2=-f(I,J)*(P1-P2+P5)
W3=-f(I,J)*(-P1+P2+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=33
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=5
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=36
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
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1235 aaaa=0
c ‘For Site(I,J)=19; C(i,j)=-1; g=1
W1=-f(I,J)*(P1-P2-P5)
W2=-f(I,J)*(-P1+P2-P5)
W3=-f(I,J)*(-P1-P2+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=36
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=5
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=33
goto 620
1220 aaaa=0
c ‘For Site(I,J)=19; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P2-P6)
W2=-f(I,J)*(P0-P2+P6)
W3=-f(I,J)*(-P0+P2+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=96
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=66
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=34
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1225 aaaa=0
c ‘For Site(I,J)=19; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P2-P6)
W2=-f(I,J)*(-P0+P2-P6)
W3=-f(I,J)*(-P0-P2+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=34
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=32
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If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=66
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=96
goto 620
1200 aaaa=0
c 'For Site(I,J)=14; C(i,j)=1
W1=-f(I,J)*(P4+P5-P6)
W2=-f(I,J)*(P4-P5+P6)
W3=-f(I,J)*(-P4+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=12
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=10
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=6
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=8
goto 620
1210 aaaa=0
c 'For Site(I,J)=14; C(i,j)=-1
W1=-f(I,J)*(P4-P5-P6)
W2=-f(I,J)*(-P4+P5-P6)
W3=-f(I,J)*(-P4-P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=8
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=6
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=10
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=12
goto 620
1190 aaaa=0
c 'For Site(I,J)=13; C(i,j)=1; g=1
W1=-f(I,J)*(P3+P5-P6)
W2=-f(I,J)*(P3-P5+P6)
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W3=-f(I,J)*(-P3+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=20
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=18
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=6
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=16
goto 620
1195 aaaa=0
c 'For Site(I,J)=13; C(i,j)=-1; g=1
W1=-f(I,J)*(P3-P5-P6)
W2=-f(I,J)*(-P3+P5-P6)
W3=-f(I,J)*(-P3-P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=16
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=6
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=18
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=20
goto 620
1180 aaaa=0
c 'For Site(I,J)=13; C(i,j)=1; g=0
W1=-f(I,J)*(P0+P4-P6)
W2=-f(I,J)*(P0-P4+P6)
W3=-f(I,J)*(-P0+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=72
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=66
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=10
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
```

```
1185 aaaa=0
c 'For Site(I,J)=13; C(i,j)=-1; g=0
W1=-f(I,J)*(P0-P4-P6)
W2=-f(I,J)*(-P0+P4-P6)
W3=-f(I,J)*(-P0-P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=10
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=66
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=72
goto 620
1170 aaaa=0
c 'For Site(I,J)=11; C(i,j)=1; g=1
W1=-f(I,J)*(P0+P1-P5)
W2=-f(I,J)*(P0-P1+P5)
W3=-f(I,J)*(-P0+P1+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=65
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=68
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=5
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=64
goto 620
1175 aaaa=0
c 'For Site(I,J)=11; C(i,j)=-1; g=1
W1=-f(I,J)*(P0-P1-P5)
W2=-f(I,J)*(-P0+P1-P5)
W3=-f(I,J)*(-P0-P1+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=64
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=5
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=1
```

```
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=68
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=65
goto 620
1160 aaaa=0
c 'For Site(I,J)=11; C(i,j)=1; g=0
W1=-f(I,J)*(P2+P5-P6)
W2=-f(I,J)*(P2-P5+P6)
W3=-f(I,J)*(-P2+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=36
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=34
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=6
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
1165 aaaa=0
c 'For Site(I,J)=11; C(i,j)=-1; g=0
W1=-f(I,J)*(P2-P5-P6)
W2=-f(I,J)*(-P2+P5-P6)
W3=-f(I,J)*(-P2-P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=32
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=6
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=34
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=36
goto 620
1150 aaaa=0
c 'For Site(I,J)=7; C(i,j)=1
W1=-f(I,J)*(P1+P5-P6)
W2=-f(I,J)*(P1-P5+P6)
```

```
W3=-f(I,J)*(-P1+P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=5
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=3
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=4
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=6
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
1155 aaaa=0
c 'For Site(I,J)=7; C(i,j)=-1
W1=-f(I,J)*(P1-P5-P6)
W2=-f(I,J)*(-P1+P5-P6)
W3=-f(I,J)*(-P1-P5+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=1
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=6
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=3
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=2
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=5
goto 620
1140 aaaa=0
c 'For Site(I,J)=96
W1=-f(I,J)*(P1-P3)
W2=-f(I,J)*(P3-P1)
If((W1.lt.W2))newsite(I,J,3)=1
If((W1.lt.W2))newsite(I,J,2)=16
If((W2.lt.W1))newsite(I,J,3)=16
If((W2.lt.W1))newsite(I,J,2)=1
goto 620
1130 aaaa=0
c 'For Site(I,J)=80
W1=-f(I,J)*(P2-P4)
```

```
W2=-f(I,J)*(P4-P2)
If((W1.lt.W2))newsite(I,J,3)=32
If((W1.lt.W2))newsite(I,J,2)=8
If((W2.lt.W1))newsite(I,J,3)=8
If((W2.lt.W1))newsite(I,J,2)=32
goto 620
1120 aaaa=0
c ‘For Site(I,J)=72
W1=-f(I,J)*(P3-P5)
W2=-f(I,J)*(P5-P3)
If((W1.lt.W2))newsite(I,J,3)=16
If((W1.lt.W2))newsite(I,J,2)=4
If((W2.lt.W1))newsite(I,J,3)=4
If((W2.lt.W1))newsite(I,J,2)=16
goto 620
1110 aaaa=0
c ‘For Site(I,J)=68
W1=-f(I,J)*(P4-P6)
W2=-f(I,J)*(P6-P4)
If((W1.lt.W2))newsite(I,J,3)=8
If((W1.lt.W2))newsite(I,J,2)=2
If((W2.lt.W1))newsite(I,J,3)=2
If((W2.lt.W1))newsite(I,J,2)=8
goto 620
1100 aaaa=0
c ‘For Site(I,J)=66
W1=-f(I,J)*(P1-P5)
W2=-f(I,J)*(P5-P1)
If((W1.lt.W2))newsite(I,J,3)=4
If((W1.lt.W2))newsite(I,J,2)=1
If((W2.lt.W1))newsite(I,J,3)=1
If((W2.lt.W1))newsite(I,J,2)=4
```

```
goto 620
1090 aaaa=0
c ‘For Site(I,J)=65
W1=-f(I,J)*(P2-P6)
W2=-f(I,J)*(P6-P2)
If((W1.lt.W2))newsite(I,J,3)=32
If((W1.lt.W2))newsite(I,J,2)=2
If((W2.lt.W1))newsite(I,J,3)=2
If((W2.lt.W1))newsite(I,J,2)=32
goto 620
1080 aaaa=0
c ‘For Site(I,J)=48
W1=-f(I,J)*(P2-P3)
W2=-f(I,J)*(P3-P2)
If((W1.lt.W2))newsite(I,J,3)=32
If((W1.lt.W2))newsite(I,J,2)=16
If((W2.lt.W1))newsite(I,J,3)=16
If((W2.lt.W1))newsite(I,J,2)=32
goto 620
1075 aaaa=0
c ‘For Site(I,J)=36).And.(g=1
W1=-f(I,J)*(P1-P4)
W2=-f(I,J)*(P4-P1)
If((W1.lt.W2))newsite(I,J,3)=1
If((W1.lt.W2))newsite(I,J,2)=8
If((W2.lt.W1))newsite(I,J,3)=8
If((W2.lt.W1))newsite(I,J,2)=1
goto 620
1070 aaaa=0
c ‘For Site(I,J)=36).And.(g=0
W1=-f(I,J)*(P3-P6)
W2=-f(I,J)*(P6-P3)
```

```
If((W1.lt.W2))newsite(I,J,3)=16
If((W1.lt.W2))newsite(I,J,2)=2
If((W2.lt.W1))newsite(I,J,3)=2
If((W2.lt.W1))newsite(I,J,2)=16
goto 620
1060 aaaa=0
c ‘For Site(I,J)=33
W1=-f(I,J)*(P1-P2)
W2=-f(I,J)*(P2-P1)
If((W1.lt.W2))newsite(I,J,3)=1
If((W1.lt.W2))newsite(I,J,2)=32
If((W2.lt.W1))newsite(I,J,3)=32
If((W2.lt.W1))newsite(I,J,2)=1
goto 620
1050 aaaa=0
c ‘For Site(I,J)=24
W1=-f(I,J)*(P3-P4)
W2=-f(I,J)*(P4-P3)
If((W1.lt.W2))newsite(I,J,3)=16
If((W1.lt.W2))newsite(I,J,2)=8
If((W2.lt.W1))newsite(I,J,3)=8
If((W2.lt.W1))newsite(I,J,2)=16
goto 620
1045 aaaa=0
c ‘For Site(I,J)=18).And.(g=1
W1=-f(I,J)*(P2-P5)
W2=-f(I,J)*(P5-P2)
If((W1.lt.W2))newsite(I,J,3)=16
If((W1.lt.W2))newsite(I,J,2)=2
If((W2.lt.W1))newsite(I,J,3)=2
If((W2.lt.W1))newsite(I,J,2)=16
goto 620
```

```
1040 aaaa=0
c ‘For Site(I,J)=18).And.(g=0
W1=-f(I,J)*(P1-P4)
W2=-f(I,J)*(P4-P1)
If((W1.lt.W2))newsite(I,J,3)=1
If((W1.lt.W2))newsite(I,J,2)=8
If((W2.lt.W1))newsite(I,J,3)=8
If((W2.lt.W1))newsite(I,J,2)=1
goto 620
1035 aaaa=0
c ‘For Site(I,J)=9).And.(g=1
W1=-f(I,J)*(P3-P6)
W2=-f(I,J)*(P6-P3)
If((W1.lt.W2))newsite(I,J,3)=16
If((W1.lt.W2))newsite(I,J,2)=2
If((W2.lt.W1))newsite(I,J,3)=2
If((W2.lt.W1))newsite(I,J,2)=16
goto 620
1030 aaaa=0
c ‘For Site(I,J)=9).And.(g=0
W1=-f(I,J)*(P2-P5)
W2=-f(I,J)*(P5-P2)
If((W1.lt.W2))newsite(I,J,3)=32
If((W1.lt.W2))newsite(I,J,2)=4
If((W2.lt.W1))newsite(I,J,3)=4
If((W2.lt.W1))newsite(I,J,2)=32
goto 620
1020 aaaa=0
c ‘For Site(I,J)=12
W1=-f(I,J)*(P4-P5)
W2=-f(I,J)*(P5-P4)
If((W1.lt.W2))newsite(I,J,3)=8
```

```
If((W1.lt.W2))newsite(I,J,2)=4
If((W2.lt.W1))newsite(I,J,3)=4
If((W2.lt.W1))newsite(I,J,2)=8
goto 620
1010 aaaa=0
c ‘For Site(I,J)=6
W1=-f(I,J)*(P5-P6)
W2=-f(I,J)*(P6-P5)
If((W1.lt.W2))newsite(I,J,3)=4
If((W1.lt.W2))newsite(I,J,2)=2
If((W2.lt.W1))newsite(I,J,3)=2
If((W2.lt.W1))newsite(I,J,2)=4
goto 620
1000 aaaa=0
c ‘For Site(I,J)=3
W1=-f(I,J)*(P1-P6)
W2=-f(I,J)*(P6-P1)
If((W1.lt.W2))newsite(I,J,3)=1
If((W1.lt.W2))newsite(I,J,2)=2
If((W2.lt.W1))newsite(I,J,3)=2
If((W2.lt.W1))newsite(I,J,2)=1
goto 620
700 aaaa=0
c ‘For Site(I,J)=5
W1=-f(I,J)*P6
W2=-f(I,J)*P3
If((W1.lt.W2))newsite(I,J,3)=2
If((W1.lt.W2))newsite(I,J,2)=64
If((W2.lt.W1))newsite(I,J,3)=64
If((W2.lt.W1))newsite(I,J,2)=2
goto 620
710 aaaa=0
```

```
c ‘For Site(I,J)=10
W1=-f(I,J)*P5
W2=-f(I,J)*P2
If((W1.lt.W2))newsite(I,J,3)=4
If((W1.lt.W2))newsite(I,J,2)=64
If((W2.lt.W1))newsite(I,J,3)=64
If((W2.lt.W1))newsite(I,J,2)=4
goto 620
720 aaaa=0
c ‘For Site(I,J)=17
W1=-f(I,J)*P2
W2=-f(I,J)*P5
If((W1.lt.W2))newsite(I,J,3)=32
If((W1.lt.W2))newsite(I,J,2)=64
If((W2.lt.W1))newsite(I,J,3)=64
If((W2.lt.W1))newsite(I,J,2)=32
goto 620
730 aaaa=0
c ‘For Site(I,J)=20
W1=-f(I,J)*P4
W2=-f(I,J)*P1
If((W1.lt.W2))newsite(I,J,3)=8
If((W1.lt.W2))newsite(I,J,2)=64
If((W2.lt.W1))newsite(I,J,3)=64
If((W2.lt.W1))newsite(I,J,2)=8
goto 620
740 aaaa=0
c ‘For Site(I,J)=21; C(i,j)=1
W1=-f(I,J)*(P2+P4-P6)
W2=-f(I,J)*(P2-P4+P6)
W3=-f(I,J)*(-P2+P4+P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=40
```

```
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=2
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=34
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=8
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=10
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=32
goto 620
750 aaaa=0
c 'For Site(I,J)=21; C(i,j)=-1
W1=-f(I,J)*(-P2-P4+P6)
W2=-f(I,J)*(-P2+P4-P6)
W3=-f(I,J)*(P2-P4-P6)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=2
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=40
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=8
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=34
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=32
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=10
goto 620
760 aaaa=0
c 'For Site(I,J)=34
W1=-f(I,J)*P1
W2=-f(I,J)*P4
If((W1.lt.W2))newsite(I,J,3)=1
If((W1.lt.W2))newsite(I,J,2)=64
If((W2.lt.W1))newsite(I,J,3)=64
If((W2.lt.W1))newsite(I,J,2)=1
goto 620
770 aaaa=0
c 'For Site(I,J)=40
W1=-f(I,J)*P3
W2=-f(I,J)*P6
If((W1.lt.W2))newsite(I,J,3)=16
```

```
If((W1.lt.W2))newsite(I,J,2)=64
If((W2.lt.W1))newsite(I,J,3)=64
If((W2.lt.W1))newsite(I,J,2)=16
goto 620
780 aaaa=0
c 'For Site(I,J)=42; C(i,j)=1
W1=-f(I,J)*(P1+P3-P5)
W2=-f(I,J)*(P1-P3+P5)
W3=-f(I,J)*(-P1+P3+P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=17
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=4
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=5
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=16
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=20
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=1
goto 620
790 aaaa=0
c 'For Site(I,J)=42; C(i,j)=-1
W1=-f(I,J)*(-P1-P3+P5)
W2=-f(I,J)*(-P1+P3-P5)
W3=-f(I,J)*(P1-P3-P5)
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,3)=4
If((W1.lt.W2).And.(W1.lt.W3))newsite(I,J,2)=17
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,3)=16
If((W2.lt.W1).And.(W2.lt.W3))newsite(I,J,2)=5
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,3)=1
If((W3.lt.W1).And.(W3.lt.W2))newsite(I,J,2)=20
goto 620
620 aaaa=0
190 continue
above=0
below=0
```

```
do 909 J=1,ydir
if(site(xdir,J,2).eq.128)goto 909
If(site(xdir,J,2).ge.64)recov=recov+1
If(mod(site(xdir,J,2),2).eq.1)recov=recov+1 If(mod((site(xdir,J,2)/2),2).
eq.1)recov=recov+1 If(mod((site(xdir,J,2)/4),2).eq.1)recov=recov+1
909 continue
do 908 J=1,ydir
If(mod(site(xdir,J,3),2).eq.1)qecov=qecov+1 If(mod((site(xdir,J,3)/2),2).
eq.1)qecov=qecov+1 If(mod((site(xdir,J,3)/4),2).eq.1)qecov=qecov+1
908 continue
do 907 J=1,ydir
If(mod(site(1,J,3),2).eq.1)pecov=pecov+1 If(mod((site(1,J,3)/2),2).eq.1)pe-
cov=pecov+1 If(mod((site(1,J,3)/4),2).eq.1)pecov=pecov+1
907 continue
do 906 i=1,ydir
If(mod(site(i,1,2),2).eq.1)above=above+1 If(mod((site(i,1,2)/32),2).eq.1)
above=above+1
906 continue
do 905 i=1,ydir
If(mod((site(i,ydir,2)/4),2).eq.1)below=below+1 If(mod((site(i,y-
dir,2)/8),2).eq.1)below=below+1
905 continue
do 904 J=1,ydir
If(mod((site(1,J,2)/8),2).eq.1)left=left+1
If(mod((site(1,J,2)/16),2).eq.1)left=left+1
If(mod((site(1,J,2)/32),2).eq.1)left=left+1
904 continue
If(t.eq.ts)goto 111
If(mod(t,20).ne.0) goto 90
c
c - Recalculating porosity in iteration –
c
111 ddddd=0
```

```
void=0
voida=0
kosong=0
kosonga=0
do 4209 I=1, xdir
do 4309 J=1, ydir
If(site(I,J,1).ne.128) void=void+1 If((site(I,J,1).ne.128).and.(site(I,J,1).
ne.192).and.(site(I,J,1)
+.ne.256))voida=voida+1
4309 continue
kosong=kosong+void
kosonga=kosonga+voida
void=0
voida=0
4209 continue
total=xdir*ydir
porosity=kosong/total
c
c - Calculating the number of adsorbed polymer particles –
c
dd=cc
c
c - Calculating oil mass –
c
massto=0
masstp=0
do 809 I=1,xdir
do 809 J=1,ydir
If (site(I,J,1).eq.128) goto 809
If ((site(I,J,3).eq.256).or.(site(I,J,3).eq.192)) goto 809
If ((site(I,J,2).eq.128).or.(site(I,J,2).eq.0)) goto 859 If(mod(site(I,J,2),2).
eq.1)massto=massto+1      If(mod((site(I,J,2)/2),2).eq.1)massto=massto+1
If(mod((site(I,J,2)/4),2).eq.1)massto=massto+1 If(mod((site(I,J,2)/8),2).
```

```
eq.1)massto=massto+1    If(mod((site(I,J,2)/16),2).eq.1)massto=massto+1
If(mod((site(I,J,2)/32),2).eq.1)massto=massto+1  If(site(I,J,2).ge.64)mass-
to=massto+1
859 aaaa=0
If(mod(site(I,J,3),2).eq.1)masstp=masstp+1  If(mod((site(I,J,3)/2),2).eq.1)
masstp=masstp+1    If(mod((site(I,J,3)/4),2).eq.1)masstp=masstp+1    If(-
mod((site(I,J,3)/8),2).eq.1)masstp=masstp+1      If(mod((site(I,J,3)/16),2).
eq.1)masstp=masstp+1    If(mod((site(I,J,3)/32),2).eq.1)masstp=masstp+1
If(site(I,J,3).ge.64)masstp=masstp+1
809 continue
denco=massto/kosonga
dencp=masstp/kosonga
poil=massto
ppol=masstp
c
c - Total mass –
c
mastot=massto+masstp
c                    -
c - Calculated variables for oil –
c                    -
void=0
voida=0
kosong=0
kosonga=0
do 4402 I=1, xdir
do 4403 J=1, ydir
If((site(I,J,1).ne.128).or.(site(I,J,2).ne.128).or.(site(I,J,3)
+.ne.128))void=void+1
4403 continue
kosong=kosong+void
void=0
4402 continue
```

```
masstot=0
vxt=0
mxt=0
do 4409 I=1, xdir
do 4409 J=1, ydir
If(site(I,J,1).eq.128) goto 4409
If(mod(site(I,J,2),2).eq.1)masstot=masstot+1 If(mod((site(I,J,2)/2),2).eq.1)
masstot=masstot+1  If(mod((site(I,J,2)/4),2).eq.1)masstot=masstot+1  If(-
mod((site(I,J,2)/8),2).eq.1)masstot=masstot+1  If(mod((site(I,J,2)/16),2).
eq.1)masstot=masstot+1 If(mod((site(I,J,2)/32),2).eq.1)masstot=masstot+1
If(site(I,J,2).ge.64)masstot=masstot+1
4409  continue
do 4509 I=1, xdir
do 4509 J=1, ydir
masite=0
If(site(I,J,1).eq.128) goto 4709
If(mod(site(I,J,2),2).eq.1)masite=masite+1  If(mod((site(I,J,2)/2),2).eq.1)
masite=masite+1  If(mod((site(I,J,2)/4),2).eq.1)masite=masite+1  If(-
mod((site(I,J,2)/8),2).eq.1)masite=masite+1 If(mod((site(I,J,2)/16),2).eq.1)
masite=masite+1 If(mod((site(I,J,2)/32),2).eq.1)masite=masite+1
If(site(I,J,2).ge.64)masite=masite+1
4709 zzzzz=0
If(site(I,J,2).eq.64) goto 4509
If((site(I,J,2).gt.0).and.(site(I,J,2).lt.128))vxt=vxt +
+(momx(site(I,J,2),2))/masite
If((site(I,J,2).gt.0).and.(site(I,J,2).lt.128))mxt=mxt +
+momx(site(I,J,2),2)
4509 continue
c
c - Oil mass –
c
masstoo=masstot
c
```

```
c - Density -
c
denco=masstot/kosong
c
c - Kinematic viscosity –
c
d=denco/7
kineo=(1.0/28/(d*(1-d))/(1-8*d*(1-d)/7))-(1/8)
c
c - Dynamic viscosity –
c
dynao=denco*kineo
c
c - Velocity –
c
velxo=vxt / kosong
c
c - Flow rate –
c
flowo=velxo*porosity
c
c - Pressure –
c
c           presso=wx/(ydir*0.8660254)
c
c - Calculated variables for polymer –
c
masstot=0
vxt=0
mxt=0
do 5409 I=1, xdir
do 5409 J=1, ydir
```

```
If(site(I,J,1).eq.128) goto 5409
If(mod(site(I,J,3),2).eq.1)masstot=masstot+1 If(mod((site(I,J,3)/2),2).eq.1)
masstot=masstot+1  If(mod((site(I,J,3)/4),2).eq.1)masstot=masstot+1  If(-
mod((site(I,J,3)/8),2).eq.1)masstot=masstot+1  If(mod((site(I,J,3)/16),2).
eq.1)masstot=masstot+1 If(mod((site(I,J,3)/32),2).eq.1)masstot=masstot+1
If(site(I,J,3).ge.64)masstot=masstot+1
5409  continue
do 5509 I=1, xdir
do 5509 J=1, ydir
masite=0
If(site(I,J,1).eq.128) goto 5509
If(mod(site(I,J,3),2).eq.1)masite=masite+1  If(mod((site(I,J,3)/2),2).eq.1)
masite=masite+1  If(mod((site(I,J,3)/4),2).eq.1)masite=masite+1  If(-
mod((site(I,J,3)/8),2).eq.1)masite=masite+1 If(mod((site(I,J,3)/16),2).eq.1)
masite=masite+1 If(mod((site(I,J,3)/32),2).eq.1)masite=masite+1
If(site(I,J,3).ge.64)masite=masite+1
5709 zzzzz=0
If(site(I,J,3).eq.64) goto 5509
If((site(I,J,3).gt.0).and.(site(I,J,3).lt.128))vxt=vxt +
+(momx(site(I,J,3),3))/masite
If((site(I,J,3).gt.0).and.(site(I,J,3).lt.128))mxt=mxt +
+momx(site(I,J,3),3)
5509 continue
c
c - Polymer mass –
c
masstop=masstot
mastot=masstoo+masstop
c
c - Polymer Saturation –
c
polsat=masstop/mastot
if(t.ne.1) goto 5469
```

```
swi=polsat
5469 eeee=0
c
c - Oil Saturation –
c
oilsat=masstoo/mastot
totsat=polsat+oilsat
c
c - Density -
c
dencp=masstot/kosong
c
c - Kinematic viscosity –
c
d=dencp/7
kinep=(1.0/28/(d*(1-d))/(1-8*d*(1-d)/7))-(1/8) c
c - Dynamic viscosity –
c
dynap=dencp*kinep
c
c - Velocity –
c
velxp=vxt / kosong
c
c - Flow rate –
c
flowp=velxp*porosity
c
c - Calculate momentum at left boundary –
c
wx=0
void=0
```

```
do 4809 J=1, ydir
If((site(0,J,3).eq.0).or.(site(0,J,3).eq.64)) goto 4809
If((site(0,J,3).eq.128).or.(site(0,J,3).eq.192)) goto 4809
If(site(0,J,3).eq.256) goto 4809
If((site(0,J,3).gt.0).and.(site(0,J,3).lt.128))
+wx=wx+momx(site(0,J,3),3)
4809 continue
c
c - Pressure –
c
pressp=wx/(ydir*0.8660254)
c
c - Pressure gradient –
c
pressgrad=wx/(ydir*0.8660254)/xdir
c
c - Permeability –
c
permeabilip=(vxt/kosong*porosity)*dynap/pressgrad
c
c - Recondition –
c
do 2005 I=1,xdir
do 2005 J=1,ydir
site(I,J,1)=newsite(I,J,1)
site(I,J,2)=newsite(I,J,2)
site(I,J,3)=newsite(I,J,3)
2005 continue
c
c - Print and Write –
c
print *,t,oilsat,polsat,dynao,dynap,recov
```

```
write (5,*)t,oilsat,polsat,dynao,dynap,recov
90 continue
print *,”Remainingoilparticles=”,poil
write (5,*)”Remainingoilparticles=”,poil
2222 end
```

BAB 6

Pemodelan dan Simulasi Injeksi Polimer Menggunakan Perhitungan Paralel

Pada bab ini dibahas mengenai pemodelan dan simulasi dengan menerapkan perhitungan parallel. Untuk kasus ini digunakan banyak komputer yang terhubung dengan jaringan. Tujuan utama simulasi dengan perhitungan paralel adalah untuk mengurangi waktu simulasi (Fathaddin dan Awang, 2005).

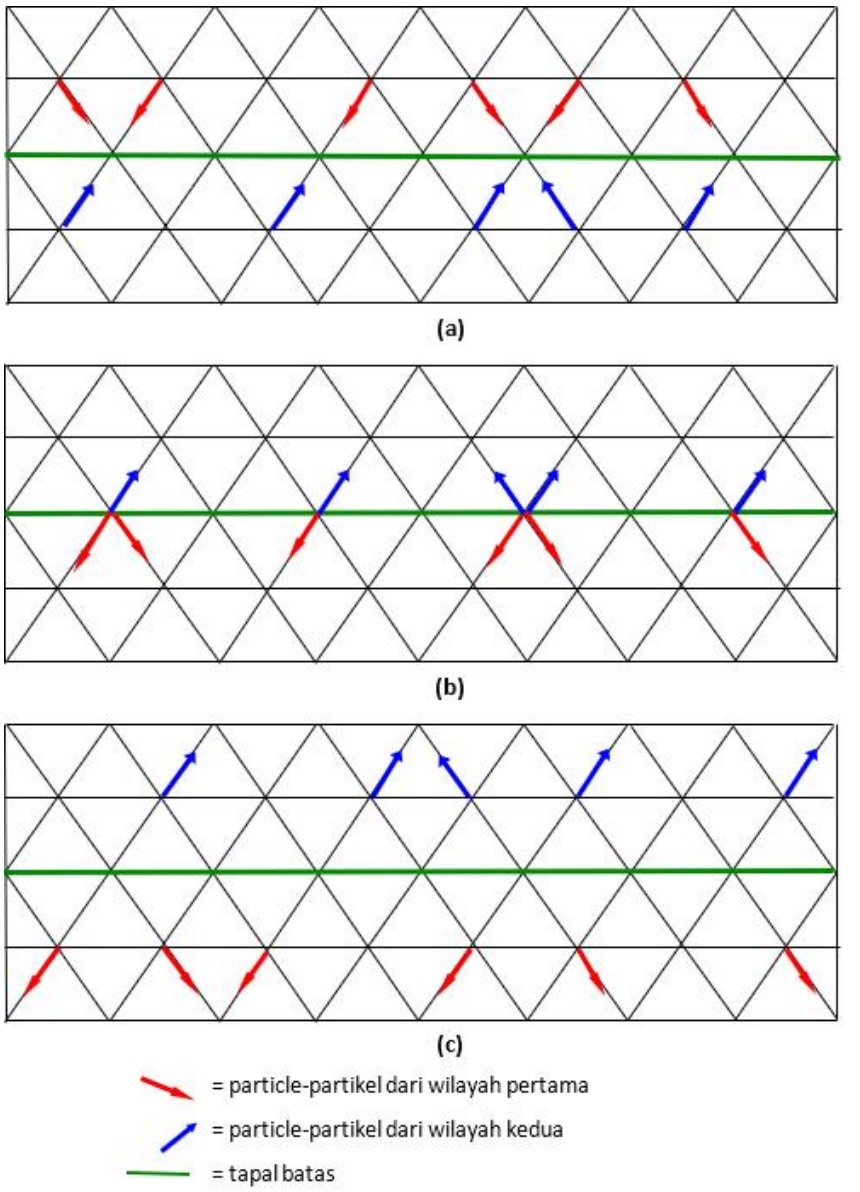
6.1 Pemodelan Injeksi Polimer Menggunakan Perhitungan Paralel

Untuk melakukan simulasi dengan perhitungan parallel, dibutuhkan jaringan komputer yang terdiri dari satu *master computer* yang bertujuan untuk memberi perintah dan mengkoordinasikan hasil perhitungan, dan sejumlah *slave computer* yang berfungsi untuk menjalankan program simulasi injeksi polimer untuk sebagian wilayah media berpori. Model media berpori Lattice Gas Automata (LGA) dibagi menjadi beberapa bagian yang sama besar jika spesifikasi seluruh *slave computer* sama. Ini berarti jumlah pembagian wilayah media berpori disesuaikan dengan jumlah *slave computer* dan luas pembagian wilayah media berpori disesuaikan dengan spe-

sifikasi dari masing-masing *slave computer*. Hal ini perlu diupayakan agar semua *slave computer* dapat menyelesaikan perhitungan pada waktu yang bersamaan untuk suatu iterasi.

Pembagian wilayah media berpori harus dilakukan searah dengan arah aliran utama fluida. Nomor urut *slave computer* ditentukan oleh *master computer* sesuai dengan urutan lokasi bagian wilayah media berpori LGA. *Master computer* tidak akan memerintahkan *slave computer* melakukan perhitungan pada iterasi berikutnya sebelum semua *slave computer* menyelesaikan perhitungan pada iterasi sebelumnya. Sehingga *slave computer* terlemah menentukan lama waktu simulasi.

Pada setiap iterasi, *master computer* mendata partikel-partikel fluida yang bergerak keluar dari wilayah media berpori yang disimulasikan oleh suatu *slave computer* menuju ke wilayah media berpori berdekatan yang disimulasikan oleh *slave computer* lain. Pada iterasi selanjutnya partikel-partikel fluida tersebut akan dinformasikan oleh *master computer* ke *slave computer* lain. Untuk mengatur perpindahan partikel dari suatu wilayah ke wilayah lain diberikan aturan tumbukan sebagaimana diperlihatkan pada Gambar 6.1 (Fathaddin dan Awang, 2009).



Gambar 6.1 Aturan tumbukan untuk pergerakan partikel melintasi tapal batas

Gambar 6.1 menunjukkan perambatan partikel melintasi tapal batas. Dengan asumsi tidak ada tumbukan yang terjadi pada tapal batas, partikel

yang mencapai tapal batas akan terus bergerak dengan arah dan kecepatan yang sama ke wilayah lain. Tumbukan antara partikel fluida di tempat lain diatur oleh aturan tumbukan model FHP-III (Buick, 1997). Partikel-partikel bergerak dari situs tetangga ke situs tapal batas (Gambar 6.1a). Partikel-partikel yang berhadapan bertemu di tapal batas (Gambar 6.1b), mereka tetap bergerak dengan arah dan kecepatan yang sama karena diasumsikan tidak ada tumbukan yang terjadi di tapal batas (Gambar 6.1c).

Jumlah dan arah partikel yang melintasi tapal batas ditentukan oleh partikel di lokasi terdekat dengan tapal batas antara wilayah yang berdekatan. *Slave computer* memberikan informasi tentang partikel-partikel ini. Sedangkan *master computer* menyediakan komunikasi antara wilayah yang berdekatan karena partikel yang meninggalkan satu wilayah akan menjadi partikel yang sama yang masuk ke wilayah lain dan sebaliknya. Situs-situs tapal batas dimiliki bersama oleh wilayah yang berdekatan. Oleh karena itu, ketika model kisi dibagi menjadi dua wilayah, situs batas yang sama dimasukkan di kedua wilayah yang berdekatan.

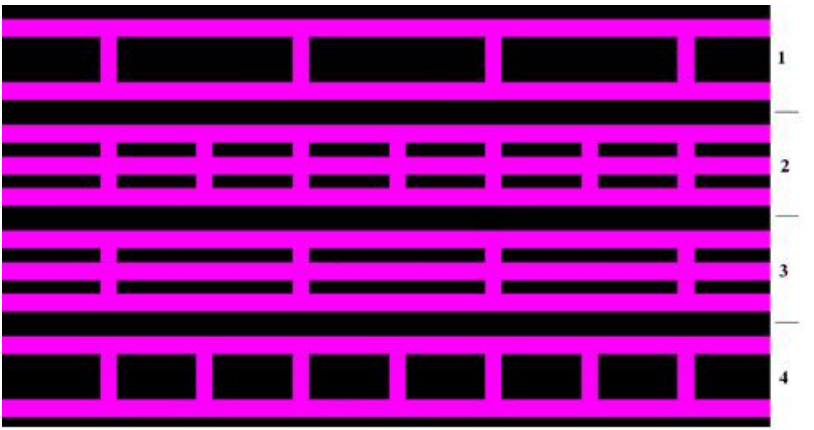
6.2 Simulasi Injeksi Polimer Menggunakan Perhitungan Paralel

Perhitungan paralel menggunakan banyak komputer yang digunakan secara bersamaan dalam jaringan dimana piranti lunak. Aplikasi *Parallel Virtual Machine* (PVM) digunakan untuk protokol paralel. PVM dimulai pada 1989 di Laboratorium Nasional Oak Ridge. PVM memberi fungsi untuk memulai tugas secara otomatis pada mesin virtual dan memungkinkan untuk berkomunikasi dan menyinkronkan satu sama lain. Istilah mesin virtual digunakan untuk menunjuk pada memori terdistribusi logistik. Tugas didefinisikan sebagai unit komputasi dalam PVM. Aplikasi dapat ditulis dalam Bahasa Fortran atau C dan dapat diparalelkan dengan penggunaan konstruksi message-passing yang umum untuk sebagian besar komputer dengan memori terdistribusi. Dengan mengirim dan menerima pesan, beberapa tugas aplikasi dapat bekerjasama untuk memecahkan masalah secara paralel. Dalam mengoperasikan simulasi paralel menggunakan PVM, diperlukan sebuah program master sebagai taskmaster untuk host-host yang berisi program slave. Host digunakan untuk menunjuk salah satu dari komputer-komputer anggota (Geist dkk., 1994a; Geist dkk., 1994b).

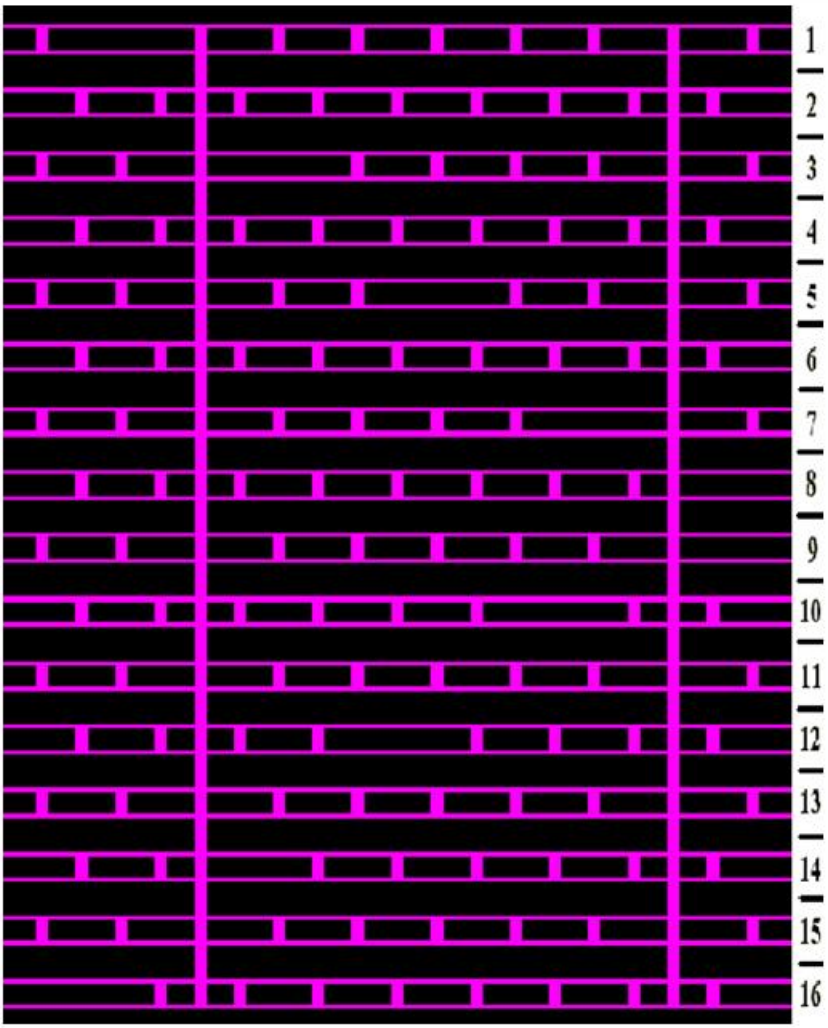
Untuk komputasi paralel, model dibagi menjadi beberapa wilayah sepanjang arah aliran fluida. Dua kasus batas dipertimbangkan. Dalam kasus pertama, wilayah-wilayah tidak berkomunikasi sebagaimana diper-

lihatkan pada Gambar 6.2. Oleh karena pembagian media berpori menjadi 4 wilayah melalui padatan dan tidak memotong saluran aliran fluida, maka tidak ada komunikasi antara aliran fluida di satu wilayah dengan aliran fluida di wilayah lainnya. Simulasi setiap wilayah dilakukan secara mandiri menggunakan komputer terpisah. Waktu penyelesaian simulasi tergantung pada bagian wilayah yang paling lambat disimulasikan.

Dalam kasus dua, pembagian dilakukan melalui saluran aliran fluida baik dengan membagi ruang pori atau rekahan sebagaimana diperlihatkan pada Gambar 6.3. Akibatnya, batas setiap wilayah berada di tengah saluran aliran dan setiap wilayah dikomunikasikan dengan wilayah lain yang berdekatan pada batas aliran. Sistem gugus (*cluster*) digunakan untuk mensimulasikan sistem ini. Dalam media berpori nyata, campuran dua batas ini akan terjadi dalam media berpori. Dengan melakukan simulasi menggunakan dua model ekstrim, perilaku nyata diperkirakan berada dalam kisaran yang dipelajari. Gambar 6.3 memperlihatkan media berpori LGA yang terdiri dari 16 wilayah. Simulasi aliran fluida dengan perhitungan parallel dapat dilakukan dengan menggunakan 16 *slave computer* yang terhubung melalui jaringan.



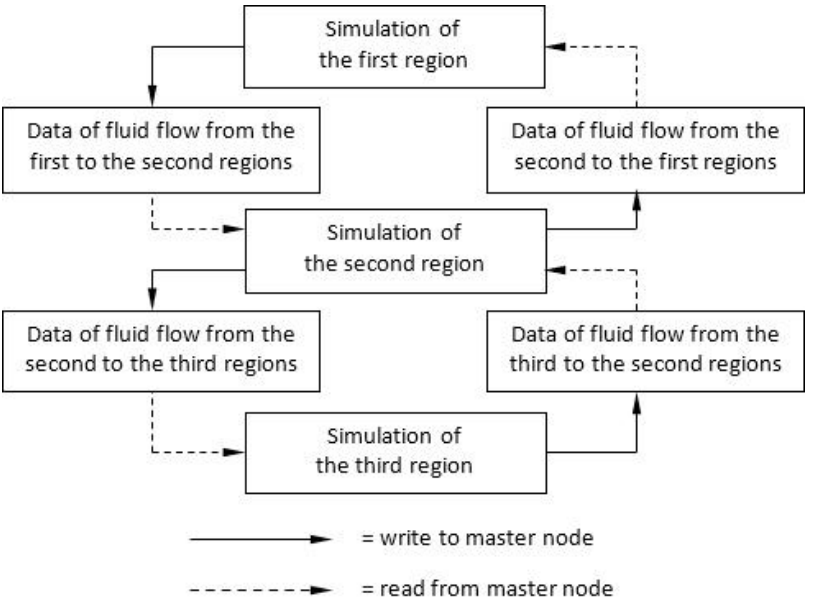
Gambar 6.2 Media berpori dengan aliran non-komunikasi. Area hitam mewakili materi (batuan) padat dan area ungu mewakili saluran pori berisi cairan



Gambar 6.3 Media berpori dengan 16 bagian wilayah yang saling berkomunikasi melalui saluran aliran fluida. Area hitam mewakili materi (batuan) padat dan area ungu mewakili saluran pori berisi cairan

Program paralel dalam sistem cluster terdiri dari program master yang berjalan pada satu node (*master computer*) yang mengontrol program slave yang diinstal pada node (*slave computer*) lainnya. Baik program master dan slave ditulis dalam Fortran. Inisialisasi, kontrol, sinkronisasi, instruksi, pengumpulan dan tampilan hasil berada pada *master node*, sedangkan perhitungan simulasi yang sebenarnya berada pada *slave node*. Setiap *slave*

node mensimulasikan suatu wilayah dan dapat menerima dan mengirim data ke *master node* serta dua *slave node* yang berdekatan yang mewakili wilayah yang berdekatan seperti yang ditunjukkan pada Gambar 6.4. Semua *slave node* memulai tugas yang sama pada waktu tertentu, yang berarti langkah propagasi atau tumbukan partikel fluida dimulai secara bersamaan di semua wilayah. Ketika semua node telah menyelesaikan tugas sebelumnya, putaran instruksi lain diterima dari master.



Gambar 6.4 Diagram alir sistem gugus

6.3 Program Simulasi Injeksi Polimer Menggunakan Perhitungan Paralel

Program komputer dibuat baik untuk *master computer* maupun *slave computer* untuk mensimulasikan proses injeksi polimer menggunakan perhitungan paralel. Program komputer dibuat dalam Bahasa FORTRAN sebagai berikut:

6.3.1 Program Simulasi Injeksi Polimer untuk Master Computer

Program master berisi data awal simulasi dan penetapan tugas untuk slave, komunikasi (pengiriman dan penerimaan informasi) ke slave dan pencetakan hasil simulasi. Program master untuk simulasi paralel adalah sebagai berikut:

```
c $ Program Id: mymaster.f, version 2005/01/23 $

program mymaster include 'fpvm3.h'
c ========================
c = PVM : Variables declaration =
c  ========================
c         xdir = Number of sites in x direction
c         ydir = Number of sites in y direction
c         arpp = Rate of polymer particles adsorbtion
c         tol = Type of layer (Monolayer: Tol = 1 ; Multilayer: Tol = 2)
c         grpp = Rate of polymer particles gelation (0.0 - 10.0)
c         ts = Time step
c         tyop = Type of particle (tyop = 0 - 127)
c         nbs = Neighbor site
c         nproc= Number of processor
c         ypart= Number of region in y direction
c         ydirpart = Position of region border in y direction
c         xpart= Number of region in x direction
c         xdirpart = Position of region border in x direction

integer xdir, ydir, ts
real tyop, arpp, grpp, tol, t
data xdir, ydir, ts /1000, 800, 1/ data tyop /3.0/
data arpp, grpp, tol /0.0, 0.0, 1/ integer I, J, K
integer g, gg, bb, ccc, ddd, ee, fff, hhh, kk integer site(0:1001,800)
integer newsite(1000,800)
```

```
integer    nbs1(1000,800),nbs2(1000,800),nbs3(1000,800)
integer    nbs4(1000,800),nbs5(1000,800),nbs6(1000,800)
integer aps(0:260,10),mass(260), cs
real*4 zr, denc, kosong
real*4 momx(260), momy(260),d,kinevis,dynavis,kinevisc,dynavisc
real*4 rdn, flow, flowc, wx
real*4 velx, velxc, press, pressc
real*4 pressgrad, pressgradc, n, h
integer a, m, seed
data a, m, seed /1027, 1048576, 1/
integer info, msgtype
integer mytid, tids(0:32)
integer who
character*18 nodename
character*8 arch
integer nproc, numt
c Only one slave
integer ypart, ydirpart(2), ysize
data nproc, ypart, ydirpart /1, 1, 0, 800/
c       Use two slaves
c       integer ypart, ydirpart(3), ysize
c       data nproc, ypart, ydirpart /2, 2, 0, 400, 800/
c       Use four slaves
c       integer ypart, ydirpart(5), ysize
c       data nproc, ypart, ydirpart /4, 4, 0, 200, 400, 600, 800/

c       Use eight slaves
c       integer ypart, ydirpart(9), ysize
c       data nproc, ypart, ydirpart /8, 8, 0, 100, 200, 300,
c       +400, 500, 600, 700, 800/
```

```
c       Use sixteen slaves
c       integer ypart, ydirpart(17), ysize
c       data nproc, ypart, ydirpart /16, 16, 0, 50, 100, 150, 200, 250,
c       +300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800/

integer xpart, xdirpart(4)
data xpart, xdirpart /2, 240, 260, 840, 860/

c ========================
c = PVM: Starting up all the tasks =
c ========================
c Enroll mymaster program in PVM
call pvmfmytid( mytid )
c Initiate nproc instances of myslave program
c If arch is set to '*' then ANY configured machine is acceptable
nodename = 'myslave'
arch = '*'
call pvmfspawn( nodename, PVMDEFAULT, arch, nproc, tids, numt )
c Check for problems
if( numt .lt. nproc ) then
print *, 'trouble spawning ',nodename
print *, ' Check tids for error code'
call shutdown( numt, tids )
endif
print *, "NProc =", nproc, " xdir =", xdir, " ydir =",ydir,
+       " Time-step =", ts
c ======================
c = PVM: Begin user program =
c ======================
z=seed
zm=m
c =================
```

```
c = setting the obstacles =
c ==================
do 101 i=1,xdir
do 101 j=1,ydir
site(i,j)=128
101 continue
c
c   - Porous Media –
c
c     The main channels
c The main channels1
do 890 i=1,xdir
do 890 j=5,20
site(i,j)=0
890 continue
do 891 i=1,xdir
do 891 j=30,45
site(i,j)=0
891 continue
c The main channels2
do 892 i=1,xdir
do 892 j=55,70
site(i,j)=0
892 continue
do 893 i=1,xdir
do 893 j=80,95
site(i,j)=0
893 continue
c The main channels3
do 894 i=1,xdir
do 894 j=105,120
site(i,j)=0
```

```
894 continue
do 895 i=1,xdir
do 895 j=130,145
site(i,j)=0
895 continue
c The main channels4
do 896 i=1,xdir
do 896 j=155,170
site(i,j)=0
896 continue
do 897 i=1,xdir
do 897 j=180,195
site(i,j)=0
897 continue
c The main channels5
do 898 i=1,xdir
do 898 j=205,220
site(i,j)=0
898 continue
do 990 i=1,xdir
do 990 j=230,245
site(i,j)=0 990 continue
c The main channels6
do 991 i=1,xdir
do 991 j=255,270
site(i,j)=0
991 continue
do 992 i=1,xdir
do 992 j=280,295
site(i,j)=0
992 continue
c The main channels7
```

```
do 993 i=1,xdir
do 993 j=305,320
site(i,j)=0
993 continue
do 994 i=1,xdir
do 994 j=330,345
site(i,j)=0
994 continue
c The main channels8
do 995 i=1,xdir
do 995 j=355,370
site(i,j)=0
995 continue
do 996 i=1,xdir
do 996 j=380,395
site(i,j)=0
996 continue
c The main channels9
do 997 i=1,xdir
do 997 j=405,420
site(i,j)=0
997 continue
do 998 i=1,xdir
do 998 j=430,445
site(i,j)=0
998 continue
c The main channels10
do 999 i=1,xdir
do 999 j=455,470
site(i,j)=0
999 continue
do 1000 i=1,xdir
```

```
do 1000 j=480,495
site(i,j)=0
1000 continue
c The main channels11
do 1001 i=1,xdir
do 1001 j=505,520
site(i,j)=0
1001 continue
do 1002 i=1,xdir
do 1002 j=530,545
site(i,j)=0
1002 continue
c The main channels12
do 1003 i=1,xdir
do 1003 j=555,570
site(i,j)=0
1003 continue
do 1004 i=1,xdir
do 1004 j=580,595
site(i,j)=0
1004 continue
c The main channels13
do 1005 i=1,xdir
do 1005 j=605,620
site(i,j)=0
1005 continue
do 1006 i=1,xdir
do 1006 j=630,645
site(i,j)=0
1006 continue
c The main channels14
do 1007 i=1,xdir
```

```
do 1007 j=655,670
site(i,j)=0
1007 continue
do 1008 i=1,xdir
do 1008 j=680,695
site(i,j)=0
1008 continue
c The main channels15
do 1009 i=1,xdir
do 1009 j=705,720
site(i,j)=0
1009 continue
do 1010 i=1,xdir
do 1010 j=730,745
site(i,j)=0
1010 continue
c The main channels16
do 1011 i=1,xdir
do 1011 j=755,770
site(i,j)=0
1011 continue
do 1012 i=1,xdir
do 1012 j=780,795
site(i,j)=0
1012 continue
c Cluster1
c Branch1
do 1015 i=40,60
do 1015 j=10,40
site(i,j)=0
1015 continue
c Branch2
```

```
do 1020 i=240,260
do 1020 j=10,790
site(i,j)=0
1020 continue
c Branch3
do 1025 i=340,360
do 1025 j=10,40
site(i,j)=0
1025 continue
c Branch4
do 1030 i=440,460
do 1030 j=10,40
site(i,j)=0
1030 continue
c Branch5
do 1035 i=540,560
do 1035 j=10,40
site(i,j)=0
1035 continue
c Branch6
do 1040 i=640,660
do 1040 j=10,40
site(i,j)=0
1040 continue
c Branch7
do 1045 i=740,760
do 1045 j=10,40
site(i,j)=0
1045 continue
c Branch8
do 1050 i=840,860
do 1050 j=10,790
```

```
site(i,j)=0
1050 continue
c Branch9
do 1055 i=940,960
do 1055 j=10,40
site(i,j)=0
1055 continue
c Cluster2
c Branch1
do 1090 i=90,110
do 1090 j=60,90
site(i,j)=0
1090 continue
c Branch2
do 1095 i=190,210
do 1095 j=60,90
site(i,j)=0
1095 continue
c Branch3
do 1100 i=290,310
do 1100 j=60,90
site(i,j)=0
1100 continue
c Branch4
do 1105 i=390,410
do 1105 j=60,90
site(i,j)=0
1105 continue
c Branch5
do 1110 i=490,510
do 1110 j=60,90
site(i,j)=0
```

```
1110 continue
c Branch6
do 1115 i=590,610
do 1115 j=60,90
site(i,j)=0
1115 continue
c Branch7
do 1120 i=690,710
do 1120 j=60,90
site(i,j)=0
1120 continue
c Branch8
do 1125 i=790,810
do 1125 j=60,90
site(i,j)=0
1125 continue
c Branch9
do 1130 i=890,910
do 1130 j=60,90
site(i,j)=0
1130 continue
c Cluster3
c Branch1
do 1215 i=40,60
do 1215 j=110,140
site(i,j)=0
1215 continue
c Branch2
do 1217 i=140,160
do 1217 j=110,140
site(i,j)=0
1217 continue
```

```
c Branch3
do 1220 i=240,260
do 1220 j=110,140
site(i,j)=0
1220 continue
c Branch4
do 1230 i=440,460
do 1230 j=110,140
site(i,j)=0
1230 continue
c Branch5
do 1235 i=540,560
do 1235 j=110,140
site(i,j)=0
1235 continue
c Branch6
do 1240 i=640,660
do 1240 j=110,140
site(i,j)=0
1240 continue
c Branch7
do 1245 i=740,760
do 1245 j=110,140
site(i,j)=0
1245 continue
c Branch8
do 1250 i=840,860
do 1250 j=110,140
site(i,j)=0
1250 continue
c Branch9
do 1255 i=940,960
```

```
do 1255 j=110,140
site(i,j)=0
1255 continue
c Cluster4
c Branch1
do 1290 i=90,110
do 1290 j=160,190
site(i,j)=0
1290 continue
c Branch2
do 1295 i=190,210
do 1295 j=160,190
site(i,j)=0
1295 continue
c Branch3
do 1300 i=290,310
do 1300 j=160,190
site(i,j)=0
1300 continue
c Branch4
do 1305 i=390,410
do 1305 j=160,190
site(i,j)=0
1305 continue
c Branch5
do 1310 i=490,510
do 1310 j=160,190
site(i,j)=0
1310 continue
c Branch6
do 1315 i=590,610
do 1315 j=160,190
```

```
site(i,j)=0
1315 continue
c Branch7
do 1320 i=690,710
do 1320 j=160,190
site(i,j)=0
1320 continue
c Branch8
do 1325 i=790,810
do 1325 j=160,190
site(i,j)=0
1325 continue
c Branch9
do 1330 i=890,910
do 1330 j=160,190
site(i,j)=0
1330 continue
c Cluster5
c          Branch1
do 1415 i=40,60
do 1415 j=210,240
site(i,j)=0
1415 continue
c Branch2
do 1417 i=140,160
do 1417 j=210,240
site(i,j)=0
1417 continue
c Branch3
do 1420 i=240,260
do 1420 j=210,240
site(i,j)=0
```

```
1420 continue
c Branch4
do 1425 i=340,360
do 1425 j=210,240
site(i,j)=0
1425 continue
c Branch5
do 1430 i=440,460
do 1430 j=210,240
site(i,j)=0
1430 continue
c Branch6
do 1440 i=640,660
do 1440 j=210,240
site(i,j)=0
1440 continue
c Branch7
do 1445 i=740,760
do 1445 j=210,240
site(i,j)=0
1445 continue
c Branch8
do 1450 i=840,860
do 1450 j=210,240
site(i,j)=0
1450 continue
c Branch9
do 1455 i=940,960
do 1455 j=210,240
site(i,j)=0
1455 continue
c Cluster6
```

```
c Branch1
do 1490 i=90,110
do 1490 j=260,290
site(i,j)=0
1490 continue
c Branch2
do 1495 i=190,210
do 1495 j=260,290
site(i,j)=0
1495 continue
c Branch3
do 1500 i=290,310
do 1500 j=260,290
site(i,j)=0
1500 continue
c Branch4
do 1505 i=390,410
do 1505 j=260,290
site(i,j)=0
1505 continue
c Branch5
do 1510 i=490,510
do 1510 j=260,290
site(i,j)=0
1510 continue
c Branch6
do 1515 i=590,610
do 1515 j=260,290
site(i,j)=0
1515 continue
c Branch7
do 1520 i=690,710
```

```
do 1520 j=260,290
site(i,j)=0
1520 continue
c Branch8
do 1525 i=790,810
do 1525 j=260,290
site(i,j)=0
1525 continue
c Branch9
do 1530 i=890,910
do 1530 j=260,290
site(i,j)=0
1530 continue
c Cluster7
c Branch1
do 1615 i=40,60
do 1615 j=310,340
site(i,j)=0
1615 continue
c Branch2
do 1617 i=140,160
do 1617 j=310,340
site(i,j)=0
1617 continue
c Branch3
do 1620 i=240,260
do 1620 j=310,340
site(i,j)=0
1620 continue
c Branch4
do 1625 i=340,360
do 1625 j=310,340
```

```
site(i,j)=0
1625 continue
c Branch5
do 1630 i=440,460
do 1630 j=310,340
site(i,j)=0
1630 continue
c Branch6
do 1635 i=540,560
do 1635 j=310,340
site(i,j)=0
1635 continue
c Branch7
do 1640 i=640,660
do 1640 j=310,340
site(i,j)=0
1640 continue
c Branch8
do 1650 i=840,860
do 1650 j=310,340
site(i,j)=0
1650 continue
c Branch9
do 1655 i=940,960
do 1655 j=310,340
site(i,j)=0
1655 continue
c Cluster8
c Branch1
do 1690 i=90,110
do 1690 j=360,390
site(i,j)=0
```

```
1690 continue
c Branch2
do 1695 i=190,210
do 1695 j=360,390
site(i,j)=0
1695 continue
c Branch3
do 1700 i=290,310
do 1700 j=360,390
site(i,j)=0
1700 continue
c Branch4
do 1705 i=390,410
do 1705 j=360,390
site(i,j)=0
1705 continue
c Branch5
do 1710 i=490,510
do 1710 j=360,390
site(i,j)=0 1710 continue
c Branch6
do 1715 i=590,610
do 1715 j=360,390
site(i,j)=0
1715 continue
c Branch7
do 1720 i=690,710
do 1720 j=360,390
site(i,j)=0
1720 continue
c Branch8
do 1725 i=790,810
```

```
do 1725 j=360,390
site(i,j)=0
1725 continue
c Cluster9
c Branch1
do 2015 i=40,60
do 2015 j=410,440
site(i,j)=0
2015 continue
c Branch2
do 2017 i=140,160
do 2017 j=410,440
site(i,j)=0
2017 continue
c Branch3
do 2020 i=240,260
do 2020 j=410,440
site(i,j)=0
2020 continue
c Branch4
do 2025 i=340,360
do 2025 j=410,440
site(i,j)=0
2025 continue
c Branch5
do 2030 i=440,460
do 2030 j=410,440
site(i,j)=0
2030 continue
c Branch6
do 2035 i=540,560
do 2035 j=410,440
```

```
site(i,j)=0
2035 continue
c Branch7
do 2040 i=640,660
do 2040 j=410,440
site(i,j)=0
2040 continue
c Branch8
do 2045 i=740,760
do 2045 j=410,440
site(i,j)=0
2045 continue
c Branch9
do 2050 i=840,860
do 2050 j=410,440
site(i,j)=0
2050 continue
c Cluster10
c Branch1
do 2090 i=90,110
do 2090 j=460,490
site(i,j)=0
2090 continue
c Branch2
do 2095 i=190,210
do 2095 j=460,490
site(i,j)=0
2095 continue
c Branch3
do 2100 i=290,310
do 2100 j=460,490
site(i,j)=0
```

```
2100 continue
c Branch4
do 2105 i=390,410
do 2105 j=460,490
site(i,j)=0
2105 continue
c Branch5
do 2110 i=490,510
do 2110 j=460,490
site(i,j)=0
2110 continue
c Branch6
do 2115 i=590,610
do 2115 j=460,490
site(i,j)=0
2115 continue
c Branch7
do 2125 i=790,810
do 2125 j=460,490
site(i,j)=0 2125 continue
c Branch8
do 2130 i=890,910
do 2130 j=460,490
site(i,j)=0
2130 continue
c Cluster11
c Branch1
do 2215 i=40,60
do 2215 j=510,540
site(i,j)=0
2215 continue
c Branch2
```

```
do 2217 i=140,160
do 2217 j=510,540
site(i,j)=0
2217 continue
c Branch3
do 2220 i=240,260
do 2220 j=510,540
site(i,j)=0
2220 continue
c Branch4
do 2225 i=340,360
do 2225 j=510,540
site(i,j)=0
2225 continue
c Branch5
do 2230 i=440,460
do 2230 j=510,540
site(i,j)=0
2230 continue
c Branch6
do 2235 i=540,560
do 2235 j=510,540
site(i,j)=0
2235 continue
c Branch7
do 2240 i=640,660
do 2240 j=510,540
site(i,j)=0
2240 continue
c Branch8
do 2245 i=740,760
do 2245 j=510,540
```

```
site(i,j)=0
2245 continue
c Branch9
do 2250 i=840,860
do 2250 j=510,540
site(i,j)=0
2250 continue
c Branch10
do 2255 i=940,960
do 2255 j=510,540
site(i,j)=0
2255 continue
c Cluster12
c Branch1
do 2290 i=90,110
do 2290 j=560,590
site(i,j)=0
2290 continue
c Branch2
do 2295 i=190,210
do 2295 j=560,590
site(i,j)=0
2295 continue
c Branch3
do 2300 i=290,310
do 2300 j=560,590
site(i,j)=0
2300 continue
c Branch4
do 2305 i=390,410
do 2305 j=560,590
site(i,j)=0
```

```
2305 continue
c Branch5
do 2315 i=590,610
do 2315 j=560,590
site(i,j)=0
2315 continue
c Branch6
do 2320 i=690,710
do 2320 j=560,590
site(i,j)=0
2320 continue
c Branch7
do 2325 i=790,810
do 2325 j=560,590
site(i,j)=0
2325 continue
c Branch8
do 2330 i=890,910
do 2330 j=560,590
site(i,j)=0
2330 continue
c Cluster13
c Branch1
do 2415 i=40,60
do 2415 j=610,640
site(i,j)=0
2415 continue
c Branch2
do 2417 i=140,160
do 2417 j=610,640
site(i,j)=0
2417 continue
```

```
c Branch3
do 2420 i=240,260
do 2420 j=610,640
site(i,j)=0
2420 continue
c Branch4
do 2425 i=340,360
do 2425 j=610,640
site(i,j)=0
2425 continue
c Branch5
do 2430 i=440,460
do 2430 j=610,640
site(i,j)=0
2430 continue
c Branch6
do 2435 i=540,560
do 2435 j=610,640
site(i,j)=0
2435 continue
c Branch7
do 2440 i=640,660
do 2440 j=610,640
site(i,j)=0
2440 continue
c Branch8
do 2445 i=740,760
do 2445 j=610,640
site(i,j)=0
2445 continue
c Branch9
do 2450 i=840,860
```

```
do 2450 j=610,640
site(i,j)=0
2450 continue
c Branch10
do 2455 i=940,960
do 2455 j=610,640
site(i,j)=0
2455 continue
c Cluster14
c Branch1
do 2490 i=90,110
do 2490 j=660,690
site(i,j)=0
2490 continue
c Branch2
do 2495 i=190,210
do 2495 j=660,690
site(i,j)=0
2495 continue
c Branch3
do 2505 i=390,410
do 2505 j=660,690
site(i,j)=0
2505 continue
c Branch4
do 2510 i=490,510
do 2510 j=660,690
site(i,j)=0
2510 continue
c Branch5
do 2515 i=590,610
do 2515 j=660,690
```

```
site(i,j)=0
2515 continue
c Branch6
do 2520 i=690,710
do 2520 j=660,690
site(i,j)=0
2520 continue
c Branch7
do 2525 i=790,810
do 2525 j=660,690
site(i,j)=0
2525 continue
c Branch8
do 2530 i=890,910
do 2530 j=660,690
site(i,j)=0
2530 continue
c Cluster15
c Branch1
do 2615 i=40,60
do 2615 j=710,740
site(i,j)=0
2615 continue
c Branch2
do 2617 i=140,160
do 2617 j=710,740
site(i,j)=0
2617 continue
c Branch3
do 2620 i=240,260
do 2620 j=710,740
site(i,j)=0
```

```
2620 continue
c Branch4
do 2625 i=340,360
do 2625 j=710,740
site(i,j)=0
2625 continue
c Branch5
do 2630 i=440,460
do 2630 j=710,740
site(i,j)=0
2630 continue
c Branch6
do 2635 i=540,560
do 2635 j=710,740
site(i,j)=0
2635 continue
c Branch7
do 2640 i=640,660
do 2640 j=710,740
site(i,j)=0
2640 continue
c Branch8
do 2645 i=740,760
do 2645 j=710,740
site(i,j)=0
2645 continue
c Branch9
do 2650 i=840,860
do 2650 j=710,740
site(i,j)=0
2650 continue
c Branch10
```

```
do 2655 i=940,960
do 2655 j=710,740
site(i,j)=0
2655 continue
c Cluster16
c Branch1
do 2695 i=190,210
do 2695 j=760,790
site(i,j)=0
2695 continue
c Branch2
do 2700 i=290,310
do 2700 j=760,790
site(i,j)=0
2700 continue
c Branch3
do 2705 i=390,410
do 2705 j=760,790
site(i,j)=0
2705 continue
c Branch4
do 2710 i=490,510
do 2710 j=760,790
site(i,j)=0
2710 continue
c Branch5
do 2715 i=590,610
do 2715 j=760,790
site(i,j)=0
2715 continue
c Branch6
do 2720 i=690,710
```

```
do 2720 j=760,790
site(i,j)=0
2720 continue
c Branch7
do 2725 i=790,810
do 2725 j=760,790
site(i,j)=0
2725 continue
c Branch8
do 2730 i=890,910
do 2730 j=760,790
site(i,j)=0
2730 continue
c
c - setting the boundary –
c
do 21 i=1,xdir
site(i,1)=128
newsite(i,1)=128
site(i,ydir)=128
newsite(i,ydir)=128
21 continue
c
c - Define neighbor sites –
c
do 25 i=1,xdir
do 25 j=2,ydir-1
nbs1(i,j)=site(i+1,j-1)
nbs2(i,j)=site(i-1,j-1)
nbs3(i,j)=site(i-1,j)
nbs4(i,j)=site(i-1,j+1)
nbs5(i,j)=site(i+1,j+1)
```

```
nbs6(i,j)=site(i+1,j)
25 continue
c
c - Contact surface –
c
cs=0
do 31 i=1,xdir
do 31 j=1,ydir
if(site(i,j).ne.128) goto 31
if((nbs1(i,j).lt.128).or.(nbs2(i,j).lt.128).or.(nbs3(i,j).lt.128)
+.or.(nbs4(i,j).lt.128).or.(nbs5(i,j).lt.128).or.
+(nbs6(i,j).lt.128)) cs = cs + 1
31 continue
c
c - setting the open sites –
c
void = 0
kosong = 0
do 50 i=1,xdir
do 40 j=1,ydir
if(site(i,j).ne.128)void=void+1
40 continue
kosong = kosong + void
void = 0
50 continue
c
c   - calculating porosity –
c
total = xdir*ydir
porosity = kosong/total
c
c - Distributing oil particles for given density and calculating oil mass -
```

```
c
do 70 i=1,xdir
do 70 j=1,ydir
if(site(i,j).lt.128) then
site(i,j)=Tyop
endif
70 continue
c
c - Calculating oil mass –
c
masstot=0
do 80 i=1,xdir
do 80 j=1,ydir
if ((site(i,j).eq.128).or.(site(i,j).eq.192)) goto 80
if (site(i,j).eq.256) goto 80
if(mod(site(i,j),2).eq.1)masstot=masstot+1 if(mod((site(i,j)/2),2).eq.1)
masstot=masstot+1 if(mod((site(i,j)/4),2).eq.1)masstot=masstot+1 if(-
mod((site(i,j)/8),2).eq.1)masstot=masstot+1 if(mod((site(i,j)/16),2).eq.1)
masstot=masstot+1 if(mod((site(i,j)/32),2).eq.1)masstot=masstot+1
if(site(i,j).ge.64)masstot=masstot+1
80 continue
denc=masstot/kosong
c ================================
c = PVM: Pack data and send to the slaves =
c ================================
msgtype = 1
do 20 J=1, nproc
c print *, 'Kirim ke-', J
ysize = ydirpart(J+1) - ydirpart(J)
call pvmfinitsend( PVMDEFAULT, info )
call pvmfpack( INTEGER4, nproc, 1, 1, info )
call pvmfpack( INTEGER4, tids, nproc, 1, info )
call pvmfpack( INTEGER4, ysize, 1, 1, info )
```

```
call pvmfpack( INTEGER4, xdir, 1, 1, info )
call pvmfpack( INTEGER4, xpart, 1, 1, info )
call pvmfpack( INTEGER4, xdirpart, 2*xpart, 1, info )
I = ydirpart(J) + 1
call pvmfpack( INTEGER4, site(0,I), (xdir+2)*ysize, 1, info )
call pvmfpack( INTEGER4, ts, 1, 1, info )
call pvmfpack( REAL4, arpp, 1, 1, info )
call pvmfpack( REAL4, grpp, 1, 1, info )
if (J.eq.1) then
neighup = 0
else
neighup = tids(J-2)
endif
if (J.eq.nproc) then
neighdn = 0
else
neighdn = tids(J)
endif
call pvmfpack( INTEGER4, neighup, 1, 1, info )
call pvmfpack( INTEGER4, neighdn, 1, 1, info )
call pvmfsend( tids(J-1), msgtype, info )
20 continue
ccc=0
ccc_p = 0
fff=0
fff_p = 0
c  ====================================
c = PVM: Wait for results from nodes =
c  ====================================
c print *, 'Receive back from myslaves'
msgtype = 2
do 30 J=1, nproc
```

```
c print *, 'Receive from myslave-', J, ' ...'
call pvmfrecv( -1, msgtype, info )
call pvmfunpack( INTEGER4, who, 1, 1, info )
call pvmfunpack( INTEGER4, ysize, 1, 1, info )
call pvmfunpack( INTEGER4, xdir, 1, 1, info )
call pvmfunpack( INTEGER4, xpart, 1, 1, info )
call pvmfunpack( INTEGER4, xdirpart, 2*xpart, 1, info )
I = ydirpart(who) + 1
call pvmfunpack( INTEGER4, site(0,I), (xdir+2)*ysize, 1, info )
call pvmfunpack( REAL4, momx, 260, 1, info )
call pvmfunpack( INTEGER4, ccc_p, 1, 1, info )
call pvmfunpack( INTEGER4, fff_p, 1, 1, info )
ccc = ccc + ccc_p
fff = fff + fff_p
30 continue
c  ==================
c = Calculating variables =
c  ==================
c
c - Calculate porosity –
c
void = 0
voida = 0
kosong = 0
kosonga = 0
do 420 I = 1, xdir
do 430 J = 1, ydir
if(site(I,J).ne.128) void = void + 1
if((site(I,J).ne.128).and.(site(I,J).ne.192).and.(site(I,J).ne.
+256))voida = voida + 1
430 continue
kosong = kosong + void
```

```
kosonga = kosonga + voida
void = 0
voida = 0
420 continue
total = xdir * ydir
porosity = kosong/total
c
c - Calculating the number of adsorbed polymer particles –
c
dd = ccc
c
c - Calculating the number of gelled polymer particles –
c
hh = fff
c
c - Calculated variables –
c
masstot = 0
vxt = 0
mxt = 0
do 440 I = 1, xdir
do 440 J = 1, ydir
if(site(I,J).eq.128) goto 4401
if(site(I,J).eq.192) goto 4401
if(site(I,J).eq.256) goto 4401
if(site(I,J).eq.0) goto 440
if(mod(site(I,J),2).eq.1)masstot=masstot+1 if(mod((site(I,J)/2),2).eq.1)
masstot=masstot+1 if(mod((site(I,J)/4),2).eq.1)masstot=masstot+1 if(-
mod((site(I,J)/8),2).eq.1)masstot=masstot+1 if(mod((site(I,J)/16),2).eq.1)
masstot=masstot+1 if(mod((site(I,J)/32),2).eq.1)masstot=masstot+1 if-
(site(I,J).ge.64)masstot=masstot+1
4401 zzzzz=0 if(site(i,j).ne.128)
void=void+1
```

```
440 continue
c
c - Velocity –
c
do 450 I = 1, xdir
do 450 J = 1, ydir
masite = 0
if(site(I,J).eq.128) goto 470
if(site(I,J).eq.192) goto 470
if(site(I,J).eq.256) goto 470
if(site(I,J).eq.0) goto 470
if(mod(site(I,J),2).eq.1)masite=masite+1 if(mod((site(I,J)/2),2).eq.1)
masite=masite+1 if(mod((site(I,J)/4),2).eq.1)masite=masite+1 if(-
mod((site(I,J)/8),2).eq.1)masite=masite+1 if(mod((site(I,J)/16),2).eq.1)
masite=masite+1 if(mod((site(I,J)/32),2).eq.1)masite=masite+1
if(site(I,J).ge.64)masite=masite+1
470 zzzzz=0
if(site(I,J).eq.64) goto 450
if((site(I,J).gt.0).and.(site(I,J).lt.128))vxt=vxt +
+(momx(site(I,J)))/masite
if((site(I,J).gt.0).and.(site(I,J).lt.128))mxt=mxt +
+momx(site(I,J)) 450 continue
c
c - Density -
c
denc = masstot/kosong
c
c - Kinematic viscosity –
c
d=denc/7
kinevis=(1.0/28/(d*(1-d))/(1-8*d*(1-d)/7))-(1/8)
c
c - Dynamic viscosity –
```

```
c
dynavis = denc * kinevis
c
c - Velocity –
c
velx = vxt / kosong
c vely = vyt / kosong
c
c - Flow rate –
c
flow = velx * porosity
c
c - Calculate momentum at left boundary –
c
wx = 0
void = 0
do 480 J = 1, ydir
if((site(0,J).eq.0).or.(site(0,J).eq.64)) goto 480
if((site(0,J).eq.128).or.(site(0,J).eq.192)) goto 480
if(site(0,J).eq.256) goto 480
if((site(0,J).gt.0).and.(site(0,J).lt.128)) wx=wx+momx(site(0,J))
480 continue
c
c - Pressure –
c
press = wx/(ydir*0.8660254)
c
c - Pressure gradient –
c
pressgrad =  wx/(ydir*0.8660254)/xdir
c
c - Permeability –
```

```
c
permeability = (vxt/kosong*porosity)*dynavis/pressgrad
c
c - Reynold number –
c
rdn=vxt/kosong*xdir/kinevis*(7.0/12*(1-2*d)/(1-d))
c ==================
c = Printing the results =
c  ==================
c
c - contact surface –
c
print *,”adsorption rate =”,arpp
print *,”gelation rate =”,grpp
print *,”contact surface =”,cs
c
c     - Porosity -
c
print *,”porosity =”,porosity c
c  - Density -
c
print *,”denc=”,denc
c
c  - kinematic viscosity –
c
print *, “kinematic viscosity(LGA)=”,kinevis
c
c - Dynamic viscosity –
c
print *, “dynamic viscosity=”,dynavis
c
c - Velocity –
```

```
c
print *,"velocity(LGA)=",velx
c
c - Flowrate –
c
print *,"flowrate(LGA)=",flow
c
c     - Pressure –
c
print *,"pressure(LGA)=",press
c
c - Pressure gradient –
c
print *,"pressgrad(LGA)=",pressgrad
c
c   - Permeability –
c
print *,"Permeability=",permeability
c
c - Reynold number –
c
print *,"Reynold number=",rdn
c
c - The number of adsorbed polymer particles –
c
print *,"number of adsorbed particles=",dd
c
c - The number of gelled polymer particles –
c
print *,"number of gelled particles=",hh
c ======================
c = PVM: End user program =
```

```
c =====================
c program finished leave PVM before exiting
call pvmfexit(info)
stop
end
c ====================================
c = PVM: Kill all tasks I spawned and then myself =
c ====================================
subroutine shutdown( nproc, tids )
integer I, nproc, tids(*)
do 10 I=0, nproc
call pvmfhill( tids(ii), info )
10 continue
call pvmfexit( info )
stop
return
end
```

6.3.2 Program Simulasi Injeksi Polimer untuk Slave Computer

Program Slave berisi program utama simulasi LGA, komunikasi (pengiriman dan penerimaan informasi) ke master dan slave yang berdekatan. Program slave untuk simulasi paralel adalah sebagai berikut:

```
c $ Program Id: myslave.f,version 2005/01/23 $ program myslave
include ‘fpvm3.h’

c ========================
c = PVM: Variables declaration =
c ========================
integer info, mytid, mtid, msgtype, me
integer tids(0:32)
```

```
c  =====================================
c = Variables declaration for the simulation software =
c  =====================================
c  xdir = Number of sites in x direction
c  ydir = Number of sites in y direction
c ts = time step
c tyop = Type of particle (tyop = 0 - 127)
integer xdir, ydir, ts
real tyop, arpp, grpp, tol, t
data xdir, ydir, ts, tyop /1000, 800, 5, 3.0/
integer I,J,K,g, gg, bb, ccc, ddd, ee, fff, hhh, kk
integer site(0:1001,800), newsite(1000,800)
integer    nbs1(1000,800),nbs2(1000,800),nbs3(1000,800)
integer    nbs4(1000,800),nbs5(1000,800),nbs6(1000,800)
integer aps(0:260,10),mass(260), cs
real*4 zr, denc, kosong
real*4 momx(260),momy(260),d,kinevis,dynavis,kinevisc,dynavisc
real*4 rdn, flow, flowc, wx
real*4 velx, velxc, press, pressc
real*4 pressgrad, pressgradc, n, h

c
c     - divide the site into nproc area –
c
integer nproc
integer xpart, xdirpart(100)
integer a ,m, seed
data a, m, seed /1027, 1048576, 1/
data ccc, ddd, fff, hhh /0, 0, 0, 0/

c  ====================
c = PVM: Slave starting up =
```

```
c ====================
c Enroll this program in PVM
call pvmfmytid( mytid )
c Get the master's task id
call pvmfparent( mtid )

c  ======================
c = PVM: Begin user program =
c  ======================
c Receive data from host
msgtype = 1
call pvmfrecv( mtid, msgtype, info )
call pvmfunpack( INTEGER4, nproc, 1, 1, info )
call pvmfunpack( INTEGER4, tids, nproc, 1, info )
call pvmfunpack( INTEGER4, ydir, 1, 1, info )
call pvmfunpack( INTEGER4, xdir, 1, 1, info )
call pvmfunpack( INTEGER4, xpart, 1, 1, info )
call pvmfunpack( INTEGER4, xdirpart, 2*xpart, 1, info )
call pvmfunpack( INTEGER4, site(0,1), (xdir+2)*ydir, 1, info )
call pvmfunpack( INTEGER4, ts, 1, 1, info )
call pvmfunpack( REAL4, arpp, 1, 1, info )
call pvmfunpack( REAL4, grpp, 1, 1, info )
call pvmfunpack( INTEGER4, neighup, 1, 1, info )
call pvmfunpack( INTEGER4, neighdn, 1, 1, info )
c Determine which slave I am (0 -- nproc-1)
do 5 J=0, nproc-1
if( tids(J) .eq. mytid ) me = J+1
5 continue
z=seed
zm=m
c
c - setting the boundary –
```

```
c
do 21 i=1,xdir
site(i,1)=128
newsite(i,1)=128
site(i,ydir)=128
newsite(i,ydir)=128
21 continue
c
c - Define neighbor sites –
c
do 25 i=1,xdir
do 25 j=2,ydir-1
nbs1(i,j)=site(i+1,j-1)
nbs2(i,j)=site(i-1,j-1)
nbs3(i,j)=site(i-1,j)
nbs4(i,j)=site(i-1,j+1)
nbs5(i,j)=site(i+1,j+1)
nbs6(i,j)=site(i+1,j)
25 continue
c
c - Contact surface –
c
cs=0
do 31 i=1,xdir
do 31 j=1,ydir
if(site(i,j).ne.128) goto 31
if((nbs1(i,j).lt.128).or.(nbs2(i,j).lt.128).or.(nbs3(i,j).lt.128)
+.or.(nbs4(i,j).lt.128).or.(nbs5(i,j).lt.128).or.
+(nbs6(i,j).lt.128)) cs = cs + 1
31 continue
c
c - setting the open sites –
```

```
c
void = 0
kosong = 0
do 50 i=1,xdir
do 40 j=1,ydir
if(site(i,j).ne.128)void=void+1
40 continue
kosong = kosong + void
void = 0
50 continue
c
c - calculating porosity –
c
total = xdir*ydir
porosity = kosong/total
c
c - Distributing oil particles for given density and calculating oil mass –
c
do 70 i=1,xdir
do 70 j=1,ydir
if(site(i,j).lt.128) then
site(i,j)=Tyop
endif
70 continue
c
c - Calculating oil mass –
c
masstot=0
do 80 i=1,xdir
do 80 j=1,ydir
if ((site(i,j).eq.128).or.(site(i,j).eq.192)) goto 80
if (site(i,j).eq.256) goto 80
```

```
if(mod(site(i,j),2).eq.1)masstot=masstot+1 if(mod((site(i,j)/2),2).eq.1)
masstot=masstot+1
if(mod((site(i,j)/4),2).eq.1)masstot=masstot+1 if(mod((site(i,j)/8),2).eq.1)
masstot=masstot+1 if(mod((site(i,j)/16),2).eq.1)masstot=masstot+1 if(-
mod((site(i,j)/32),2).eq.1)masstot=masstot+1
if(site(i,j).ge.64)masstot=masstot+1
80 continue
denc=masstot/kosong
c =============
c = Main program =
c =============
do 90 t=1,ts
z=mod(a*z,m)
zr=z/zm
g=nint(zr*4.)
c
c - input the particles along the left boundary –
c
do 95 j=1,ydir
c Second run
if(g.eq.0)site(0,j)=2
if(g.eq.1)site(0,j)=1
if(g.eq.2)site(0,j)=2
if(g.eq.3)site(0,j)=4
c First run
c  if(g.eq.0)site(0,j)=3
c  if(g.eq.1)site(0,j)=5
c  if(g.eq.2)site(0,j)=6
c if(g.eq.3)site(0,j)=2
95 continue
c
c - Periodic boundary –
c
```

```
do 110 j=1,ydir
if(mod((site(0,j)/32),2).eq.1)site(xdir,ydir+1-j)=32
if(mod((site(0,j)/16),2).eq.1)site(xdir,ydir+1-j)=16
if(mod((site(0,j)/8),2).eq.1)site(xdir,ydir+1-j)=8
if((mod((site(0,j)/32),2).eq.1).and.(mod((site(0,j)/16),2).eq.1
+))site(xdir,ydir+1-j)=48
if((mod((site(0,j)/32),2).eq.1).and.(mod((site(0,j)/8),2).eq.1)
+)site(xdir,ydir+1-j)=40
if((mod((site(0,j)/16),2).eq.1).and.(mod((site(0,j)/8),2).eq.1)
+)site(xdir,ydir+1-j)=24
if((mod((site(0,j)/32),2).eq.1).and.(mod((site(0,j)/16),2).eq.1
+).and.(mod((site(xdir,j)/8),2).eq.1))site(xdir,ydir+1-j)=56
if(mod(site(xdir,j),2).eq.1)site(0,ydir+1-j)=1
if(mod((site(xdir,j)/2),2).eq.1)site(0,ydir+1-j)=2
if(mod((site(xdir,j)/4),2).eq.1)site(0,ydir+1-j)=4
if((mod(site(xdir,j),2).eq.1).and.(mod((site(xdir,j)/2),2).eq.1))
+site(0,ydir+1-j)=3
if((mod(site(xdir,j),2).eq.1).and.(mod((site(xdir,j)/4),2).eq.1))
+site(0,ydir+1-j)=5
if((mod((site(xdir,j)/2),2).eq.1).and.(mod((site(xdir,j)/4),2)
+.eq.1)) site(0,ydir+1-j)=6
if((mod(site(xdir,j),2).eq.1).and.(mod((site(xdir,j)/2),2).eq.1)
+.and.(mod((site(xdir,j)/4),2).eq.1))site(0,ydir+1-j)=7
110 continue
c
c - Forcing rules along the left boundary –
c
do 100 j=1,ydir
if(mod((site(0,j)/32),2).eq.1)site(0,j)=1
if(mod((site(0,j)/16),2).eq.1)site(0,j)=2
if(mod((site(0,j)/8),2).eq.1)site(0,j)=4 if((mod((site(0,j)/32),2).eq.1).and.
(mod((site(0,j)/16),2).eq.1
```

```
+))site(0,j)=3
if((mod((site(0,j)/32),2).eq.1).and.(mod((site(0,j)/8),2).eq.1)
+)site(0,j)=5
if((mod((site(0,j)/16),2).eq.1).and.(mod((site(0,j)/8),2).eq.1)
+)site(0,j)=6
if((mod((site(0,j)/32),2).eq.1).and.(mod((site(0,j)/16),2).eq.1
+).and.(mod((site(xdir,j)/8),2).eq.1))site(0,j)=7 100 continue
c
c - Define neighbor sites –
c
do 120 i=1,xdir
do 120 j=2,ydir-1
nbs1(i,j)=site(i+1,j-1)
nbs2(i,j)=site(i-1,j-1)
nbs3(i,j)=site(i-1,j)
nbs4(i,j)=site(i-1,j+1)
nbs5(i,j)=site(i+1,j+1)
nbs6(i,j)=site(i+1,j)
120 continue
c
c - Translation procedure –
c
c Reset newsite(i,j)
do 150 i = 1,xdir
do 150 j = 1,ydir
newsite(i,j)=0
150 continue
c
c - Define added particles from neighbor sites after particle collisions –
c
do 130 k=1,128
c Reset added particle from neighbor sites
```

```
aps(k,1)=0
aps(k,2)=0
aps(k,3)=0
aps(k,4)=0
aps(k,5)=0
aps(k,6)=0
c Reset mass and momentum at neighbor sites
mass(k)=0
momx(k)=0
momy(k)=0
130 continue
do 140 k=0,128
c Added particles to site(i,j) from the first nighbor site
if(mod((k/8),2).eq.1)aps(k,1)=8
c Added particles to site(i,j) from the second nighbor site
if(mod((k/4),2).eq.1)aps(k,2)=4
c Added particles to site(i,j) from the third nighbor site
if(mod((k/2),2).eq.1)aps(k,3)=2
c Added particles to site(i,j) from the fourth nighbor site
if(mod(k,2).eq.1)aps(k,4)=1
c Added particles to site(i,j) from the fifth nighbor site
if(mod((k/32),2).eq.1)aps(k,5)=32
c Added particles to site(i,j) from the sixth nighbor site
if(mod((k/16),2).eq.1)aps(k,6)=16
c Define mass and momentum of particle moving toward the first nighbor
site
if(mod(k,2).eq.1) then
mass(k)=mass(k)+1
momx(k)=momx(k)+0.5
momy(k)=momy(k)+((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the second nigh-
```

```
bor site
if(mod((k/32),2).eq.1) then
mass(k)=mass(k)+1
momx(k)=momx(k)-0.5
momy(k)=momy(k)+((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the third nighbor
site
if(mod((k/16),2).eq.1) then
mass(k)=mass(k)+1
momx(k)=momx(k)-1
momy(k)=0
endif
c Define mass and momentum of particle moving toward the fourth nigh-
bor site
if(mod((k/8),2).eq.1) then
mass(k)=mass(k)+1
momx(k)=momx(k)-0.5
momy(k)=momy(k)-((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the fifth nighbor
site
if(mod((k/4),2).eq.1) then
mass(k)=mass(k)+1
momx(k)=momx(k)+0.5
momy(k)=momy(k)-((sqrt(3.0))/2.0)
endif
c Define mass and momentum of particle moving toward the sixth nighbor
site
if(mod((k/2),2).eq.1) then
mass(k)=mass(k)+1
momx(k)=momx(k)+1
momy(k)=0
```

```
endif
if(k.ge.64)mass(k)=mass(k)+1
140 continue
c
c - Gelling process –
c
do 415 i=1,xdir
do 415 j=1,ydir
if(grpp.eq.0) goto 415
z=mod(a*z,m)
zr=z/zm
kk=nint(zr*ts/grpp)
ll=0
c To the first nighbor site
if((mod(site(i,j),2).eq.1).and.(nbs1(i,j).eq.128))ll=ll+1
if((mod((site(i,j)/32),2).eq.1).and.(nbs1(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs1(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs1(i,j).eq.128))ll=ll-1
if((mod((site(i,j)/4),2).eq.1).and.(nbs1(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs1(i,j).eq.128))ll=ll+0.866
if((mod(site(i,j),2).eq.1).and.(nbs1(i,j).eq.256))ll=ll+1
if((mod((site(i,j)/32),2).eq.1).and.(nbs1(i,j).eq.256))ll=ll+0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs1(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs1(i,j).eq.256))ll=ll-1
if((mod((site(i,j)/4),2).eq.1).and.(nbs1(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs1(i,j).eq.256))ll=ll+0.866
c To the second nighbor site
if((mod((site(i,j)/32),2).eq.1).and.(nbs2(i,j).eq.128))ll=ll+1
if((mod((site(i,j)/16),2).eq.1).and.(nbs2(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs2(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs2(i,j).eq.128))ll=ll-1
if((mod((site(i,j)/2),2).eq.1).and.(nbs2(i,j).eq.128))ll=ll-0.866
```

```
if((mod(site(i,j),2).eq.1).and.(nbs2(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs2(i,j).eq.256))ll=ll+1
if((mod((site(i,j)/16),2).eq.1).and.(nbs2(i,j).eq.256))ll=ll+0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs2(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs2(i,j).eq.256))ll=ll-1
if((mod((site(i,j)/2),2).eq.1).and.(nbs2(i,j).eq.256))ll=ll-0.866
if((mod(site(i,j),2).eq.1).and.(nbs2(i,j).eq.256))ll=ll+0.866
c To the third nighbor site
if((mod((site(i,j)/16),2).eq.1).and.(nbs3(i,j).eq.128))ll=ll+1
if((mod((site(i,j)/8),2).eq.1).and.(nbs3(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs3(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs3(i,j).eq.128))ll=ll-1
if((mod(site(i,j),2).eq.1).and.(nbs3(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs3(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs3(i,j).eq.256))ll=ll+1
if((mod((site(i,j)/8),2).eq.1).and.(nbs3(i,j).eq.256))ll=ll+0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs3(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs3(i,j).eq.256))ll=ll-1
if((mod(site(i,j),2).eq.1).and.(nbs3(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs3(i,j).eq.256))ll=ll+0.866
c To the fourth nighbor site
if((mod((site(i,j)/8),2).eq.1).and.(nbs4(i,j).eq.128))ll=ll+1
if((mod((site(i,j)/4),2).eq.1).and.(nbs4(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs4(i,j).eq.128))ll=ll-0.866
if((mod(site(i,j),2).eq.1).and.(nbs4(i,j).eq.128))ll=ll-1
if((mod((site(i,j)/32),2).eq.1).and.(nbs4(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs4(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs4(i,j).eq.256))ll=ll+1
if((mod((site(i,j)/4),2).eq.1).and.(nbs4(i,j).eq.256))ll=ll+0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs4(i,j).eq.256))ll=ll-0.866
if((mod(site(i,j),2).eq.1).and.(nbs4(i,j).eq.256))ll=ll-1
if((mod((site(i,j)/32),2).eq.1).and.(nbs4(i,j).eq.256))ll=ll-0.866
```

```
if((mod((site(i,j)/16),2).eq.1).and.(nbs4(i,j).eq.256))ll=ll+0.866
c To the fifth nighbor site
if((mod((site(i,j)/4),2).eq.1).and.(nbs5(i,j).eq.128))ll=ll+1
if((mod((site(i,j)/2),2).eq.1).and.(nbs5(i,j).eq.128))ll=ll+0.866
if((mod(site(i,j),2).eq.1).and.(nbs5(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs5(i,j).eq.128))ll=ll-1
if((mod((site(i,j)/16),2).eq.1).and.(nbs5(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs5(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs5(i,j).eq.256))ll=ll+1
if((mod((site(i,j)/2),2).eq.1).and.(nbs5(i,j).eq.256))ll=ll+0.866
if((mod(site(i,j),2).eq.1).and.(nbs5(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs5(i,j).eq.256))ll=ll-1
if((mod((site(i,j)/16),2).eq.1).and.(nbs5(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs5(i,j).eq.256))ll=ll+0.866
c To the sixth nighbor site
if((mod((site(i,j)/2),2).eq.1).and.(nbs6(i,j).eq.128))ll=ll+1
if((mod(site(i,j),2).eq.1).and.(nbs6(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs6(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs6(i,j).eq.128))ll=ll-1
if((mod((site(i,j)/8),2).eq.1).and.(nbs6(i,j).eq.128))ll=ll-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs6(i,j).eq.128))ll=ll+0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs6(i,j).eq.256))ll=ll+1
if((mod(site(i,j),2).eq.1).and.(nbs6(i,j).eq.256))ll=ll+0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs6(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs6(i,j).eq.256))ll=ll-1
if((mod((site(i,j)/8),2).eq.1).and.(nbs6(i,j).eq.256))ll=ll-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs6(i,j).eq.256))ll=ll+0.866
if((site(i,j).eq.128).or.(site(i,j).eq.0).or.(site(i,j).eq.64)
+.or.(site(i,j).eq.192).or.(site(i,j).eq.256)) goto 415
if((kk.gt.0).or.(ll.le.0)) goto 415
if((ll.gt.0).and.(kk.eq.0)) ee = mass(site(i,j))
if((ll.gt.0).and.(kk.eq.0)) site(i,j) = 256
```

```
fff = fff + ee
newsite(i,j)=256
site(i,j)=256
415 continue
c
c - Polymer adsorption process –
c
do 410 i=1,xdir
do 410 j=1,ydir
z=mod(a*z,m)
zr=z/zm
gg=nint(zr*ts/Arpp)
aa=0
if(tol.gt.1) goto 143
c Monolayer (Langmuir) Type
c To the first neighbor site
if((mod(site(i,j),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/32),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/4),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa+0.866
c To the second neighbor site
if((mod((site(i,j)/32),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/16),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/2),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa-0.866
if((mod(site(i,j),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa+0.866
c To the third neighbor site
if((mod((site(i,j)/16),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/8),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa+0.866
```

```
if((mod((site(i,j)/4),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa-1
if((mod(site(i,j),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa+0.866
c To the fourth neighbor site
if((mod((site(i,j)/8),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/4),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa-0.866
if((mod(site(i,j),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/32),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa+0.866
c To the fifth neighbor site
if((mod((site(i,j)/4),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/2),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa+0.866
if((mod(site(i,j),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/16),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa+0.866
c To the sixth neighbor site
if((mod((site(i,j)/2),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa+1
if((mod(site(i,j),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/8),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa+0.866
goto 147
143 zzzzz=0
c Multilayer Type
c To the first neighbor site
if((mod(site(i,j),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/32),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa-0.866
```

```
if((mod((site(i,j)/8),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/4),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs1(i,j).eq.128))aa=aa+0.866
if((mod(site(i,j),2).eq.1).and.(nbs1(i,j).eq.192))aa=aa+1
if((mod((site(i,j)/32),2).eq.1).and.(nbs1(i,j).eq.192))aa=aa+0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs1(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs1(i,j).eq.192))aa=aa-1
if((mod((site(i,j)/4),2).eq.1).and.(nbs1(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs1(i,j).eq.192))aa=aa+0.866
c To the second neighbor site
if((mod((site(i,j)/32),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/16),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/2),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa-0.866
if((mod(site(i,j),2).eq.1).and.(nbs2(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs2(i,j).eq.192))aa=aa+1
if((mod((site(i,j)/16),2).eq.1).and.(nbs2(i,j).eq.192))aa=aa+0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs2(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs2(i,j).eq.192))aa=aa-1
if((mod((site(i,j)/2),2).eq.1).and.(nbs2(i,j).eq.192))aa=aa-0.866
if((mod(site(i,j),2).eq.1).and.(nbs2(i,j).eq.192))aa=aa+0.866
c To the third neighbor site
if((mod((site(i,j)/16),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/8),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa-1
if((mod(site(i,j),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs3(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs3(i,j).eq.192))aa=aa+1
if((mod((site(i,j)/8),2).eq.1).and.(nbs3(i,j).eq.192))aa=aa+0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs3(i,j).eq.192))aa=aa-0.866
```

```
if((mod((site(i,j)/2),2).eq.1).and.(nbs3(i,j).eq.192))aa=aa-1
if((mod(site(i,j),2).eq.1).and.(nbs3(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs3(i,j).eq.192))aa=aa+0.866
c To the fourth neighbor site
if((mod((site(i,j)/8),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/4),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa-0.866
if((mod(site(i,j),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/32),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs4(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs4(i,j).eq.192))aa=aa+1
if((mod((site(i,j)/4),2).eq.1).and.(nbs4(i,j).eq.192))aa=aa+0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs4(i,j).eq.192))aa=aa-0.866
if((mod(site(i,j),2).eq.1).and.(nbs4(i,j).eq.192))aa=aa-1
if((mod((site(i,j)/32),2).eq.1).and.(nbs4(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs4(i,j).eq.192))aa=aa+0.866
c To the fifth neighbor site
if((mod((site(i,j)/4),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa+1
if((mod((site(i,j)/2),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa+0.866
if((mod(site(i,j),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/16),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs5(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs5(i,j).eq.192))aa=aa+1
if((mod((site(i,j)/2),2).eq.1).and.(nbs5(i,j).eq.192))aa=aa+0.866
if((mod(site(i,j),2).eq.1).and.(nbs5(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs5(i,j).eq.192))aa=aa-1
if((mod((site(i,j)/16),2).eq.1).and.(nbs5(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/8),2).eq.1).and.(nbs5(i,j).eq.192))aa=aa+0.866
c To the sixth neighbor site
if((mod((site(i,j)/2),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa+1
if((mod(site(i,j),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa+0.866
```

```
if((mod((site(i,j)/32),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa-1
if((mod((site(i,j)/8),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs6(i,j).eq.128))aa=aa+0.866
if((mod((site(i,j)/2),2).eq.1).and.(nbs6(i,j).eq.192))aa=aa+1
if((mod(site(i,j),2).eq.1).and.(nbs6(i,j).eq.192))aa=aa+0.866
if((mod((site(i,j)/32),2).eq.1).and.(nbs6(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/16),2).eq.1).and.(nbs6(i,j).eq.192))aa=aa-1
if((mod((site(i,j)/8),2).eq.1).and.(nbs6(i,j).eq.192))aa=aa-0.866
if((mod((site(i,j)/4),2).eq.1).and.(nbs6(i,j).eq.192))aa=aa+0.866
147 zzzzz=0
if((site(i,j).eq.128).or.(site(i,j).eq.0).or.(site(i,j).eq.64)
+.or.(site(i,j).eq.192)) goto 410
if((gg.gt.0).or.(aa.le.0)) goto 410
if((aa.gt.0).and.(gg.eq.0)) bb = mass(site(i,j))
if((aa.gt.0).and.(gg.eq.0)) site(i,j) = 192
ccc = ccc + bb
newsite(i,j)=192
site(i,j)=192
410 continue
c
c - Translation procedure –
c
c Translation scheme
do 160 i=1,xdir
do 160 j=1,ydir
c Collision rule between fluid and solid particle
if((site(i,j).eq.0).or.(site(i,j).eq.64).or.(site(i,j).eq.128)
+.or.(site(i,j).eq.192).or.(site(i,j).eq.256))goto 160
if((mod(site(i,j),2).eq.1).and.(nbs1(i,j).eq.128))nbs1(i,j)=8
if((mod((site(i,j)/32),2).eq.1).and.(nbs2(i,j).eq.128))nbs2(i,j)=4
if((mod((site(i,j)/16),2).eq.1).and.(nbs3(i,j).eq.128))nbs3(i,j)=2
```

```
if((mod((site(i,j)/8),2).eq.1).and.(nbs4(i,j).eq.128))nbs4(i,j)=1
if((mod((site(i,j)/4),2).eq.1).and.(nbs5(i,j).eq.128))nbs5(i,j)=32
if((mod((site(i,j)/2),2).eq.1).and.(nbs6(i,j).eq.128))nbs6(i,j)=16
c Collision rule between fluid and adsorbed polymer particle
if((mod(site(i,j),2).eq.1).and.(nbs1(i,j).eq.192))nbs1(i,j)=8
if((mod((site(i,j)/32),2).eq.1).and.(nbs2(i,j).eq.192))nbs2(i,j)=4
if((mod((site(i,j)/16),2).eq.1).and.(nbs3(i,j).eq.192))nbs3(i,j)=2
if((mod((site(i,j)/8),2).eq.1).and.(nbs4(i,j).eq.192))nbs4(i,j)=1
if((mod((site(i,j)/4),2).eq.1).and.(nbs5(i,j).eq.192))nbs5(i,j)=32
if((mod((site(i,j)/2),2).eq.1).and.(nbs6(i,j).eq.192))nbs6(i,j)=16
c Collision rule between fluid and gelled polymer particle
if((mod(site(i,j),2).eq.1).and.(nbs1(i,j).eq.256))nbs1(i,j)=8
if((mod((site(i,j)/32),2).eq.1).and.(nbs2(i,j).eq.256))nbs2(i,j)=4
if((mod((site(i,j)/16),2).eq.1).and.(nbs3(i,j).eq.256))nbs3(i,j)=2
if((mod((site(i,j)/8),2).eq.1).and.(nbs4(i,j).eq.256))nbs4(i,j)=1
if((mod((site(i,j)/4),2).eq.1).and.(nbs5(i,j).eq.256))nbs5(i,j)=32
if((mod((site(i,j)/2),2).eq.1).and.(nbs6(i,j).eq.256))nbs6(i,j)=16
160 continue
c
c   - New configuration of particles in site(i,j) –
c
do 165 i=1,xdir
do 165 j=1,ydir
if(site(i,j).ge.64)newsite(i,j)=64
newsite(i,j)=newsite(i,j)+aps(nbs1(i,j),1)
newsite(i,j)=newsite(i,j)+aps(nbs2(i,j),2)
newsite(i,j)=newsite(i,j)+aps(nbs3(i,j),3)
newsite(i,j)=newsite(i,j)+aps(nbs4(i,j),4)
newsite(i,j)=newsite(i,j)+aps(nbs5(i,j),5)
newsite(i,j)=newsite(i,j)+aps(nbs6(i,j),6)
if(site(i,j).eq.128)newsite(i,j)=128
if(site(i,j).eq.192)newsite(i,j)=192
```

```
if(site(i,j).eq.256)newsite(i,j)=256
165 continue
do 167 i=1,xdir
do 167 j=1,ydir
nbs1(i,j)=0
nbs2(i,j)=0
nbs3(i,j)=0
nbs4(i,j)=0
nbs5(i,j)=0
nbs6(i,j)=0
167 continue
c
c - Updating site(i,j) –
c
do 170 i=1,xdir
do 170 j=1,ydir
site(i,j)=newsite(i,j)
if(newsite(i,j).eq.128)site(i,j)=128
if(newsite(i,j).eq.192)site(i,j)=192
if(newsite(i,j).eq.256)site(i,j)=256
170 continue
c
c - Rotation rule –
c
do 180 i=1,xdir
do 180 j=1,ydir
if(site(i,j).eq.0)newsite(i,j)=0
if(site(i,j).eq.1)newsite(i,j)=1
if(site(i,j).eq.2)newsite(i,j)=2
if(site(i,j).eq.3)newsite(i,j)=3
if(site(i,j).eq.4)newsite(i,j)=4
if(site(i,j).eq.6)newsite(i,j)=6
```

```
if(site(i,j).eq.7)newsite(i,j)=7
if(site(i,j).eq.8)newsite(i,j)=8
if(site(i,j).eq.12)newsite(i,j)=12
if(site(i,j).eq.14)newsite(i,j)=14
if(site(i,j).eq.15)newsite(i,j)=15
if(site(i,j).eq.16)newsite(i,j)=16
if(site(i,j).eq.24)newsite(i,j)=24
if(site(i,j).eq.28)newsite(i,j)=28
if(site(i,j).eq.30)newsite(i,j)=30
if(site(i,j).eq.32)newsite(i,j)=32
if(site(i,j).eq.33)newsite(i,j)=33
if(site(i,j).eq.35)newsite(i,j)=35
if(site(i,j).eq.39)newsite(i,j)=39
if(site(i,j).eq.48)newsite(i,j)=48
if(site(i,j).eq.49)newsite(i,j)=49
if(site(i,j).eq.51)newsite(i,j)=51
if(site(i,j).eq.56)newsite(i,j)=56
if(site(i,j).eq.57)newsite(i,j)=57
if(site(i,j).eq.60)newsite(i,j)=60
if(site(i,j).eq.63)newsite(i,j)=63
if(site(i,j).eq.64)newsite(i,j)=64
if(site(i,j).eq.67)newsite(i,j)=67
if(site(i,j).eq.70)newsite(i,j)=70
if(site(i,j).eq.71)newsite(i,j)=71
if(site(i,j).eq.76)newsite(i,j)=76
if(site(i,j).eq.78)newsite(i,j)=78
if(site(i,j).eq.79)newsite(i,j)=79
if(site(i,j).eq.88)newsite(i,j)=88
if(site(i,j).eq.92)newsite(i,j)=92
if(site(i,j).eq.94)newsite(i,j)=94
if(site(i,j).eq.95)newsite(i,j)=95
if(site(i,j).eq.97)newsite(i,j)=97
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if(site(i,j).eq.99)newsite(i,j)=99
if(site(i,j).eq.103)newsite(i,j)=103
if(site(i,j).eq.111)newsite(i,j)=111
if(site(i,j).eq.112)newsite(i,j)=112
if(site(i,j).eq.113)newsite(i,j)=113
if(site(i,j).eq.115)newsite(i,j)=115
if(site(i,j).eq.119)newsite(i,j)=119
if(site(i,j).eq.120)newsite(i,j)=120
if(site(i,j).eq.121)newsite(i,j)=121
if(site(i,j).eq.123)newsite(i,j)=123
if(site(i,j).eq.124)newsite(i,j)=124
if(site(i,j).eq.125)newsite(i,j)=125
if(site(i,j).eq.126)newsite(i,j)=126
if(site(i,j).eq.127)newsite(i,j)=127
if(site(i,j).eq.5)newsite(i,j)=66
if(site(i,j).eq.10)newsite(i,j)=68
if(site(i,j).eq.17)newsite(i,j)=96
if(site(i,j).eq.20)newsite(i,j)=72
if(site(i,j).eq.21)newsite(i,j)=42
if(site(i,j).eq.31)newsite(i,j)=110
if(site(i,j).eq.34)newsite(i,j)=65
if(site(i,j).eq.40)newsite(i,j)=80
if(site(i,j).eq.42)newsite(i,j)=21
if(site(i,j).eq.47)newsite(i,j)=87
if(site(i,j).eq.55)newsite(i,j)=107
if(site(i,j).eq.59)newsite(i,j)=117
if(site(i,j).eq.61)newsite(i,j)=122
if(site(i,j).eq.62)newsite(i,j)=93
if(site(i,j).eq.65)newsite(i,j)=34
if(site(i,j).eq.66)newsite(i,j)=5
if(site(i,j).eq.68)newsite(i,j)=10
if(site(i,j).eq.72)newsite(i,j)=20
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if(site(i,j).eq.80)newsite(i,j)=40
if(site(i,j).eq.85)newsite(i,j)=106
if(site(i,j).eq.87)newsite(i,j)=47
if(site(i,j).eq.93)newsite(i,j)=62
if(site(i,j).eq.96)newsite(i,j)=17
if(site(i,j).eq.106)newsite(i,j)=85
if(site(i,j).eq.107)newsite(i,j)=55
if(site(i,j).eq.110)newsite(i,j)=31
if(site(i,j).eq.117)newsite(i,j)=59
if(site(i,j).eq.122)newsite(i,j)=61
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.9).and.(g.eq.0))newsite(i,j)=36
if((site(i,j).eq.9).and.(g.eq.1))newsite(i,j)=18
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.11).and.(g.eq.0))newsite(i,j)=38
if((site(i,j).eq.11).and.(g.eq.1))newsite(i,j)=69
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.13).and.(g.eq.0))newsite(i,j)=74
if((site(i,j).eq.13).and.(g.eq.1))newsite(i,j)=22
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.18).and.(g.eq.0))newsite(i,j)=9
if((site(i,j).eq.18).and.(g.eq.1))newsite(i,j)=36
z=mod(a*z,m)
zr=z/zm g=nint(zr*1.)
```

```
if((site(i,j).eq.19).and.(g.eq.0))newsite(i,j)=98
if((site(i,j).eq.19).and.(g.eq.1))newsite(i,j)=37
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.22).and.(g.eq.0))newsite(i,j)=13
if((site(i,j).eq.22).and.(g.eq.1))newsite(i,j)=74
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.23).and.(g.eq.0))newsite(i,j)=102
if((site(i,j).eq.23).and.(g.eq.1))newsite(i,j)=75
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.25).and.(g.eq.0))newsite(i,j)=52
if((site(i,j).eq.25).and.(g.eq.1))newsite(i,j)=104
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.26).and.(g.eq.0))newsite(i,j)=84
if((site(i,j).eq.26).and.(g.eq.1))newsite(i,j)=44
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.27).and.(g.eq.0))newsite(i,j)=45
if((site(i,j).eq.27).and.(g.eq.1))newsite(i,j)=54
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.29).and.(g.eq.0))newsite(i,j)=90
if((site(i,j).eq.29).and.(g.eq.1))newsite(i,j)=108
```

```
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.36).and.(g.eq.0))newsite(i,j)=18
if((site(i,j).eq.36).and.(g.eq.1))newsite(i,j)=9
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.37).and.(g.eq.0))newsite(i,j)=19
if((site(i,j).eq.37).and.(g.eq.1))newsite(i,j)=98
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.38).and.(g.eq.0))newsite(i,j)=69
if((site(i,j).eq.38).and.(g.eq.1))newsite(i,j)=11
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.41).and.(g.eq.0))newsite(i,j)=81
if((site(i,j).eq.41).and.(g.eq.1))newsite(i,j)=50
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.43).and.(g.eq.0))newsite(i,j)=83
if((site(i,j).eq.43).and.(g.eq.1))newsite(i,j)=101
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.44).and.(g.eq.0))newsite(i,j)=26
if((site(i,j).eq.44).and.(g.eq.1))newsite(i,j)=84
z=mod(a*z,m)
zr=z/zm
```

```
g=nint(zr*1.)
if((site(i,j).eq.45).and.(g.eq.0))newsite(i,j)=54
if((site(i,j).eq.45).and.(g.eq.1))newsite(i,j)=27
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.46).and.(g.eq.0))newsite(i,j)=77
if((site(i,j).eq.46).and.(g.eq.1))newsite(i,j)=86
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.50).and.(g.eq.0))newsite(i,j)=41
if((site(i,j).eq.50).and.(g.eq.1))newsite(i,j)=81
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.52).and.(g.eq.0))newsite(i,j)=104
if((site(i,j).eq.52).and.(g.eq.1))newsite(i,j)=25
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.53).and.(g.eq.0))newsite(i,j)=105
if((site(i,j).eq.53).and.(g.eq.1))newsite(i,j)=114
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.54).and.(g.eq.0))newsite(i,j)=27
if((site(i,j).eq.54).and.(g.eq.1))newsite(i,j)=45
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.58).and.(g.eq.0))newsite(i,j)=116
```

```
if((site(i,j).eq.58).and.(g.eq.1))newsite(i,j)=89
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.69).and.(g.eq.0))newsite(i,j)=11
if((site(i,j).eq.69).and.(g.eq.1))newsite(i,j)=38
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.73).and.(g.eq.0))newsite(i,j)=100
if((site(i,j).eq.73).and.(g.eq.1))newsite(i,j)=82
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.74).and.(g.eq.0))newsite(i,j)=22
if((site(i,j).eq.74).and.(g.eq.1))newsite(i,j)=13
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.75).and.(g.eq.0))newsite(i,j)=23
if((site(i,j).eq.75).and.(g.eq.1))newsite(i,j)=102
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.77).and.(g.eq.0))newsite(i,j)=86
if((site(i,j).eq.77).and.(g.eq.1))newsite(i,j)=46
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.81).and.(g.eq.0))newsite(i,j)=50
if((site(i,j).eq.81).and.(g.eq.1))newsite(i,j)=41
z=mod(a*z,m)
```

```
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.82).and.(g.eq.0))newsite(i,j)=73
if((site(i,j).eq.82).and.(g.eq.1))newsite(i,j)=100
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.83).and.(g.eq.0))newsite(i,j)=101
if((site(i,j).eq.83).and.(g.eq.1))newsite(i,j)=43
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.84).and.(g.eq.0))newsite(i,j)=44
if((site(i,j).eq.84).and.(g.eq.1))newsite(i,j)=26
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.86).and.(g.eq.0))newsite(i,j)=46
if((site(i,j).eq.86).and.(g.eq.1))newsite(i,j)=77
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.89).and.(g.eq.0))newsite(i,j)=58
if((site(i,j).eq.89).and.(g.eq.1))newsite(i,j)=116
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.90).and.(g.eq.0))newsite(i,j)=108
if((site(i,j).eq.90).and.(g.eq.1))newsite(i,j)=29
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
```

```
if((site(i,j).eq.91).and.(g.eq.0))newsite(i,j)=109
if((site(i,j).eq.91).and.(g.eq.1))newsite(i,j)=118
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.98).and.(g.eq.0))newsite(i,j)=37
if((site(i,j).eq.98).and.(g.eq.1))newsite(i,j)=19
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.100).and.(g.eq.0))newsite(i,j)=82
if((site(i,j).eq.100).and.(g.eq.1))newsite(i,j)=73
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.101).and.(g.eq.0))newsite(i,j)=43
if((site(i,j).eq.101).and.(g.eq.1))newsite(i,j)=83
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.102).and.(g.eq.0))newsite(i,j)=75
if((site(i,j).eq.102).and.(g.eq.1))newsite(i,j)=23
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.104).and.(g.eq.0))newsite(i,j)=25
if((site(i,j).eq.104).and.(g.eq.1))newsite(i,j)=52
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.105).and.(g.eq.0))newsite(i,j)=114
if((site(i,j).eq.105).and.(g.eq.1))newsite(i,j)=53
```

```
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.108).and.(g.eq.0))newsite(i,j)=29
if((site(i,j).eq.108).and.(g.eq.1))newsite(i,j)=90
z=mod(a*z,m) zr=z/zm g=nint(zr*1.)
if((site(i,j).eq.109).and.(g.eq.0))newsite(i,j)=118
if((site(i,j).eq.109).and.(g.eq.1))newsite(i,j)=91
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.114).and.(g.eq.0))newsite(i,j)=53
if((site(i,j).eq.114).and.(g.eq.1))newsite(i,j)=105
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.116).and.(g.eq.0))newsite(i,j)=89
if((site(i,j).eq.116).and.(g.eq.1))newsite(i,j)=58
z=mod(a*z,m)
zr=z/zm
g=nint(zr*1.)
if((site(i,j).eq.118).and.(g.eq.0))newsite(i,j)=91
if((site(i,j).eq.118).and.(g.eq.1))newsite(i,j)=109
if(site(i,j).eq.128)newsite(i,j)=128
if(site(i,j).eq.192)newsite(i,j)=192
if(site(i,j).eq.256)newsite(i,j)=256
if(site(i,j).eq.0)newsite(i,j)=0
site(i,j) = newsite(i,j) 180 continue
90 continue
c  ================
c = Send result to host =
c  ================
```

```
msgtype = 2
call pvmfinitsend( PVMDEFAULT,  info  )
call pvmfpack( INTEGER4, me, 1, 1, info )
call pvmfpack( INTEGER4, ydir, 1, 1, info )
call pvmfpack( INTEGER4, xdir, 1, 1, info )
call pvmfpack( INTEGER4, xpart, 1, 1, info )
call pvmfpack( INTEGER4, xdirpart, 2*xpart, 1, info )
call pvmfpack( INTEGER4, site(0,1), (xdir+2)*ydir, 1, info )
call pvmfpack( REAL4, momx, 260, 1, info )
call pvmfpack( INTEGER4, ccc, 1, 1, info )
call pvmfpack( INTEGER4, fff, 1, 1, info )
call pvmfsend( mtid, msgtype, info )

c ======================
c = PVM: End user program =
c ======================
c          Program finished. Leave PVM before exiting
call pvmfexit(info)
stop
end
```

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PROFIL PENULIS

Muhammad Taufiq Fathaddin mengikuti pendidikan Teknik Perminyakan pada tingkat sarjana di Institut Teknologi Bandung (ITB). Pada tahun 1993 bergabung dengan Universitas Trisakti. Pada tahun 1996 dia melanjutkan pendidikan pada tingkat magister di ITB. Pada 2007 dia menamatkan pendidikan di tingkat doktor di Universiti Teknologi Malaysia. Dua tahun kemudian pada 2008-2010 dia mengikuti post doctoral research dan menjadi vice head officer pada Enhanced Oil Recovery Research Center di Universiti Teknologi Petronas, Malaysia. Pada kurun Oktober–November 2014 dia menjadi Dosen Tamu di Ecole Superieure Polytechnique, University of Antananarivo, Madagascar. Pada 2016 dia menjabat sebagai Sekretaris Prodi S2 Teknik Perminyakan Universitas Trisakti dan sejak 2017 hingga saat ini menjabat sebagai Ketua Prodi. Kemudian pada 2016-2017 dia mengikuti post doctoral research di Sejong University, Korea Selatan. Selanjutnya pada November 2019 dia menjadi Dosen Tamu di Universiti Teknologi Malaysia. Di samping itu dia juga aktif sebagai konsultan mengerjakan puluhan proyek dan kajian yang berkaitan dengan pengembangan lapangan minyak dan gas bumi serta hidrokarbon non-konvensional pada institusi BATM sejak 2001 dan Pukesmigas-Usakti sejak 2010. Puluhan karya tulisnya telah dipublikasikan baik dalam jurnal maupun konferensi baik di tingkat nasional maupun internasional. Di samping itu ada tiga buah buku yang telah diterbitkan berjudul "Konsep Teknologi Industri Perminyakan", "Penerapan Metode Monte Carlo Untuk Perkiraan Cadangan Reservoir Hidrokarbon Dan Panasbumi", dan "Teknik Reservoir 1". Sejak 2018 dia dipercaya menjadi Chief Editor pada Journal of Earth Energy Science, Engineering, and Technology. Selain itu sejak 2019 dia menjadi reviewer pada Journal of Earth Energy Engineering, Jurnal Petro, Jurnal Offshore, dan Jurnal Dedikasi.

Pri Agung Rakhmanto, Ph.D dikenal sebagai ahli ekonomi energi, khususnya minyak dan gas bumi, dengan pengalaman luas di dunia industri, birokrasi, akademisi dan riset, dan juga organisasi non-pemerintah. Doktor (Ph.D) dari Universiteit Twente, Belanda, di bidang Ekonomi Politik dengan spesialisasi sektor energi; Master of Science (MSc) dari Colorado School of Mines, USA, di bidang Ekonomi Energi dan Sumberdaya Mineral; Master of Business Administration (MBA) dari Universiteit Twente, Belanda, di bidang Manajemen Energi dan Lingkungan; dan Sarjana Teknik (ST) di bidang Teknik Perminyakan dari Institut Teknologi Bandung. Kepakarannya di bidang ekonomi energi telah banyak digunakan untuk memberikan masukan dan pemikiran solusi atas berbagai permasalahan yang ada di pemerintahan maupun dunia industri. Aktif menjadi narasumber dalam berbagai forum nasional dan internasional dan terlibat aktif dalam perumusan dan rekomendasi berbagai kebijakan di bidang energi. Anggota Kelompok Kerja Bidang Energi Tim Transisi Pemerintahan Jokowi-Jusuf Kalla. Anggota Dewan Pakar IATMI (2014 – 2016), Ketua I Ikatan Ahli Teknik Perminyakan Indonesia (IATMI) (2017 – 2018), Divisi Technical Research and Publication IATMI (2022 – 2025). Pendiri dan sekaligus Direktur Eksekutif ReforMiner Institute (Research Institute for Mining and Energy Economics) periode 2008 – 2014. Saat ini menjadi penasehat ReforMiner Institute dan aktif sebagai Pengajar Ekonomi Energi/Minyak dan Gas Bumi di program Pascasarjana dan Sarjana Teknik Perminyakan, Fakultas Teknologi Kebumian dan Energi Universitas Trisakti. Menjadi rujukan berbagai media nasional dan internasional dalam bidang ekonomi dan kebijakan energi, aktif menjadi pembicara di berbagai seminar dan forum diskusi, dan pengisi kolom di sejumlah media cetak utama nasional.

Dwi Atty Mardiana, menempuh pendidikan Sarjana Teknik Industri di Universitas Islam Indonesia pada 1999 hingga 2003. Memulai pengalaman di industri Perminyakan sejak tahun 2005 dan melanjutkan studi magister di Universitas Trisakti tahun 2009 di bidang Teknik Perminyakan. Tahun 2011 hingga 2014 menyelesaikan pendidikan doktor di bidang Ekonomi dengan konsentrasi Sustainablilty dengan fokus pada bidang ekonomi energi. Memulai karir di bidang akademik pada tahun 2016 di Universitas Trisakti dan menjadi dosen tetap pada Program Study Magister Teknik Perminyakan hingga saat ini. Selain mengajar, beberapa artikel ilmiah dan buku telah dihasilkan terkait dengan ekonomi migas.

Alvita Kumala Sari lahir di Jakarta pada 31 Juli 1988. Dia menamatkan kuliah di bidang Teknik Perminyakan di Universitas Trisakti. Perjalanan karirnya dimulai dengan bekerja sebagai Technical & Marketing Engineer di PT Putra Sejati Indomakmur sebuah perusahaan kontraktor minyak dan gas dalam waktu 2 tahunan. Selanjutnya dia bekerja sebagai Production (Operation) Engineer di Pertamina selama kurun waktu lebih dari 9 tahun. Pada saat ini bekerja sebagai Operation Planning & Engineering Engineer Regional di Pertamina EP Cepu.

Daddy Sutansyah lahir di Sukabumi pada 10 September 2022. Dia menamatkan kuliah di bidang Teknik Perminyakan di Universitas Trisakti. Dia bekerja selama lebih dari 20 tahun sebagai Profesional Drilling and Workover Senior Engineer dan Operation. Dia telah bekerja di industri perminyakan pada beberapa perusahaan seperti VICO Indonesia, Mont'Dor Petroleum, Pertamina Geothermal Enegy dan Pertamina EP. Pada saat ini bekerja sebagai Senior Drilling Engineer Regional di Pertamina Internasional EP.

Hardi Maifra Kurniadi, lahir di Pasaman pada 2 Mei 1995. Dia menempuh Pendidikan S1 dan S2 di Jurusan Teknik Perminyakan. Lulus dari Universitas Trisakti pada Tahun 2021. Dia adalah Founder Petroleum ID.

PEMODELAN DAN SIMULASI

Aliran Polimer dalam Media Berpori Menggunakan Metode Lattice Gas Automata

Lattice Gas Automata (LGA) adalah suatu metode yang digunanakan untuk memodelkan partikel bergerak dan partikel diam pada skala meso dan mikro. Pergerakan dan tumbukan antar partikel fluida memenuhi hukum kekekalan masa dan momentum. Aturan tumbukan juga dibuat untuk mengatur tumbukan antara partikel fluida dan partikel padat. Aturan tumbukan tersebut memenuhi hukum kekekalan massa. Dalam buku ini diterapkan metode LGA dengan kisi-kisi berbentuk segi enam dan aturan tumbukan model FHP-III. Metode tersebut digunakan untuk memodelkan aliran polimer dalam media berpori. Fenomena adsorpsi dan gelasi umumnya terjadi akibat interaksi antara partikel polimer dan batuan. Untuk memodelkan proses adsorpsi dan gelasi, dibuat aturan tumbukan tambahan. Aturan tumbukan tersebut memungkinkan partikel polimer bergerak menjadi partikel polimer diam dan menempel pada partikel batuan. Penempelan partikel polimer mengakibatkan berkurangnya densitas partikel fluida sehingga mengubah sifat fisik fluida. Di samping itu penempelan partikel polimer mengakibatkan perubahan sifat fisik batuan akibat berkuranghnya saluran fluida.

Simulasi aliran fluida dalam media berpori yang lebih besar seperti sandpack berukuran panjang 30 cm, memerlukan waktu simulasi yang cukup lama. Untuk mengurangi waktu simulasi, maka diterapkan perhitungan paralel. Perhitungan paralel melibatkan banyak komputer dalam jaringan, dimana satu komputer bertindak sebagai *master computer* dan sisanya sebagai *slave computer*. Dalam penerapan teknik ini, model media berpori dibagi sebanyak jumlah *slave computer* yang digunakan. Pembagian media berpori dilakukan searah dengan aliran utama dalam media berpori. Untuk menghubungkan simulasi aliran fluida antara daerah yang berdekatan, dibuat aturan tumbukan tambahan. Partikel-partikel fluida yang bergerak ke batas suatu wilayah yang disimulasikan suatu *slave computer* diinfomasikan oleh *master computer* sebagai partikel-partikel baru pada wilayah lain. Waktu simulasi menggunakan teknik perhitungan paralel dipengaruh oleh *slave computer* terlemah, karena perhitungan iterasi selanjutnya menunggu selesainya perhitungan seluruh *slave computer* pada iterasi sebelumnya.

WAWASANILMU

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