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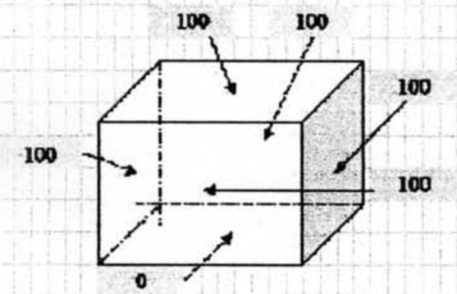
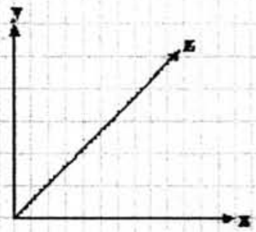
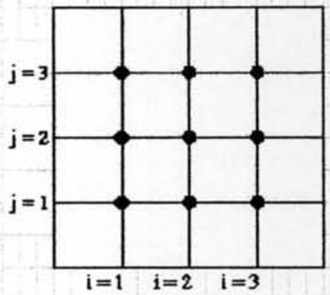
APPENDICES

APPENDIX A ADI Method by Calculation of Excel Spreadsheet.

Example ขนาด 4 x 4 x 4







k=1

	i=1	i=2	i=3
j=3	25	25	25
j=2	25	25	25
j=1	25	25	25

k=2

	i=1	i=2	i=3
j=3	25	25	25
j=2	25	25	25
j=1	25	25	25

k=3

	i=1	i=2	i=3
j=3	25	25	25
j=2	25	25	25
j=1	25	25	25

$\Delta x = \Delta y = \Delta z$

k = 0.835

Δt = 10

Δx = 10

λ = 0.0835

Forward

$P_N = \gamma_N$

$P_i = \gamma_i - \dfrac{c_i P_{i+1}}{\beta_i}$, i = N-1, N-2,…,1.

Backward

$\beta_1 = b_1$, $\gamma_1 = d_1/\beta_1$.

$\beta_i = b_i - \dfrac{a_i c_{i-1}}{\beta_{i-1}}$, i = 2,3,…,N.

$\gamma_i = \dfrac{d_i - a_i \gamma_{i-1}}{\beta_i}$, i = 2,3,…,N.

Step 1. ----- $t = t_0 + \Delta t/3$

k=1

	i=1	i=2	i=3
j=3	28.353	28.353	28.353
j=2	26.320	26.320	26.320
j=1	25.643	25.643	25.643

k=2

	i=1	i=2	i=3
j=3	27.154	27.154	27.154
j=2	25.070	25.070	25.070
j=1	24.375	24.375	24.375

k=3

	i=1	i=2	i=3
j=3	28.353	28.353	28.353
j=2	26.320	26.320	26.320
j=1	25.643	25.643	25.643

Step 2. ----- $t = t_0 + (\Delta t \times 2/3)$

k=1	i=1	i=2	i=3
j=3	31.378	29.436	31.378
j=2	29.505	27.508	29.505
j=1	28.881	26.865	28.881

k=2	i=1	i=2	i=3
j=3	29.361	27.338	29.361
j=2	27.345	25.264	27.345
j=1	26.673	24.573	26.673

k=3	i=1	i=2	i=3
j=3	31.378	29.436	31.378
j=2	29.505	27.508	29.505
j=1	28.881	26.865	28.881

Step 3. ----- $t = t_0 + \Delta t$

k=1	i=1	i=2	i=3
j=3	34.071	30.525	34.071
j=2	31.458	27.676	31.458
j=1	29.265	25.593	29.265

k=2	i=1	i=2	i=3
j=3	32.205	28.535	32.205
j=2	29.366	25.448	29.366
j=1	27.233	23.429	27.233

k=3	i=1	i=2	i=3
j=3	34.071	30.525	34.071
j=2	31.458	27.676	31.458
j=1	29.265	25.593	29.265

Input

```
Amount of node:           3
Input Dt:
10.0
Input Dx:
10.0
Input k:
0.835
```

Output

```
ratio =     .08350
```

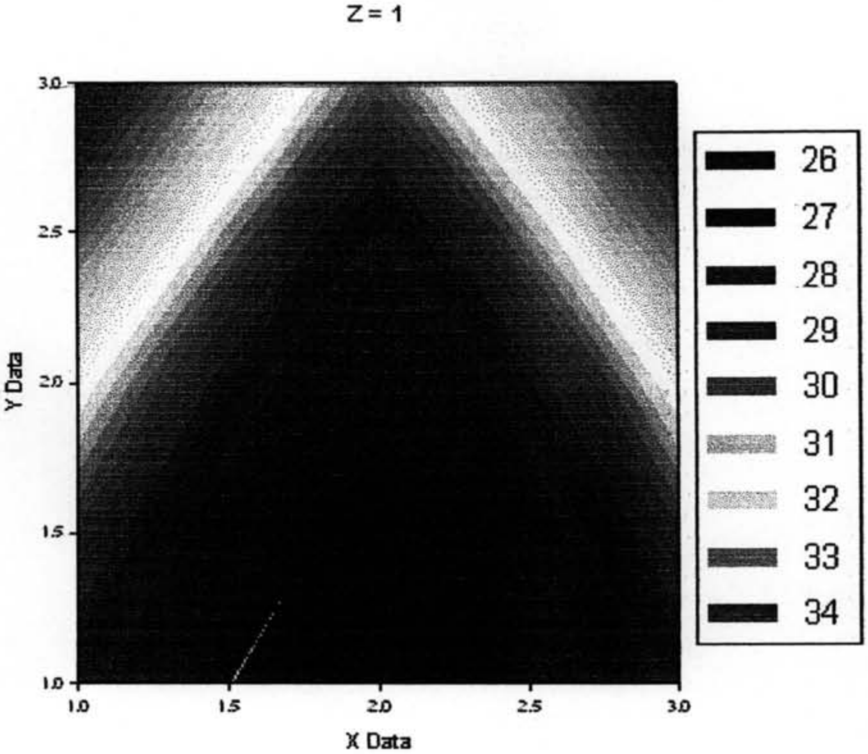
```
Initial Temperature at plane k:          1
          25.00000        25.00000       25.00000
          25.00000        25.00000       25.00000
          25.00000        25.00000       25.00000

Initial Temperature at plane k:          2
          25.00000        25.00000       25.00000
          25.00000        25.00000       25.00000
          25.00000        25.00000       25.00000

Initial Temperature at plane k:          3
          25.00000        25.00000       25.00000
          25.00000        25.00000       25.00000
          25.00000        25.00000       25.00000
```

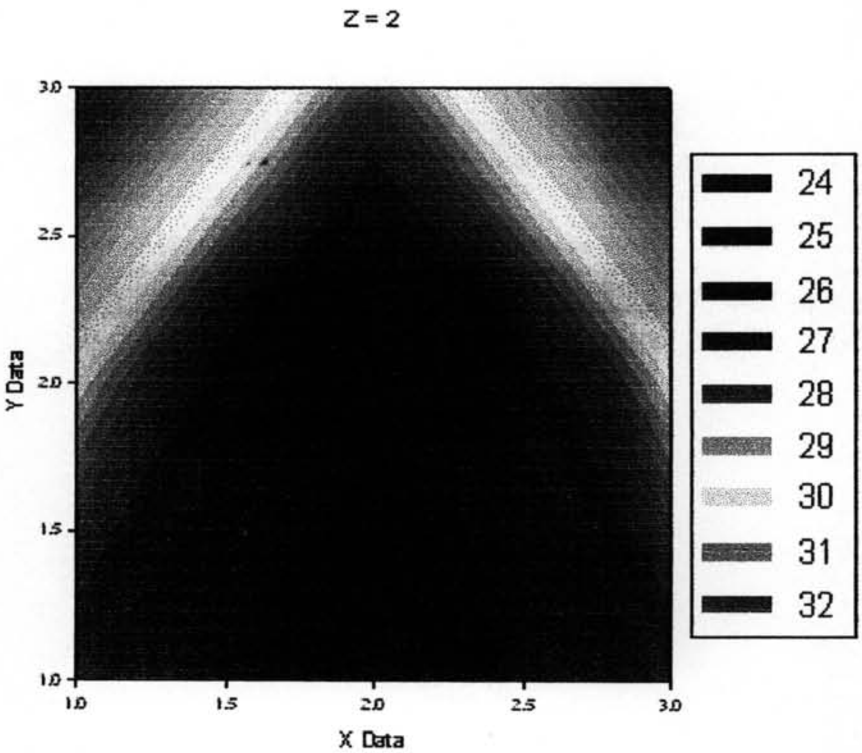
```
a =   -.08350   b =   3.16700   c =   -.08350
```

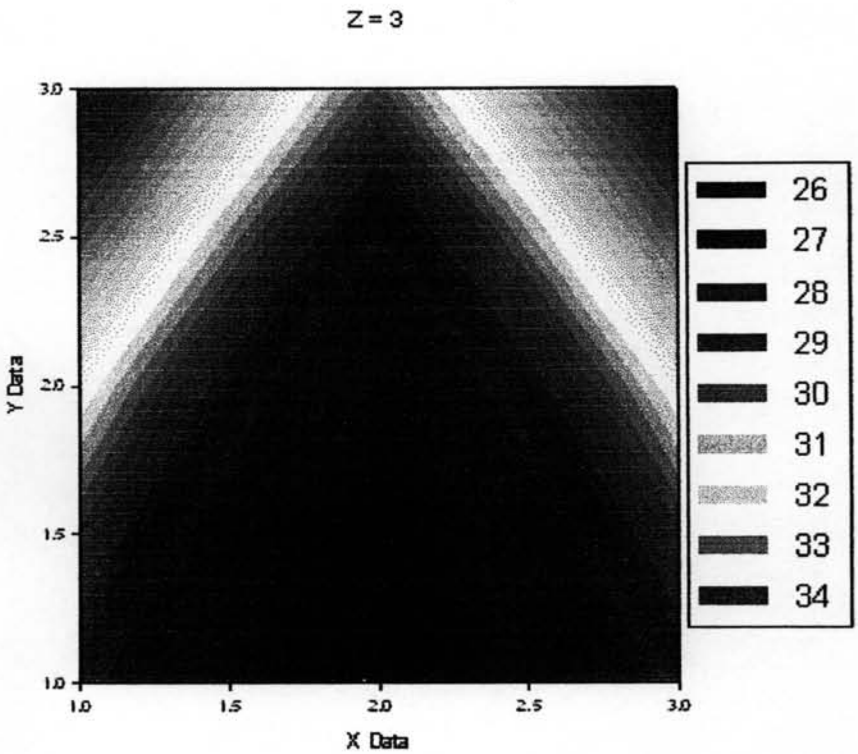
```
 First Step
 At t =   3.33333

Temperature of first Step at plane k:           1
          28.35250        28.35250        28.35250
          26.32012        26.32012        26.32012
          25.64265        25.64265        25.64265

Temperature of first Step at plane k:           2
          27.15421        27.15421        27.15421
          25.06961        25.06961        25.06961
          24.37475        24.37475        24.37475

Temperature of first Step at plane k:           3
          28.35250        28.35250        28.35250
          26.32012        26.32012        26.32012
          25.64265        25.64265        25.64265
```

```
Second Step
 At t =   6.66667

Temperature of Second Step at plane k:          1
          31.37802        29.43565        31.37802
          29.50546        27.50797        29.50546
          28.88127        26.86541        28.88127

Temperature of Second Step at plane k:          2
          29.36075        27.33770        29.36075
          27.34505        25.26413        27.34505
          26.67315        24.57294        26.67315

Temperature of Second Step at plane k:          3
          31.37802        29.43565        31.37802
          29.50546        27.50797        29.50546
          28.88127        26.86541        28.88127
```

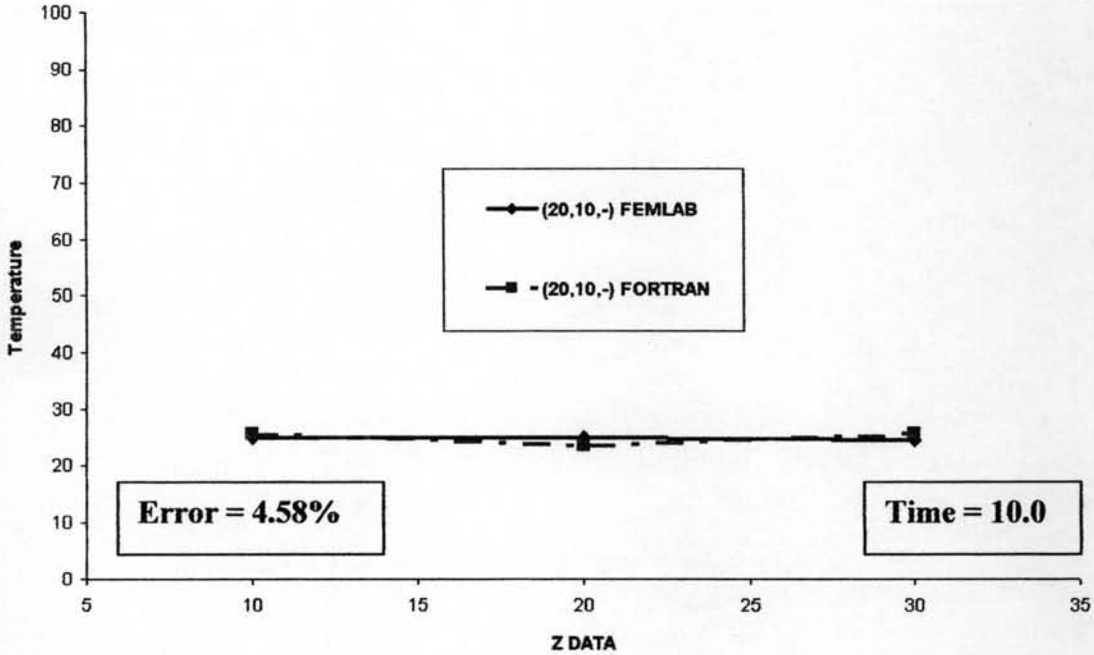
```
Third Step
 At t =  10.00000

Final temperature at plane k:           1
          34.07078        30.52525        34.07078
          31.45836        27.67626        31.45836
          29.26466        25.59338        29.26466

Final temperature at plane k:           2
          32.20519        28.53489        32.20519
          29.36640        25.44816        29.36640
          27.23330        23.42922        27.23330

Final temperature at plane k:           3
          34.07077        30.52524        34.07077
          31.45835        27.67626        31.45835
          29.26466        25.59338        29.26466
```

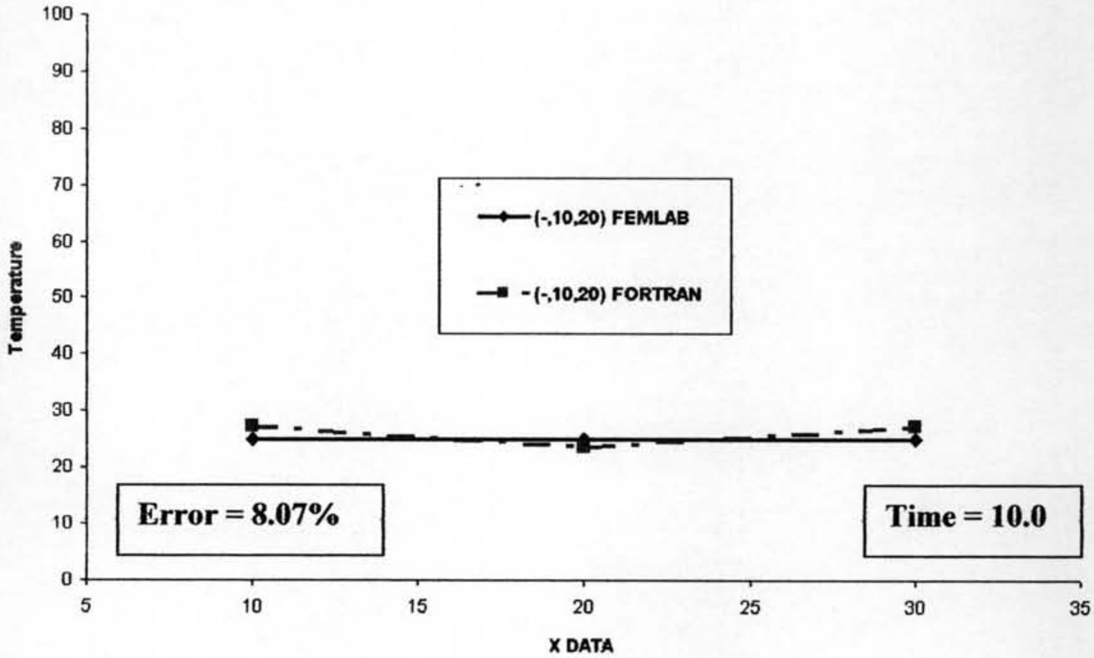

Z = 1
3.0
2.5
2.0
1.5
1.0
Y Data
1.0
1.5
2.0
2.5
3.0
X Data
26
27
28
29
30
31
32
33
34


Z = 2
3.0
2.5
2.0
1.5
1.0
Y Data
1.0
1.5
2.0
2.5
3.0
X Data
24
25
26
27
28
29
30
31
32


Z = 3
Y Data
X Data
1.0
1.5
2.0
2.5
3.0
26
27
28
29
30
31
32
33
34

APPENDIX B Comparison of Results between FEMLAB and ADI Method.





APPENDIX C Fortran Code of ADI Method to solve Heat Transfer Problem

```
c       Applied Numerical Methods, Regular Shape
c       Three-dimensional Heat Transfer Problem
c       Solved By ADI Technique

c       T = 0 at the bottom surface,
c       T = 100 at the other surface,
c       T = 25 everywhere in this cubic.

        IMPLICIT NONE
        Integer N,NN,NT
        Integer i,j,k,ICOUNT
        Real a,b,c,d,d1,d2,f
        Real Dt,Dx,constant,t,t0
        Real ratio,Ti,T1,T2,Temp,V
        Dimension Ti(5,5,5),T1(5,5,5),T2(5,5,5),Temp(5,5,5)
        Dimension V(3),d(3),d1(3),d2(3)

        OPEN(6,FILE='Temperature 2 OUTPUT.DOC')
        OPEN(7,FILE='Temperature 2 OUTPUT.DAT')
        OPEN(8,FILE='Third Step 2 OUTPUT.DAT')

c       .....Set Basic Values.....
        ICOUNT = 0.0
        N = 3
        Write(6,*) 'Amounts of node: ',N
        t0 = 0
        t = 0
        NN = N+1
        NT = N+2
```

```
c       .....Read and Check Input Parameter.....
        Dt = 10.0
        Write(6,*) 'Dt: ',Dt
        Dx = 10.0
        Write(6,*) 'Dx: ',Dx
        constant = 0.835
        Write(6,*) 'k: ',constant
        Write(6,*)
        ratio = constant*Dt/(Dx**2)
        Write(6,800) ratio
        Write(6,*)

c       .....Set Initial and Boundary Values.....
        Do 500 j = 2,NN
         Do 501 k = 2,NN
         Ti(1,j,k)  = 100
         Ti(NT,j,k) = 100
         T1(1,j,k)  = Ti(1,j,k)
         T1(NT,j,k) = Ti(NT,j,k)
         T2(1,j,k)  = Ti(1,j,k)
         T2(NT,j,k) = Ti(NT,j,k)
501      Continue
500     Continue

        Do 502 i = 2,NN
         Do 503 k = 2,NN
         Ti(i,1,k)  = 0
         Ti(i,NT,k) = 100
         T1(i,1,k)  = Ti(i,1,k)
         T1(i,NT,k) = Ti(i,NT,k)
         T2(i,1,k)  = Ti(i,1,k)
         T2(i,NT,k) = Ti(i,NT,k)
```

```
503     Continue
502     Continue

        Do 504 i = 2,NN
         Do 505 j = 2,NN
         Ti(i,j,1)  = 100
         Ti(i,j,NT) = 100
         T1(i,j,1)  = Ti(i,j,1)
         T1(i,j,NT) = Ti(i,j,NT)
         T2(i,j,1)  = Ti(i,j,1)
         T2(i,j,NT) = Ti(i,j,NT)
505      Continue
504     Continue

        Do 506 i = 2,NN
         Do 507 j = 2,NN
          Do 508 k = 2,NN
          Ti(i,j,k) = 25
508       Continue
507      Continue
506     Continue

        Do 510 j = NN,2,-1
        Write(7,803) (Ti(i,j,2),i=2,NN),(Ti(i,j,3),i=2,NN),
       *             (Ti(i,j,4),i=2,NN)

        Write(8,803) (Ti(i,j,2),i=2,NN),(Ti(i,j,3),i=2,NN),
       *             (Ti(i,j,4),i=2,NN)
510     Continue
        Write(7,*)
        Write(8,*)
```

```
c          .....Set Coefficient Array a, b, and c
           a = -1*ratio
           b = 3+(2*ratio)
           c = -1*ratio
           f = 3-(4*ratio)
           Write(6,801) a,b,c
           Write(6,*)

300        ICOUNT = ICOUNT + 1
           Write(6,*) ' ICOUNT: ',ICOUNT
           Write(7,*) ' ICOUNT: ',ICOUNT
           Write(8,*) ' ICOUNT: ',ICOUNT

c          .....Compute Temperatures at First Step.....
c          .....Implicit in x direction.....
           t = t0 + Dt/3
           Write(6,*) ' First Step'
           Write(6,802) t
           Write(6,*)

           Do 550 i = 2,NN
            Do 551 j = 2,NN
             Do 552 k = 2,NN
             d(k) = ratio*Ti(i,j-1,k)+ratio*Ti(i,j+1,k)+ratio*Ti(i,j,k-1)
          *        +ratio*Ti(i,j,k+1)+f*Ti(i,j,k)
552          Continue
            Call TRIDAG (2,NN,a,b,c,d,V)
             Do 553 k = 2,NN
             T1(i,j,k) = V(k)
553          Continue
551         Continue
550        Continue
```

```
      Do 556 j = NN,2,-1
      Write(7,803) (T1(i,j,2),i=2,NN),(T1(i,j,3),i=2,NN),
     *             (T1(i,j,4),i=2,NN)
556   Continue
      Write(7,*)

c     .....Compute Temperatures at Second Step.....
c     .....Implicit in y direction.....
      t = t0 + 2*Dt/3
      Write(6,*) 'Second Step'
      Write(6,802) t
      Write(6,*)

      Do 600 j = 2,NN
       Do 601 i = 2,NN
        Do 602 k = 2,NN
        d1(k) = ratio*T1(i,j,k-1)+ratio*T1(i,j,k+1)
     *         +ratio*T1(i-1,j,k)+ratio*T1(i+1,j,k)+f*T1(i,j,k)
602     Continue
       Call TRIDAG (2,NN,a,b,c,d1,V)
        Do 603 k = 2,NN
        T2(i,j,k) = V(k)
603     Continue
601    Continue
600   Continue

      Do 606 j = NN,2,-1
      Write(7,803) (T2(i,j,2),i=2,NN),(T2(i,j,3),i=2,NN),
     *             (T2(i,j,4),i=2,NN)
606   Continue
      Write(7,*)
```

```
c       .....Compute Temperatures at Third Step......
c       .....Implicit in z direction.....
        t = t0 + Dt
        Write(6,*) 'Third Step'
        Write(6,802) t
        Write(6,*)

        Do 650 k = 2,NN
         Do 651 i = 2,NN
          Do 652 j = 2,NN
          d2(j) = ratio*T2(i-1,j,k)+ratio*T2(i+1,j,k)
     *          +ratio*T2(i,j-1,k)+ratio*T2(i,j+1,k)+f*T2(i,j,k)
652       Continue
         Call TRIDAG (2,NN,a,b,c,d2,V)
          Do 653 j = 2,NN
          Temp(i,j,k) = V(j)
          Ti(i,j,k) = Temp(i,j,k)
653       Continue
651      Continue
650     Continue

        Do 656 j = NN,2,-1
        Write(7,803) (Temp(i,j,2),i=2,NN),(Temp(i,j,3),i=2,NN),
     *               (Temp(i,j,4),i=2,NN)

        Write(8,803) (Temp(i,j,2),i=2,NN),(Temp(i,j,3),i=2,NN),
     *               (Temp(i,j,4),i=2,NN)
656     Continue
        Write(7,*)
        Write(8,*)
```

```
c       .....Checking Conditions.....
        t0 = t
        If (ICOUNT .NE. 200) Then
        GOTO 300
        End If

c       .....Format of Output Statement.....
800     Format(2x,'ratio =',F10.5)
801     Format(2x,'a =',F10.5,3x,'b =',F10.5,3x,'c =',F10.5)
802     Format(2x,'At t =',F10.5)
803     Format(2x,3F10.5,5x,'###',3F10.5,5x,'###',3F10.5)

        CLOSE(6)
        CLOSE(7)
        CLOSE(8)

        Stop
        End
```

```
        Subroutine TRIDAG (First,Last,a,b,c,d,V)
c       .....Procedure for solving a system of simultaneous.....
c       .....Linear equation with a tri-diagonal coefficient matrix.....

        IMPLICIT NONE
        Integer First,Last,e
        Real a,b,c,d,v,gamma,beta
        Dimension d(3),V(3)
        Dimension gamma(3),beta(3)

c       .....Compute Intermediate Arrays Beta and Gamma.....
        beta(First) = b
        gamma(First) = d(First)/beta(First)

        Do 900 e = First+1,Last
        beta(e) = b-(a*c)/beta(e-1)
        gamma(e) = (d(e)-(a*gamma(e-1)))/beta(e)
900     Continue

c       .....Compute Temperature.....
        V(Last) = gamma(Last)
        Do 901 e = Last-1,First,-1
        V(e) = gamma(e)-(c*V(e+1))/beta(e)
901     Continue

        Return
        End
```

APPENDIX D Fluid Flow from Reservoir into Well

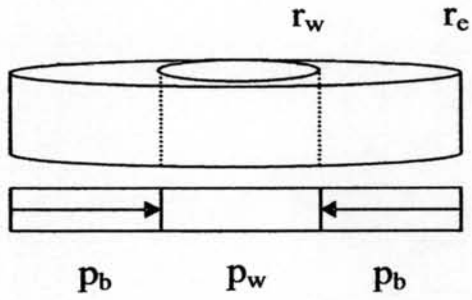


Figure D1. Radial flow system.

<u>Assume</u>: Natural gas flow in reservoir behaves like flow in radial system
From Darcy's law

$$q = vA \quad \text{(D-1)}$$

$$q = -\frac{k}{\mu}\frac{dp}{dr} * 2\pi rh \quad \text{(D-2)}$$

Compare volumetric flow at standard condition,

$$Qi = \frac{\rho q}{\rho_{sc}} \quad \text{(D-3)}$$

When,

$$\frac{\rho}{\rho_{sc}} = \frac{pT_{sc}}{Zp_{sc}T} \quad \text{(D-4)}$$

Replace Eq. (D-4) into Eq. (D-3)

$$Q_i = -\frac{pT_{sc}}{Zp_{sc}T} * 2\pi rh * \frac{k}{\mu}\frac{dp}{dr} \tag{D-5}$$

Integration from surface (r_w) to any location (r)

BC. $r = r_w, \quad p = p_{wi}$

$r = r, \quad p = p$

$$\frac{-Q_i Zp_{sc}T\mu}{2\pi hkT_{sc}} \int_{r_w}^{r} dr / r = \int_{p_{wi}}^{p} pdp \tag{D-6}$$

$$-\frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk} \ln\frac{r}{r_w} = (p^2 - p_{si}^2) \tag{D-7}$$

$$p^2 = p_{si}^2 - \frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk} \ln\frac{r}{r_w} \tag{D-8}$$

Get p_b^2 from the average of p^2 over radius r_w and r_e

$$p_b^2 = \frac{\int_{r_w}^{r_e} p^2 rdr}{\int_{r_w}^{r_e} rdr} \tag{D-9}$$

$$p_b^2 = \frac{\int_{r_w}^{r_e} (p_{wi}^2 - \frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk} \ln\frac{r}{rw}) rdr}{\int_{r_w}^{r_e} rdr} \tag{D-10}$$

$$p_b^2 = \frac{\left[\frac{r^2}{2} p_{wi}^2 - \left(\frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk} \times \frac{r^2}{2}(\ln\frac{r}{rw} - 0.5)\right)\right]_{r_w}^{r_e}}{\frac{r_e^{\,2}}{2} - \frac{r_w^{\,2}}{2}} \tag{D-11}$$

Gives, $r_e^2 - r_w^2 = r_e^2 (1 - (r_w^2 / r_e^2)) \approx r_e^2$

$$p_b^2 = \frac{2}{re^2}\left[\frac{r^2}{2} p_{wi}^2 - \left(\frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk} \times \frac{r^2}{2}(\ln\frac{r}{r_w} - 0.5)\right)\right]_{r_w}^{r_e} \tag{D-12}$$

$$p_b^2 = p_{wi}^2 - \frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk} * \frac{2}{r_e^{\,2}}\left[\frac{r^2}{2}(\ln\frac{r}{r_w} - 0.5)\right]_{r_w}^{r_e} \tag{D-13}$$

$$p_b^2 = p_{wi}^2 - \frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk} * \frac{2}{r_e^{\,2}}\left[\frac{r_e^{\,2}}{2}\ln\frac{r_e}{r_w} - 0.5\frac{r_e^{\,2}}{2} - \frac{r_w^{\,2}}{2}\ln\frac{r_w}{r_w} + 0.5\frac{r_w^{\,2}}{2}\right] \tag{D-14}$$

$$p_b^2 = p_{wi}^2 - \frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk} * \frac{2}{r_e^{\,2}}\left[\frac{re^2}{2}\ln\frac{r_e}{r_w} - \frac{0.5}{2}(r_e^{\,2} - r_w^{\,2})\right] \tag{D-15}$$

$$p_b^2 = p_{wi}^2 - \frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk}(\ln\frac{r_e}{r_w} - 0.5) \tag{D-16}$$

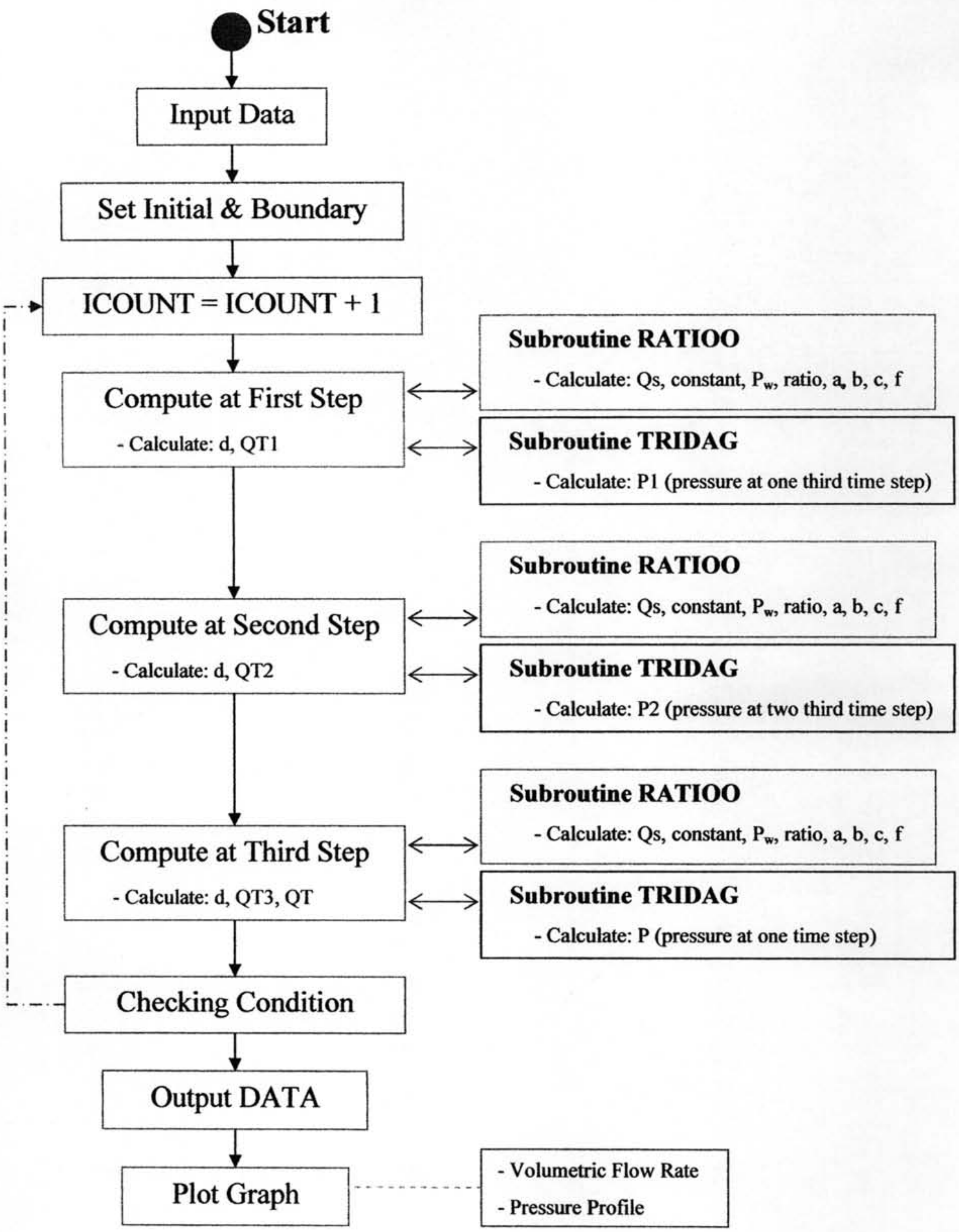
$$p_{wi}^2 - p_b^2 = \frac{Q_i TZp_{sc}\mu}{T_{sc}\pi hk}(\ln\frac{r_e}{r_w} - 0.5) \tag{D-17}$$

Rearrange Eq. (D-17) into volume flow rate, Q_i ;

$$Q_i = \frac{T_{sc}\pi hk}{TZP_{sc}\mu} \frac{(p_{wi}^2 - p_b^2)}{\ln\frac{r_e}{r_w} - 0.5} \tag{D-18}$$

where, p_{wi}, is well pressure; p_b, the block average pressure; Qi, the volume flow rate; r_e, the equivalent radius of external boundary; r_w, the well radius; Z, the mean compressibility factor; μ, the gas viscosity; k, the rock permeability; and h, the reservoir thickness.

APPENDIX E Flow Chart of the Reservoir Simulation Programming



APPENDIX F Fortran Code for Computing Pressure Profile for Reservoir Simulation with One Well

```
c       ADI-Reservoir Simulation-Pressure (1 Well)

        IMPLICIT NONE
        Integer i,j,k,o,o1,o2,N,NN,COUNT,ICOUNT,Year,Day
        Real L,W,H,Dx,Dy,Dz,WellX,WellY,WellZ
        Real t,t0,Dt,constanta,constant,Por,GV,Z,Qmax
        Real Ps,Ts,Tr,Pw,rw,re,Alpha,Beta,center
        Real Pi,P1,P2,P,PHI,V,Qs,QT1,QT2,QT3,QT,PP,DQT,QTOld
        Real a,b,c,d,f,ratio,constant1,Pb
        Dimension P1(103,103,103),P2(103,103,103),P(103,103,103)
        Dimension Pi(103,103,103),PHI(103,103,103),PP(103,103,103)
        Dimension a(103),b(103),c(103),d(103),f(103)
        Dimension constant(103,103,103)
        Dimension Qs(103),V(103),ratio(103),constant1(103)

        OPEN(4,FILE='Input Data 1 Well.DAT')
        OPEN(6,FILE='OUTPUT 1 Well.DOC')
        OPEN(7,FILE='OUTPUT 1 Well.DAT')
        OPEN(8,FILE='Third Step 1 OUTPUTl.DAT')
        OPEN(9,FILE='Graph 1 OUTPUT.DAT')
        OPEN(10,FILE='QT Graph OUTPUT 1 Well.DAT')

c       .....Set Basic Values.....
        ICOUNT = 0.0
        t0 = 0.0
        t = 0.0
        constanta = 0.0
        Qmax = 0.0
        QT = 0.0
```

```
QTOld = 0.0
Write(10,*) t,QT

L = 5000.0
Write(6,*) 'Reservoir Length: ',L,' ','ft'
W = 5000.0
Write(6,*) 'Reservoir Width: ',W,' ','ft'
H = 5000.0
Write(6,*) 'Reservoir Thickness: ',H,' ','ft'
N = 51.0
Write(6,*) 'Amounts of grid: ',N
NN = N + 1

Dx = L/(N-1)
Dy = W/(N-1)
Dz = H/(N-1)
If (Dx .LE. Dy) Then
 If (Dy .LE. Dz) Then
 Dx = Dz
 Else
 Dx = Dy
 End If
Else If (Dx .LE. Dz) Then
Dx = Dz
End If
Write(6,*) 'Grid spacing: ',Dx,'  ','ft'

Dt = 1.0
Write(6,*) 'Time step: ',Dt,'  ','days'
Por = 0.148
Write(6,*) 'Porosity: ',Por
GV = 0.05
```

```
Write(6,*) 'Gas viscosity: ',GV,' ','cP'
Ps = 14.7
Write(6,*) 'Standard pressure: ',Ps,' ','psia'
Ts = 518.67
Write(6,*) 'Standard temperature: ',Ts,' ','R'
Tr = 609.67
Write(6,*) 'Reservoir temperature: ',Tr,' ','R'
Pw = 3000.0
Write(6,*) 'Well pressure: ',Pw,' ','psia'
rw = 0.5
Write(6,*) 'Well radius: ',rw,' ','ft'

re = SQRT((4.0*Dx**2.0)/(22.0/7.0))
Write(6,*) 'Equivalent radius: ',re,' ','ft'

Z = 1.0
Write(6,*) 'Compressibility factor: ',Z

Alpha = Tr*Ps/Ts
Beta = Por*SQRT(GV/2.0)

center = INT(NN/2)
WellX = center
Write(6,*) 'Well location in x direction: ', WellX
WellY = center
Write(6,*) 'Well location in y direction: ', WellY
WellZ = center
Write(6,*) 'Well location in z direction: ', WellZ

Write(6,*)
```

```
c          .....Set Initial and Boundary Values.....
          Do 400 k = NN,2,-1
           Do 401 i = 2,NN
           Read(4,*) (Pi(i,j,k),j=2,NN)
            Do 402 j = 2,NN
             If (Pi(i,j,k) .EQ. 0.0) Then
             constant(i,j,k) = 0.0
             Else If (i .EQ. WellX .AND. j .EQ. WellY .AND.
     *           k .EQ. WellZ) Then
             Pi(i,j,k) = Pw
             constant(i,j,k) = 0.001
             Else
             constant(i,j,k) = 0.001
             End If
            PHI(i,j,k) = (Pi(i,j,k)**2.0)/(2.0*GV)
            PP(i,j,k) = PHI(i,j,k)
402         Continue
401        Continue
400       Continue

          Write(7,*) 'Initial Pressure at plane k:'
           Do 457 i = 2,NN
            Do 458 j = 2,NN
            Write(7,*) i-1,j-1,Pi(i,j,2),Pi(i,j,WellZ),Pi(i,j,NN)
            Write(8,*) i-1,j-1,Pi(i,j,2),Pi(i,j,WellZ),Pi(i,j,NN)
458         Continue
           Write(9,*) i-1,Pi(i,WellY,WellZ)
457        Continue
          Write(7,*)

          Do 350 i = WellX-1,WellX+1
           Do 351 j = WellY-1,WellY+1
```

```
      Pb = Pb + Pi(i,j,WellZ)
       constanta = constanta + constant(i,j,WellZ)
351    Continue
350   Continue
      Pb = (Pb - Pi(WellX,WellY,WellZ))/8.0
      constanta = (constanta - constant(WellX,WellY,WellZ))/8.0

      Qmax = -1.0*((22.0/7.0)*constanta*(Pw**2 - Pb**2))
     *        /(Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)

      write(6,*) ' Qmax: ',Qmax,'  day-1'

300   ICOUNT = ICOUNT + 1
      Write(*,*) ' ICOUNT: ',ICOUNT
      Write(6,*) ' ICOUNT: ',ICOUNT
      Write(7,*) ' ICOUNT: ',ICOUNT
      Write(8,*) ' ICOUNT: ',ICOUNT
      Write(9,*) ' ICOUNT: ',ICOUNT
      COUNT = 0.0
      QT1 = 0.0
      QT2 = 0.0
      QT3 = 0.0
      QT = 0.0

c     .....Compute Pressure at First Step.....
c     .....Implicit in x direction.....
      t = t0 + Dt/3
      Pb = 0.0
      Write(6,*) ' First Step: ',t,'  ','days'

      Do 500 i = WellX-1,WellX+1
       Do 501 j = WellY-1,WellY+1
```

```
      Pb = Pb + Pi(i,j,WellZ)
501   Continue
500   Continue
      Pb = (Pb - Pi(WellX,WellY,WellZ))/8.0

      Write(6,*)

      Do 550 i = 2,NN
       Do 551 k = 2,NN
        Do 552 j = 2,NN
311     o = j
        Call RATIOO (i,j,k,o,constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,
     *              Qmax,GV,re,rw,Qs,ratio,constant1,a,b,c,f)

        If (i .EQ. WellX .AND. j .EQ. WellY .AND. k .EQ. WellZ) Then
        Qs(j) = 0.0
        End If

        COUNT = COUNT + 1.0
        QT1 = QT1 + Qs(j)

        If (constant(i,j-1,k) .EQ. 0) Then
        PHI(i,j-1,k) = PP(i,j+1,k)
        PHI(i,j+1,k) = PP(i,j+1,k)
        PHI(i,j,k) = PP(i,j,k)
        Else If (constant(i,j+1,k) .EQ. 0) Then
        PHI(i,j+1,k) = PP(i,j-1,k)
        PHI(i,j-1,k) = PP(i,j-1,k)
        PHI(i,j,k) = PP(i,j,k)
        Else
        PHI(i,j-1,k) = PP(i,j-1,k)
        PHI(i,j+1,k) = PP(i,j+1,k)
```

```
PHI(i,j,k) = PP(i,j,k)
End If

If (constant(i,j,k-1) .EQ. 0) Then
PHI(i,j,k-1) = PP(i,j,k+1)
PHI(i,j,k+1) = PP(i,j,k+1)
PHI(i,j,k) = PP(i,j,k)
Else If (constant(i,j,k+1) .EQ. 0) Then
PHI(i,j,k+1) = PP(i,j,k-1)
PHI(i,j,k-1) = PP(i,j,k-1)
PHI(i,j,k) = PP(i,j,k)
ELse
PHI(i,j,k-1) = PP(i,j,k-1)
PHI(i,j,k+1) = PP(i,j,k+1)
PHI(i,j,k) = PP(i,j,k)
End If

 d(j) = ratio(j)*PHI(i,j-1,k) + ratio(j)*PHI(i,j+1,k)
*       + ratio(j)*PHI(i,j,k-1) + ratio(j)*PHI(i,j,k+1)
*       + f(j)*PHI(i,j,k) + f(j)*PHI(i,j,k) - constant1(j)

If (k .EQ. WellZ) Then
 If (j .EQ. WellY-1 .AND. i .EQ. WellX) Then
 o1 = 2.0
 o2 = WellY - 1.0
 GOTO 310
 Else If (j .EQ. NN .AND. i .EQ. WellX) Then
 o1 = WellY + 1.0
 o2 = NN
 GOTO 310
 Else
 o1 = 2.0
```

```
        o2 = NN
        End If
       Else
       o1 = 2.0
       o2 = NN
       End If

552    Continue
310    Call TRIDAG (o1,o2,a,b,c,d,Pw,GV,V)
       If (j .LT. NN) Then
       j = j + 1.0
       GOTO 311
       End If

       Do 553 j = 2,NN
       If (i .EQ. WellX .AND. j .EQ. WellY .AND. k .EQ. WellZ) Then
       P1(i,j,k) = Pw
       PHI(i,j,k) = (Pw**2.0)/(2.0*GV)
       Else
       PHI(i,j,k) = V(j)
       PP(i,j,k) = PHI(i,j,k)
       P1(i,j,k) = SQRT(2.0*GV*PHI(i,j,k))
       End If
553    Continue
551    Continue
550    Continue

       QT1 = QT1/(COUNT - 1.0)

       Write(7,*) 'Pressure of First Step at plane k:'
       Do 557 i = 2,NN
        Do 558 j = 2,NN
```

```
          Write(7,*) i-1,j-1,P1(i,j,2),P1(i,j,WellZ),P1(i,j,NN)
558       Continue
          Write(7,*)
557       Continue
          Write(7,*)

c         .....Compute Pressure at Second Step.....
c         .....Implicit in y direction.....
          t = t0 + (2*Dt/3)
          Pb = 0.0
          Write(6,*) ' Second Step: ',t,'  ','days'

          Do 600 i = WellX-1,WellX+1
           Do 601 j = WellY-1,WellY+1
           Pb = Pb + P1(i,j,WellZ)
601        Continue
600       Continue
          Pb = (Pb - P1(WellX,WellY,WellZ))/8.0

          Write(6,*)

          Do 650 j = 2,NN
           Do 651 k = 2,NN
            Do 652 i = 2,NN
321         o = i
            Call RATIOO (i,j,k,o,constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,
     *                   Qmax,GV,re,rw,Qs,ratio,constant1,a,b,c,f)

            If (i .EQ. WellX .AND. j .EQ. WellY .AND. k .EQ. WellZ) Then
            Qs(i) = 0.0
            End If
```

```
COUNT = COUNT + 1.0
QT2 = QT2 + Qs(i)

If (constant(i-1,j,k) .EQ. 0) Then
PHI(i-1,j,k) = PP(i+1,j,k)
PHI(i+1,j,k) = PP(i+1,j,k)
PHI(i,j,k) = PP(i,j,k)
Else If (constant(i+1,j,k) .EQ. 0) Then
PHI(i+1,j,k) = PP(i-1,j,k)
PHI(i-1,j,k) = PP(i-1,j,k)
PHI(i,j,k) = PP(i,j,k)
Else
PHI(i-1,j,k) = PP(i-1,j,k)
PHI(i+1,j,k) = PP(i+1,j,k)
PHI(i,j,k) = PP(i,j,k)
End If

If (constant(i,j,k-1) .EQ. 0) Then
PHI(i,j,k-1) = PP(i,j,k+1)
PHI(i,j,k+1) = PP(i,j,k+1)
PHI(i,j,k) = PP(i,j,k)
Else If (constant(i,j,k+1) .EQ. 0) Then
PHI(i,j,k+1) = PP(i,j,k-1)
PHI(i,j,k-1) = PP(i,j,k-1)
PHI(i,j,k) = PP(i,j,k)
ELse
PHI(i,j,k-1) = PP(i,j,k-1)
PHI(i,j,k+1) = PP(i,j,k+1)
PHI(i,j,k) = PP(i,j,k)
End If
```

```
      d(i) =  ratio(i)*PHI(i-1,j,k) + ratio(i)*PHI(i+1,j,k)
     *         + ratio(i)*PHI(i,j,k-1) + ratio(i)*PHI(i,j,k+1)
     *         + f(i)*PHI(i,j,k) + f(i)*PHI(i,j,k) - constant1(i)

      If (k .EQ. WellZ) Then
       If (i .EQ. WellX-1 .AND. j .EQ. WellY) Then
       o1 = 2.0
       o2 = WellX - 1.0
       GOTO 320
       Else If (i .EQ. NN .AND. j .EQ. WellY) Then
       o1 = WellX + 1.0
       o2 = NN
       GOTO 320
       Else
       o1 = 2.0
       o2 = NN
       End If
      Else
      o1 = 2.0
      o2 = NN
      End If

652   Continue
320   Call TRIDAG (o1,o2,a,b,c,d,Pw,GV,V)
      If (i .LT. NN) Then
      i = i + 1.0
      GOTO 321
      End If

      Do 653 i = 2,NN
      If (i .EQ. WellX .AND. j .EQ. WellY .AND. k .EQ. WellZ) Then
      P2(i,j,k) = Pw
```

```
      PHI(i,j,k) = (Pw**2.0)/(2.0*GV)
      Else
      PHI(i,j,k) = V(i)
      PP(i,j,k) = PHI(i,j,k)
      P2(i,j,k) = SQRT(2.0*GV*PHI(i,j,k))
      End If
653   Continue
651   Continue
650   Continue

      QT2 = QT2/(COUNT - 1.0)

      Write(7,*) 'Pressure of Second Step at plane k:'
      Do 657 i = 2,NN
      Do 658 j = 2,NN
      Write(7,*) i-1,j-1,P2(i,j,2),P2(i,j,WellZ),P2(i,j,NN)
658   Continue
      Write(7,*)
657   Continue
      Write(7,*)

c     .....Compute Pressure at Third Step.....
c     .....Implicit in z direction.....
      t = t0 + Dt
      Pb = 0.0
      Write(6,*) ' Third Step: ',t,'  ','days'

      Do 700 i = WellX-1,WellX+1
      Do 701 j = WellY-1,WellY+1
      Pb = Pb + P2(i,j,WellZ)
701   Continue
700   Continue
```

```
      Pb = (Pb - P2(WellX,WellY,WellZ))/8.0

      Write(6,*)
      Write(6,*) 'Qs: ',Qs

      Do 750 k = 2,NN
       Do 751 i = 2,NN
        Do 752 j = 2,NN
331     o = j
        Call RATIOO (i,j,k,o,constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,
     *               Qmax,GV,re,rw,Qs,ratio,constant1,a,b,c,f)

        If (i .EQ. WellX .AND. j .EQ. WellY .AND. k .EQ. WellZ) Then
        Qs(j) = 0.0
        End If

        COUNT = COUNT + 1.0
        QT3 = QT3 + Qs(j)

        If (constant(i-1,j,k) .EQ. 0) Then
        PHI(i-1,j,k) = PP(i+1,j,k)
        PHI(i+1,j,k) = PP(i+1,j,k)
        PHI(i,j,k) = PP(i,j,k)
        Else If (constant(i+1,j,k) .EQ. 0) Then
        PHI(i+1,j,k) = PP(i-1,j,k)
        PHI(i-1,j,k) = PP(i-1,j,k)
        PHI(i,j,k) = PP(i,j,k)
        Else
        PHI(i-1,j,k) = PP(i-1,j,k)
        PHI(i+1,j,k) = PP(i+1,j,k)
        PHI(i,j,k) = PP(i,j,k)
        End If
```

```
If (constant(i,j-1,k) .EQ. 0) Then
PHI(i,j-1,k) = PP(i,j+1,k)
PHI(i,j+1,k) = PP(i,j+1,k)
PHI(i,j,k) = PP(i,j,k)
Else If (constant(i,j+1,k) .EQ. 0) Then
PHI(i,j-1,k) = PP(i,j-1,k)
PHI(i,j+1,k) = PP(i,j-1,k)
PHI(i,j,k) = PP(i,j,k)
Else
PHI(i,j-1,k) = PP(i,j-1,k)
PHI(i,j+1,k) = PP(i,j+1,k)
PHI(i,j,k) = PP(i,j,k)
End If

d(j) =  ratio(j)*PHI(i-1,j,k) + ratio(j)*PHI(i+1,j,k)
*        + ratio(j)*PHI(i,j-1,k) + ratio(j)*PHI(i,j+1,k)
*        + f(j)*PHI(i,j,k) + f(j)*PHI(i,j,k) - constant1(j)

If (k .EQ. WellZ) Then
If (j .EQ. WellY-1 .AND. i .EQ. WellX) Then
o1 = 2.0
o2 = WellY - 1.0
GOTO 330
Else If (j .EQ. NN .AND. i .EQ. WellX) Then
o1 = WellY + 1.0
o2 = NN
GOTO 330
Else
o1 = 2.0
o2 = NN
End If
Else
```

```
        o1 = 2.0
        o2 = NN
        End If

752     Continue
330     Call TRIDAG (o1,o2,a,b,c,d,Pw,GV,V)
        If (j .LT. NN) Then
        j = j + 1.0
        GOTO 331
        End If

        Do 753 j = 2,NN
        If (i .EQ. WellX .AND. j .EQ. WellY .AND. k .EQ. WEllZ) Then
        P(i,j,k) = Pw
        PHI(i,j,k) = (Pw**2.0)/(2.0*GV)
        Else
        PHI(i,j,k) = V(j)
        P(i,j,k) = SQRT(2.0*GV*PHI(i,j,k))
        End If
        PP(i,j,k) = PHI(i,j,k)
        Pi(i,j,k) = P(i,j,k)
753     Continue
751     Continue
750     Continue

        QT3 = QT3/(COUNT - 1.0)

        Write(7,*) 'Pressure of Third Step at plane k:'
        Do 757 i = 2,NN
        Do 758 j = 2,NN
        Write(7,*) i-1,j-1,P(i,j,2),P(i,j,WellZ),P(i,j,NN)
```

```
      If (ICOUNT .EQ. 1.0 .OR. ICOUNT .EQ. 5.0 .OR. ICOUNT .EQ. 10.0
     *   .OR. ICOUNT .EQ. 20.0 .OR. ICOUNT .EQ. 40.0
     *   .OR. ICOUNT .EQ. 70.0 .OR.  ICOUNT .EQ. 95.0) Then

      Write(8,*) i-1,j-1,P(i,j,2),P(i,j,WellZ),P(i,j,NN)

      End If

758   Continue
      Write(7,*)
      Write(9,*) i-1,P(i,WellY,WellZ)
757   Continue
      Write(7,*)
      Write(9,*)

      QT = QT1 + QT2 + QT3
      Write(10,*) t,QT

c     .....Checking Conditions.....
      DQT = ABS(QTOld - QT)

      t0 = t
      If (Pb .LE. 1000.0 .OR. DQT .LE. 0.00001 .AND. DQT .NE. 0.0) Then

      Year = INT(t/365.0)
      Day = t - (Year*365.0)
      Write(6,*) ' Production Time: ',Year,'  ','years',Day,'  ','days'
      Write(*,*) ' Production Time: ',Year,'  ','years',Day,'  ','days'
      Stop
      Else
      GOTO 300
      End If
```

```
      CLOSE(6)
      CLOSE(7)
      CLOSE(8)
      CLOSE(9)
      CLOSE(10)

      Stop
      End

      Subroutine RATIOO (i,j,k,o,constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,
     *                  Qmax,GV,re,rw,Qs,ratio,constant1,a,b,c,f)
c     .....Set Coefficient Array a, b, and c.....

      IMPLICIT NONE
      Integer i,j,k,o
      Real constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,Check
      Real GV,re,rw,Qs,ratio,constant1,a,b,c,f,Qmax
      Dimension PHI(103,103,103),constant(103,103,103)
      Dimension ratio(103),constant1(103)
      Dimension a(103),b(103),c(103),f(103),Qs(103)

      Qs(o) = Qmax
      If (constant(i,j,k) .EQ. 0) Then
      Qs(o) = -1.0*((22.0/7.0)*constant(i,j,k)*(Pw**2 - Pb**2.0))
     *        /(Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)

      GOTO 901
      Else
      Check = -1.0*(Qs(o)*Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)
     *        /((22.0/7.0)*constant(i,j,k)) + Pb**2

      End If
```

```
      If (Check .LE. 0) Then
      Qs(o) = -1.0*((22.0/7.0)*constant(i,j,k)*(Pw**2 - Pb**2.0))
     *         /(Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)

      Else
      Pw = SQRT(-1.0*(Qs(o)*Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)
     *              /((22.0/7.0)*constant(i,j,k)) + Pb**2)

      End If

901   ratio(o) = constant(i,j,k)*Dt*SQRT(PHI(i,j,k))
     *         /(3.0*Beta*Dx**2.0)

      constant1(o) = Alpha*SQRT(PHI(i,j,k))*Qs(o)*Dt/(3.0*Beta)

      a(o) = -1.0*ratio(o)
      b(o) = 1.0+(2.0*ratio(o))
      c(o) = -1.0*ratio(o)
      f(o) = (1.0-(4.0*ratio(o)))/2.0

      Return
      End

      Subroutine TRIDAG (First,Last,a,b,c,d,Pw,GV,V)
c     .....Procedure for solving a system of simultaneous.....
c     .....Linear equation with a tri-diagonal coefficient matrix.....

      IMPLICIT NONE
      Integer e,First,Last
      Real a,b,c,d,Pw,PHIw,GV,V,beta,gamma
      Dimension a(103),b(103),c(103),d(103)
      Dimension beta(103),gamma(103),V(103)
```

```
      PHIw = (Pw**2.0)/(2.0*GV)

c     .....Compute Intermediate Arrays Beta and Gamma.....
      beta(First) = b(First)
      gamma(First) = d(First)/beta(First)

      Do 950 e = First+1,Last
      beta(e) = b(e)-((a(e)*c(e-1))/beta(e-1))
      gamma(e) = (d(e)-(a(e)*gamma(e-1)))/beta(e)
950   Continue

c     .....Compute Pressure.....
      V(Last) = gamma(Last)
      If (V(Last) .LT. PHIw .AND. V(Last) .NE. 0) Then
      V(Last) = PHIw
      End If

      Do 951 e = Last-1,First,-1
       V(e) = gamma(e)-(c(e)*V(e+1))/beta(e)
       If (V(e) .LT. PHIw .AND. V(e) .NE. 0) Then
       V(e) = PHIw
       End If
951   Continue

      Return
      End
```

APPENDIX G Fortran Code for Computing Pressure Profile for Reservoir Simulation with Two Wells

```
c          ADI-Reservoir Simulation-Pressure (2 Wells)

           IMPLICIT NONE
           Integer i,j,k,ww,o,o1,o2,N,NN,COUNT,ICOUNT,Year,Day
           Integer WellX,WellY,WellZ,nw
           Real L,W,H,Dx,Dy,Dz
           Real t,t0,Dt,constanta,constant,Por,GV,Z,Qmax
           Real Ps,Ts,Tr,Pw,rw,re,Alpha,Beta
           Real P0,Pi,P1,P2,P,PHI,V,PP
           Real Qs1,Qs2,QT1,QT2,QT3,QT,QTOld,DQT
           Real a,b,c,d,f,ratio,constant1,constant2,Pb
           Dimension P1(103,103,103),P2(103,103,103),P(103,103,103)
           Dimension Pi(103,103,103),PHI(103,103,103),PP(103,103,103)
           Dimension a(103),b(103),c(103),d(103),f(103)
           Dimension constant(103,103,103),constant1(103),constant2(103)
           Dimension V(103),ratio(103),constanta(2)
           Dimension WellX(2),WellY(2),WellZ(2),Pb(2),Pw(2)
           Dimension Qmax(2),Qs1(103),Qs2(103)
           Dimension QT1(2),QT2(2),QT3(2),QT(2),QTOld(2),DQT(2)

           OPEN(4,FILE='Input Data 2 Wells.DAT')
           OPEN(6,FILE='OUTPUT 2 Wells.DOC')
           OPEN(7,FILE='Third Step 2 OUTPUT Well1.DAT')
           OPEN(8,FILE='Third Step 2 OUTPUT Well2.DAT')
           OPEN(9,FILE='Graph 2 OUTPUT Well1.DAT')
           OPEN(10,FILE='Graph 2 OUTPUT Well2.DAT')
           OPEN(11,FILE='QT Graph OUTPUT 2 Wells.DAT')
```

```
c       .....Set Basic Values.....
        ICOUNT = 0.0
        t0 = 0.0
        t = 0.0
        constanta = 0.0
        Qmax = 0.0
        QT(1) = 0.0
        QT(2) = 0.0
        QTOld(1) = 0.0
        QTOld(2) = 0.0
        P0 = 4000.0
        Write(11,*) t,QT

        L = 5000.0
        Write(6,*) 'Reservoir Length: ',L,' ','ft'
        W = 5000.0
        Write(6,*) 'Reservoir Width: ',W,' ','ft'
        H = 5000.0
        Write(6,*) 'Reservoir Thickness: ',H,' ','ft'
        N = 51.0
        Write(6,*) 'Amounts of grid: ',N
        NN = N + 1

        Dx = L/(N-1)
        Dy = W/(N-1)
        Dz = H/(N-1)
        If (Dx .LE. Dy) Then
         If (Dy .LE. Dz) Then
         Dx = Dz
         Else
         Dx = Dy
         End If
```

```
Else If (Dx .LE. Dz) Then
Dx = Dz
End If
Write(6,*) 'Grid spacing: ',Dx,' ','ft'

Dt = 1.0
Write(6,*) 'Time step: ',Dt,' ','days'
Por = 0.148
Write(6,*) 'Porosity: ',Por
GV = 0.05
Write(6,*) 'Gas viscosity: ',GV,' ','cP'
Ps = 14.7
Write(6,*) 'Standard pressure: ',Ps,' ','psia'
Ts = 518.67
Write(6,*) 'Standard temperature: ',Ts,' ','R'
Tr = 609.67
Write(6,*) 'Reservoir temperature: ',Tr,' ','R'
Pw(1) = 3000.0
Write(6,*) 'The First Well pressure: ',Pw(1),' ','psia'
Pw(2) = 2800.0
Write(6,*) 'The Second Well pressure: ',Pw(2),' ','psia'
rw = 0.5
Write(6,*) 'Well radius: ',rw,' ','ft'
re = SQRT((4.0*Dx**2.0)/(22.0/7.0))
Write(6,*) 'Equivalent radius: ',re,' ','ft'

Z = 1.0
Write(6,*) 'Compressibility factor: ',Z

Alpha = Tr*Ps/Ts
Beta = Por*SQRT(GV/2.0)
```

```
      nw = 2.0
      Write(6,*) 'Number of Wells: ',nw

      WellX(1) = 35.0+1.0
      WellY(1) = 15.0+1.0
      WellZ(1) = 26.0
      Write(6,*) 'First Well Location: ',WellX(1)-1,WellY(1)-1,WellZ(1)

      WellX(2) = 20.0+1.0
      WellY(2) = 35.0+1.0
      WellZ(2) = 26.0
      Write(6,*) 'Second Well Location: ',WellX(2)-1,WellY(2)-1,WellZ(2)

      Write(6,*)

c     .....Set Initial and Boundary Values.....
      Do 400 k = NN,2,-1
       Do 401 i = 2,NN
       Read(4,*) (Pi(i,j,k),j=2,NN)
        Do 402 j = 2,NN
         If (Pi(i,j,k) .EQ. 0.0) Then
         constant(i,j,k) = 0.0
         Else If (i .EQ. WellX(1) .AND. j .EQ. Welly(1) .AND.
     *           k .EQ. WellZ(1)) Then
         Pi(i,j,k) = Pw(1)
         constant(i,j,k) = 0.001
         Else If (i .EQ. WellX(2) .AND. j .EQ. Welly(2) .AND.
     *           k .EQ. WellZ(2)) Then
         Pi(i,j,k) = Pw(2)
         constant(i,j,k) = 0.001
         Else
         constant(i,j,k) = 0.001
```

```
          End If
          PHI(i,j,k) = (Pi(i,j,k)**2.0)/(2.0*GV)
          PP(i,j,k) = PHI(i,j,k)
402       Continue
401      Continue
400     Continue

         Do 457 i = 2,NN
          Do 458 j = 2,NN
          Write(7,*) i-1,j-1,Pi(i,j,2),Pi(i,j,WellZ(1)),Pi(i,j,NN)
          Write(8,*) i-1,j-1,Pi(i,j,2),Pi(i,j,WellZ(2)),Pi(i,j,NN)
458       Continue
         Write(9,*) i-1,Pi(i,WellY(1),WellZ(1))
         Write(10,*) i-1,Pi(i,WellY(2),WellZ(2))
457      Continue

        Do 352 ww = 1,nw
         Do 350 i = WellX(ww)-1,WellX(ww)+1
          Do 351 j = WellY(ww)-1,WellY(ww)+1
          Pb(ww) = Pb(ww) + Pi(i,j,WellZ(ww))
          constanta(ww) = constanta(ww) + constant(i,j,WellZ(ww))
351       Continue
350      Continue
         Pb(ww) = (Pb(ww) - Pi(WellX(ww),WellY(ww),WellZ(ww)))/8.0

         constanta(ww) = (constanta(ww) -
     *                 constant(WellX(ww),WellY(ww),WellZ(ww)))/8.0

         Qmax(ww) = -1.0*((22.0/7.0)*constanta(ww)*(Pw(ww)**2 -
     *              Pb(ww)**2))/(Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)

352     Continue
```

```
      Write(6,*) ' Qmax: ',Qmax,' day-1'

300   ICOUNT = ICOUNT + 1
      Write(*,*) ' ICOUNT: ',ICOUNT
      Write(6,*) ' ICOUNT: ',ICOUNT
      Write(7,*) ' ICOUNT: ',ICOUNT
      Write(8,*) ' ICOUNT: ',ICOUNT
      Write(9,*) ' ICOUNT: ',ICOUNT
      Write(10,*) ' ICOUNT: ',ICOUNT
      COUNT = 0.0
      QT1 = 0.0
      QT2 = 0.0
      QT3 = 0.0
      QT = 0.0

c     .....Compute Pressure at First Step.....
c     .....Implicit in x direction.....
      t = t0 + Dt/3
      Pb = 0.0
      Write(6,*) ' First Step: ',t,' ','days'

      Do 532 ww = 1,nw
       Do 500 i = WellX(ww)-1,WellX(ww)+1
        Do 501 j = WellY(ww)-1,WellY(ww)+1
        Pb(ww) = Pb(ww) + Pi(i,j,WellZ(ww))
501     Continue
500    Continue
       Pb(ww) = (Pb(ww) - Pi(WellX(ww),WellY(ww),WellZ(ww)))/8.0
532   Continue

      Write(6,*)
```

```
      Do 550 i = 2,NN
       Do 551 k = 2,NN
        Do 552 j = 2,NN
311     o = j
        Call RATIOO (i,j,k,o,constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,
     *               Qmax,GV,re,rw,Qs1,Qs2,ratio,constant1,constant2,
     *               a,b,c,f)

        If (i .EQ. WellX(1) .AND. j .EQ. WellY(1) .AND.
     *     k .EQ. WellZ(1)) Then
        Qs1(j) = 0.0
        End If

        If (i .EQ. WellX(2) .AND. j .EQ. WellY(2) .AND.
     *     k .EQ. WellZ(2)) Then
        Qs2(j) = 0.0
        End If

        COUNT = COUNT + 1.0
        QT1(1) = QT1(1) + Qs1(j)
        QT1(2) = QT1(2) + Qs2(j)

        If (constant(i,j-1,k) .EQ. 0) Then
        PHI(i,j-1,k) = PP(i,j+1,k)
        PHI(i,j+1,k) = PP(i,j+1,k)
        PHI(i,j,k) = PP(i,j,k)
        Else If (constant(i,j+1,k) .EQ. 0) Then
        PHI(i,j+1,k) = PP(i,j-1,k)
        PHI(i,j-1,k) = PP(i,j-1,k)
        PHI(i,j,k) = PP(i,j,k)
        Else
        PHI(i,j-1,k) = PP(i,j-1,k)
```

```
PHI(i,j+1,k) = PP(i,j+1,k)
PHI(i,j,k) = PP(i,j,k)
End If

If (constant(i,j,k-1) .EQ. 0) Then
PHI(i,j,k-1) = PP(i,j,k+1)
PHI(i,j,k+1) = PP(i,j,k+1)
PHI(i,j,k) = PP(i,j,k)
Else If (constant(i,j,k+1) .EQ. 0) Then
PHI(i,j,k+1) = PP(i,j,k-1)
PHI(i,j,k-1) = PP(i,j,k-1)
PHI(i,j,k) = PP(i,j,k)
ELse
PHI(i,j,k-1) = PP(i,j,k-1)
PHI(i,j,k+1) = PP(i,j,k+1)
PHI(i,j,k) = PP(i,j,k)
End If

d(j) =  ratio(j)*PHI(i,j-1,k) + ratio(j)*PHI(i,j+1,k)
*     + ratio(j)*PHI(i,j,k-1) + ratio(j)*PHI(i,j,k+1)
*     + f(j)*PHI(i,j,k) + f(j)*PHI(i,j,k)
*     - constant1(j) - constant2(j)

If (WellZ(1) .EQ. WellZ(2) .AND. k .EQ. WellZ(1)) Then
 If (WellX(1) .EQ. WellX(2) .AND. i .EQ. WellX(1)) Then
  If (WellY(1) .GT. WellY(2) .AND. j .EQ. WellY(2)-1) Then
  o1 = 2.0
  o2 = WellY(2) - 1.0
  GOTO 310
  Else If (WellY(1) .GT. WellY(2) .AND. j .EQ. WellY(1)-1) Then
  o1 = WellY(2) + 1.0
  o2 = WellY(1) - 1.0
```

```
GOTO 310
Else If (WellY(1) .GT. WellY(2) .AND. j .EQ. NN) Then
o1 = WellY(1) + 1.0
o2 = NN
GOTO 310

Else If (WellY(1) .LT. WellY(2) .AND. j .EQ. WellY(2)-1) Then
o1 = WellY(1) + 1.0
o2 = WellY(2) - 1.0
GOTO 310
Else If (WellY(1) .LT. WellY(2) .AND. j .EQ. WellY(1)-1) Then
o1 = 2.0
o2 = WellY(1) - 1.0
GOTO 310
Else If (WellY(1) .LT. WellY(2) .AND. j .EQ. NN) Then
o1 = WellY(2) + 1.0
o2 = NN
GOTO 310

Else If (WellY(1) .EQ. WellY(2) .AND. j .EQ. WellY(1)-1) Then
o1 = 2.0
o2 = WellY(1) - 1.0
GOTO 310
Else If (WellY(1) .EQ. WellY(2) .AND. j .EQ. NN) Then
o1 = WellY(1) + 1.0
o2 = NN
GOTO 310
End If

Else If (WellX(1) .NE. WellX(2) .AND. i .EQ. WellX(1)) Then
If (j .EQ. WellY(1)-1) Then
o1 = 2.0
```

```
o2 = WellY(1) - 1.0
GOTO 310
Else If (j .EQ. NN) Then
o1 = WellY(1) + 1.0
o2 = NN
GOTO 310
End If

Else If (WellX(1) .NE. WellX(2) .AND. i .EQ. WellX(2)) Then
If (j .EQ. WellY(2)-1) Then
o1 = 2.0
o2 = WellY(2) - 1.0
GOTO 310
Else If (j .EQ. NN) Then
o1 = WellY(2) + 1.0
o2 = NN
GOTO 310
End If

Else
o1 = 2.0
o2 = NN
End If

Else If (WellZ(1) .NE. WellZ(2) .AND. k .EQ. WellZ(1)) Then
If (j .EQ. WellY(1)-1 .AND. i .EQ. WellX(1)) Then
o1 = 2.0
o2 = WellY(1) - 1.0
GOTO 310
Else If (j .EQ. NN) Then
o1 = WellY(1) + 1.0
o2 = NN
```

```
      GOTO 310
      End If

      Else If (WellZ(1) .NE. WellZ(2) .AND. k .EQ. WellZ(2)) Then
      If (j .EQ. WellY(2)-1 .AND. i .EQ. WellX(2)) Then
      o1 = 2.0
      o2 = WellY(2) - 1.0
      GOTO 310
      Else If (j .EQ. NN) Then
      o1 = WellY(2) + 1.0
      o2 = NN
      GOTO 310
      End If

      Else
      o1 = 2.0
      o2 = NN
      End If

552   Continue
310   Call TRIDAG (o1,o2,a,b,c,d,V)
      If (j .LT. NN) Then
      j = j + 1.0
      GOTO 311
      End If

      Do 553 j = 2,NN
      If (i .EQ. WellX(1) .AND. j .EQ. WellY(1) .AND.
     *   k .EQ. WellZ(1)) Then
      P1(i,j,k) = Pw(1)
      PHI(i,j,k) = (Pw(1)**2.0)/(2.0*GV)
```

```
      Else If (i .EQ. WellX(2) .AND. j .EQ. WellY(2) .AND.
     *         k .EQ. WellZ(2)) Then
      P1(i,j,k) = Pw(2)
      PHI(i,j,k) = (Pw(2)**2.0)/(2.0*GV)
      Else
      PHI(i,j,k) = V(j)
      PP(i,j,k) = PHI(i,j,k)
      P1(i,j,k) = SQRT(2.0*GV*PHI(i,j,k))
      End If
553   Continue
551   Continue
550   Continue

      QT1(1) = QT1(1)/(COUNT - 1.0)
      QT1(2) = QT1(2)/(COUNT - 1.0)

c     .....Compute Pressure at Second Step.....
c     .....Implicit in y direction.....
      t = t0 + (2*Dt/3)
      Pb = 0.0
      Write(6,*) ' Second Step: ',t,'  ','days'

      Do 632 ww = 1,nw
       Do 600 i = WellX(ww)-1,WellX(ww)+1
        Do 601 j = WellY(ww)-1,WellY(ww)+1
        Pb(ww) = Pb(ww) + P1(i,j,WellZ(ww))
601     Continue
600    Continue
       Pb(ww) = (Pb(ww) - P1(WellX(ww),WellY(ww),WellZ(ww)))/8.0
632   Continue

      Write(6,*)
```

```
      Do 650 j = 2,NN
       Do 651 k = 2,NN
        Do 652 i = 2,NN
321     o = i
        Call RATIOO (i,j,k,o,constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,
     *                 Qmax,GV,re,rw,Qs1,Qs2,ratio,constant1,constant2,
     *                 a,b,c,f)

        If (i .EQ. WellX(1) .AND. j .EQ. WellY(1) .AND.
     *     k .EQ. WellZ(1)) Then
        Qs1(i) = 0.0
        End If

        If (i .EQ. WellX(2) .AND. j .EQ. WellY(2) .AND.
     *     k .EQ. WellZ(2)) Then
        Qs2(i) = 0.0
        End If

        COUNT = COUNT + 1.0
        QT2(1) = QT2(1) + Qs1(i)
        QT2(2) = QT2(2) + Qs2(i)

        If (constant(i-1,j,k) .EQ. 0) Then
        PHI(i-1,j,k) = PP(i+1,j,k)
        PHI(i+1,j,k) = PP(i+1,j,k)
        PHI(i,j,k) = PP(i,j,k)
        Else If (constant(i+1,j,k) .EQ. 0) Then
        PHI(i+1,j,k) = PP(i-1,j,k)
        PHI(i-1,j,k) = PP(i-1,j,k)
        PHI(i,j,k) = PP(i,j,k)
```

```
Else
PHI(i-1,j,k) = PP(i-1,j,k)
PHI(i+1,j,k) = PP(i+1,j,k)
PHI(i,j,k) = PP(i,j,k)
End If

If (constant(i,j,k-1) .EQ. 0) Then
PHI(i,j,k-1) = PP(i,j,k+1)
PHI(i,j,k+1) = PP(i,j,k+1)
PHI(i,j,k) = PP(i,j,k)
Else If (constant(i,j,k+1) .EQ. 0) Then
PHI(i,j,k+1) = PP(i,j,k-1)
PHI(i,j,k-1) = PP(i,j,k-1)
PHI(i,j,k) = PP(i,j,k)
ELse
PHI(i,j,k-1) = PP(i,j,k-1)
PHI(i,j,k+1) = PP(i,j,k+1)
PHI(i,j,k) = PP(i,j,k)
End If

d(i) = ratio(i)*PHI(i-1,j,k) + ratio(i)*PHI(i+1,j,k)
*     + ratio(i)*PHI(i,j,k-1) + ratio(i)*PHI(i,j,k+1)
*     + f(i)*PHI(i,j,k) + f(i)*PHI(i,j,k)
*     - constant1(i) - constant2(i)

If (WellZ(1) .EQ. WellZ(2) .AND. k .EQ. WellZ(1)) Then
 If (WellY(1) .EQ. WellY(2) .AND. j .EQ. WellY(1)) Then
  If (WellX(1) .GT. WellX(2) .AND. i .EQ. WellX(2)-1) Then
  o1 = 2.0
  o2 = WellX(2) - 1.0
  GOTO 320
```

```
Else If (WellX(1) .GT. WellX(2) .AND. i .EQ. WellX(1)-1) Then
o1 = WellX(2) + 1.0
o2 = WellX(1) - 1.0
GOTO 320
Else If (WellX(1) .GT. WellX(2) .AND. i .EQ. NN) Then
o1 = WellX(1) + 1.0
o2 = NN
GOTO 320

Else If (WellX(1) .LT. WellX(2) .AND. i .EQ. WellX(2)-1) Then
o1 = WellX(1) + 1.0
o2 = WellX(2) - 1.0
GOTO 320
Else If (WellX(1) .LT. WellX(2) .AND. i .EQ. WellX(1)-1) Then
o1 = 2.0
o2 = WellX(1) - 1.0
GOTO 320
Else If (WellX(1) .LT. WellX(2) .AND. i .EQ. NN) Then
o1 = WellX(2) + 1.0
o2 = NN
GOTO 320

Else If (WellX(1) .EQ. WellX(2) .AND. i .EQ. WellX(1)-1) Then
o1 = 2.0
o2 = WellX(1) - 1.0
GOTO 320
Else If (WellX(1) .EQ. WellX(2) .AND. i .EQ. NN) Then
o1 = WellX(1) + 1.0
o2 = NN
GOTO 320
End If
```

```
Else If (WellY(1) .NE. WellY(2) .AND. j .EQ. WellY(1)) Then
 If (i .EQ. WellX(1)-1) Then
 o1 = 2.0
 o2 = WellX(1) - 1.0
 GOTO 320
 Else If (i .EQ. NN) Then
 o1 = WellX(1) + 1.0
 o2 = NN
 GOTO 320
 End If

Else If (WellY(1) .NE. WellY(2) .AND. j .EQ. WellY(2)) Then
 If (i .EQ. WellX(2)-1) Then
 o1 = 2.0
 o2 = WellX(2) - 1.0
 GOTO 320
 Else If (i .EQ. NN) Then
 o1 = WellX(2) + 1.0
 o2 = NN
 GOTO 320
 End If

Else
o1 = 2.0
o2 = NN
End If

Else If (WellZ(1) .NE. WellZ(2) .AND. k .EQ. WellZ(1)) Then
If (i .EQ. WellX(1)-1 .AND. j .EQ. WellY(1)) Then
o1 = 2.0
o2 = WellX(1) - 1.0
GOTO 320
```

```
       Else If (i .EQ. NN) Then
       o1 = WellX(1) + 1.0
       o2 = NN
       GOTO 320
       End If

      Else If (WellZ(1) .NE. WellZ(2) .AND. k .EQ. WellZ(2)) Then
       If (i .EQ. WellX(2)-1 .AND. j .EQ. WellY(2)) Then
       o1 = 2.0
       o2 = WellX(2) - 1.0
       GOTO 320
       Else If (i .EQ. NN) Then
       o1 = WellX(2) + 1.0
       o2 = NN
       GOTO 320
       End If

      Else
      o1 = 2.0
      o2 = NN
      End If

652   Continue
320   Call TRIDAG (o1,o2,a,b,c,d,V)
      f (i .LT. NN) Then
      i = i + 1.0
      GOTO 321
      End If

      Do 653 i = 2,NN
      If (i .EQ. WellX(1) .AND. j .EQ. WellY(1) .AND.
     *   k .EQ. WellZ(1)) Then
```

```
              P2(i,j,k) = Pw(1)
              PHI(i,j,k) = (Pw(1)**2.0)/(2.0*GV)
              Else If (i .EQ. WellX(2) .AND. j .EQ. WellY(2) .AND.
     *            k .EQ. WellZ(2)) Then
              P2(i,j,k) = Pw(2)
              PHI(i,j,k) = (Pw(2)**2.0)/(2.0*GV)
              Else
              PHI(i,j,k) = V(i)
              PP(i,j,k) = PHI(i,j,k)
              P2(i,j,k) = SQRT(2.0*GV*PHI(i,j,k))
              End If
653           Continue
651          Continue
650         Continue

            QT2(1) = QT2(1)/(COUNT - 1.0)
            QT2(2) = QT2(2)/(COUNT - 1.0)

c           .....Compute Pressure at Third Step.....
c           .....Implicit in z direction.....
            t = t0 + Dt
            Pb = 0.0
            Write(6,*) ' Third Step: ',t,' ','days'

            Do 732 ww = 1,nw
             Do 700 i = WellX(ww)-1,WellX(ww)+1
              Do 701 j = WellY(ww)-1,WellY(ww)+1
            Pb(ww) = Pb(ww) + P2(i,j,WellZ(ww))
701           Continue
700          Continue
             Pb(ww) = (Pb(ww) - P2(WellX(ww),WellY(ww),WellZ(ww)))/8.0
732         Continue
```

```
      Write(6,*)

      Do 750 k = 2,NN
       Do 751 i = 2,NN
        Do 752 j = 2,NN
331     o = j
        Call RATIOO (i,j,k,o,constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,
     *               Qmax,GV,re,rw,Qs1,Qs2,ratio,constant1,constant2,
     *               a,b,c,f)

        If (i .EQ. WellX(1) .AND. j .EQ. WellY(1) .AND.
     *      k .EQ. WellZ(1)) Then
        Qs1(j) = 0.0
        End If

        If (i .EQ. WellX(2) .AND. j .EQ. WellY(2) .AND.
     *      k .EQ. WellZ(2)) Then
        Qs2(j) = 0.0
        End If

        COUNT = COUNT + 1.0
        QT3(1) = QT3(1) + Qs1(j)
        QT3(2) = QT3(2) + Qs2(j)

        If (constant(i-1,j,k) .EQ. 0) Then
        PHI(i-1,j,k) = PP(i+1,j,k)
        PHI(i+1,j,k) = PP(i+1,j,k)
        PHI(i,j,k) = PP(i,j,k)
        Else If (constant(i+1,j,k) .EQ. 0) Then
        PHI(i+1,j,k) = PP(i-1,j,k)
        PHI(i-1,j,k) = PP(i-1,j,k)
        PHI(i,j,k) = PP(i,j,k)
```

```
Else
PHI(i-1,j,k) = PP(i-1,j,k)
PHI(i+1,j,k) = PP(i+1,j,k)
PHI(i,j,k) = PP(i,j,k)
End If

If (constant(i,j-1,k) .EQ. 0) Then
PHI(i,j-1,k) = PP(i,j+1,k)
PHI(i,j+1,k) = PP(i,j+1,k)
PHI(i,j,k) = PP(i,j,k)
Else If (constant(i,j+1,k) .EQ. 0) Then
PHI(i,j+1,k) = PP(i,j-1,k)
PHI(i,j-1,k) = PP(i,j-1,k)
PHI(i,j,k) = PP(i,j,k)
Else
PHI(i,j-1,k) = PP(i,j-1,k)
PHI(i,j+1,k) = PP(i,j+1,k)
PHI(i,j,k) = PP(i,j,k)
End If

d(j) = ratio(j)*PHI(i-1,j,k) + ratio(j)*PHI(i+1,j,k)
*      + ratio(j)*PHI(i,j-1,k) + ratio(j)*PHI(i,j+1,k)
*      + f(j)*PHI(i,j,k) + f(j)*PHI(i,j,k)
*      - constant1(j) - constant2(j)

If (WellZ(1) .EQ. WellZ(2) .AND. k .EQ. WellZ(1)) Then
 If (WellX(1) .EQ. WellX(2) .AND. i .EQ. WellX(1)) Then
  If (WellY(1) .GT. WellY(2) .AND. j .EQ. WellY(2)-1) Then
  o1 = 2.0
  o2 = WellY(2) - 1.0
  GOTO 330
  Else If (WellY(1) .GT. WellY(2) .AND. j .EQ. WellY(1)-1) Then
```

```
o1 = WellY(2) + 1.0
o2 = WellY(1) - 1.0
GOTO 330
Else If (WellY(1) .GT. WellY(2) .AND. j .EQ. NN) Then
o1 = WellY(1) + 1.0
o2 = NN
GOTO 330

Else If (WellY(1) .LT. WellY(2) .AND. j .EQ. WellY(2)-1) Then
o1 = WellY(1) + 1.0
o2 = WellY(2) - 1.0
GOTO 330
Else If (WellY(1) .LT. WellY(2) .AND. j .EQ. WellY(1)-1) Then
o1 = 2.0
o2 = WellY(1) - 1.0
GOTO 330
Else If (WellY(1) .LT. WellY(2) .AND. j .EQ. NN) Then
o1 = WellY(2) + 1.0
o2 = NN
GOTO 330

Else If (WellY(1) .EQ. WellY(2) .AND. j .EQ. WellY(1)-1) Then
o1 = 2.0
o2 = WellY(1) - 1.0
GOTO 330
Else If (WellY(1) .EQ. WellY(2) .AND. j .EQ. NN) Then
o1 = WellY(1) + 1.0
o2 = NN
GOTO 330
End If
```

```
Else If (WellX(1) .NE. WellX(2) .AND. i .EQ. WellX(1)) Then
 If (j .EQ. WellY(1)-1) Then
 o1 = 2.0
 o2 = WellY(1) - 1.0
 GOTO 330
 Else If (j .EQ. NN) Then
 o1 = WellY(1) + 1.0
 o2 = NN
 GOTO 330
 End If

Else If (WellX(1) .NE. WellX(2) .AND. i .EQ. WellX(2)) Then
 If (j .EQ. WellY(2)-1) Then
 o1 = 2.0
 o2 = WellY(2) - 1.0
 GOTO 330
 Else If (j .EQ. NN) Then
 o1 = WellY(2) + 1.0
 o2 = NN
 GOTO 330
 End If

Else
o1 = 2.0
o2 = NN
End If

Else If (WellZ(1) .NE. WellZ(2) .AND. k .EQ. WellZ(1)) Then
If (j .EQ. WellY(1)-1 .AND. i .EQ. WellX(1)) Then
o1 = 2.0
o2 = WellY(1) - 1.0
GOTO 330
```

```
        Else If (j .EQ. NN) Then
        o1 = WellY(1) + 1.0
        o2 = NN
        GOTO 330
        End If

       Else If (WellZ(1) .NE. WellZ(2) .AND. k .EQ. WellZ(2)) Then
        If (j .EQ. WellY(2)-1 .AND. i .EQ. WellX(1)) Then
        o1 = 2.0
        o2 = WellY(2) - 1.0
        GOTO 330
        Else If (j .EQ. NN) Then
        o1 = WellY(2) + 1.0
        o2 = NN
        GOTO 330
        End If

       Else
       o1 = 2.0
       o2 = NN
       End If

752    Continue
330    Call TRIDAG (o1,o2,a,b,c,d,V)
       If (j .LT. NN) Then
       j = j + 1.0
       GOTO 331
       End If

       Do 753 j = 2,NN
       If (i .EQ. WellX(1) .AND. j .EQ. WellY(1) .AND.
     *   k .EQ. WellZ(1)) Then
```

```
      P(i,j,k) = Pw(1)
      PHI(i,j,k) = (Pw(1)**2.0)/(2.0*GV)
      Else If (i .EQ. WellX(2) .AND. j .EQ. WellY(2) .AND.
*           k .EQ. WellZ(2)) Then
      P(i,j,k) = Pw(2)
      PHI(i,j,k) = (Pw(2)**2.0)/(2.0*GV)
      Else
      PHI(i,j,k) = V(j)
      P(i,j,k) = SQRT(2.0*GV*PHI(i,j,k))
      End If
      PP(i,j,k) = PHI(i,j,k)
      Pi(i,j,k) = P(i,j,k)
753   Continue
751  Continue
750 Continue

    QT3(1) = QT3(1)/(COUNT - 1.0)
    QT3(2) = QT3(2)/(COUNT - 1.0)

    Do 757 i = 2,NN
     Do 758 j = 2,NN
     If (ICOUNT .EQ. 1.0 .OR. ICOUNT .EQ. 5.0 .OR. ICOUNT .EQ. 10.0
*      .OR. ICOUNT .EQ. 15.0 .OR. ICOUNT .EQ. 20.0
*      .OR. ICOUNT .EQ. 35.0 .OR.  ICOUNT .EQ. 51.0) Then

     Write(7,*) i-1,j-1,P(i,j,2),P(i,j,WellZ(1)),P(i,j,NN)
     Write(8,*) i-1,j-1,P(i,j,2),P(i,j,WellZ(2)),P(i,j,NN)

     End If

758  Continue
    Write(9,*) i-1,P(i,WellY(1),WellZ(1))
```

```
      Write(10,*) i-1,P(i,WellY(2),WellZ(2))
757   Continue

      Do 775 ww = 1,nw
      QT(ww) = QT1(ww) + QT2(ww) + QT3(ww)
775   Continue

      Write(11,*) t,QT

c     .....Checking Conditions.....
      Do 950 ww = 1,nw
      DQT(ww) = ABS(QTOld(ww) - QT(ww))
      QTOld(ww) = QT(ww)
950   Continue

      t0 = t
      If (Pb(1) .LE. 1000.0 .AND. Pb(2) .LE. 1000.0 .OR.
     *    DQT(1) .LE. 0.00001 .AND. DQT(2) .LE. 0.00001 .AND.
     *    DQT(1) .NE. 0.0 .AND. DQT(2) .NE. 0.0) Then
      Year = INT(t/365.0)
      Day = t - (Year*365.0)
      Write(6,*) ' Production Time: ',Year,' ','years',Day,' ','days'
      Write(*,*) ' Production Time: ',Year,' ','years',Day,' ','days'
      Stop
      Else
      GOTO 300
      End If

      CLOSE(6)
      CLOSE(7)
      CLOSE(8)
      CLOSE(9)
```

```
      CLOSE(10)

      Stop
      End

      Subroutine RATIOO (i,j,k,o,constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,
     *                  Qmax,GV,re,rw,Qs1,Qs2,ratio,constant1,constant2,
     *                  a,b,c,f)
c     .....Set Coefficient Array a, b, and c.....

      IMPLICIT NONE
      Integer i,j,k,o
      Real constant,Dt,Beta,Dx,Alpha,PHI,Pb,Pw,Z,Check
      Real GV,re,rw,Qs1,Qs2,ratio,constant1,constant2,a,b,c,f,Qmax
      Dimension PHI(103,103,103),constant(103,103,103)
      Dimension ratio(103),constant1(103),constant2(103)
      Dimension a(103),b(103),c(103),f(103),Qs1(103),Qs2(103)
      Dimension Qmax(2),Check(2),Pb(2),Pw(2)

      Qs1(o) = Qmax(1)
      Qs2(o) = Qmax(2)

      If (constant(i,j,k) .EQ. 0) Then
      Qs1(o) = -1.0*((22.0/7.0)*constant(i,j,k)*(Pw(1)**2 - Pb(1)**2.0))
     *        /(Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)

      Qs2(o) = -1.0*((22.0/7.0)*constant(i,j,k)*(Pw(2)**2 - Pb(2)**2.0))
     *        /(Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)
      GOTO 901
```

```
      Else
      Check(1) = -1.0*(Qs1(o)*Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)
     *           /((22.0/7.0)*constant(i,j,k)) + Pb(1)**2

      Check(2) = -1.0*(Qs2(o)*Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)
     *           /((22.0/7.0)*constant(i,j,k)) + Pb(2)**2

      End If

      If (Check(1) .LE. 0) Then
      Qs1(o) = -1.0*((22.0/7.0)*constant(i,j,k)*(Pw(1)**2 - Pb(1)**2.0))
     *          /(Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)

      Else
      Pw(1) = SQRT(-1.0*(Qs1(o)*Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)
     *                 /((22.0/7.0)*constant(i,j,k)) + Pb(1)**2)

      End If

      If (Check(2) .LE. 0) Then
      Qs2(o) = -1.0*((22.0/7.0)*constant(i,j,k)*(Pw(2)**2 - Pb(2)**2.0))
     *          /(Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)

      Else
      Pw(2) = SQRT(-1.0*(Qs2(o)*Z*Alpha*GV*(ALOG(re/rw)-0.5)*Dx**2.0)
     *                 /((22.0/7.0)*constant(i,j,k)) + Pb(2)**2)

      End If

901   ratio(o) = constant(i,j,k)*Dt*SQRT(PHI(i,j,k))
     *          /(3.0*Beta*Dx**2.0)
```

```
      constant1(o) = Alpha*SQRT(PHI(i,j,k))*Qs1(o)*Dt/(3.0*Beta)
      constant2(o) = Alpha*SQRT(PHI(i,j,k))*Qs2(o)*Dt/(3.0*Beta)

      a(o) = -1.0*ratio(o)
      b(o) = 1.0+(2.0*ratio(o))
      c(o) = -1.0*ratio(o)
      f(o) = (1.0-(4.0*ratio(o)))/2.0

      Return
      End

      Subroutine TRIDAG (First,Last,a,b,c,d,V)
c     .....Procedure for solving a system of simultaneous.....
c     .....Linear equation with a tri-diagonal coefficient matrix.....

      IMPLICIT NONE
      Integer e,First,Last
      Real a,b,c,d,V,beta,gamma
      Dimension a(103),b(103),c(103),d(103)
      Dimension beta(103),gamma(103),V(103)

c     .....Compute Intermediate Arrays Beta and Gamma.....
      beta(First) = b(First)
      gamma(First) = d(First)/beta(First)

      Do 950 e = First+1,Last
      beta(e) = b(e)-((a(e)*c(e-1))/beta(e-1))
      gamma(e) = (d(e)-(a(e)*gamma(e-1)))/beta(e)
950   Continue
```

```
c       .....Compute Pressure.....
        V(Last) = gamma(Last)
        Do 951 e = Last-1,First,-1
         V(e) = gamma(e)-(c(e)*V(e+1))/beta(e)
951     Continue

        Return
        End
```

CURRICULUM VITAE

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