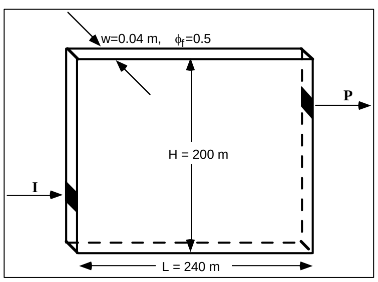
TOUGH Training Courses

Problem EOS1:

A. Heat Sweep
B. Five-Sport Geothermal Injection-Production (MINC)

Earth Sciences Division
Lawrence Berkeley National Laboratory
Berkeley, California

Heat Sweep in a Vertical Fracture



Summary of EOS1

Components	# 1: water # 2: "water 2" (optional)
Parameter choices	
(NK, NEQ, NPH, NB) =	(1, 2, 2, 6) one water component, nonisothermal (default) (1, 1, 2, 6) only liquid, or only vapor; isothermal (2, 3, 2, 6) two-waters, nonisothermal*
molecular diffusion can be modeled by setting NK = 2, NB = 8	
Primary Variables	
single-phase conditions	(P, T, [X]) - (pressure, temperature, [mass fraction of water 2]†)
two-phase conditions	(P_g, S_g, [X]) - (gas phase pressure, gas saturation, [mass fraction of water 2]†)

* two waters cannot be run in isothermal mode, because in this case temperature is not the last primary variable
† optional, for NK = 2 only

```
*rvf* - vertical fracture problem for EOS1
ROCKS----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
FRACT          2650.       .50  200.E-12  200.E-12  200.E-12       0.00     1000.
CONBD          2650.       .00    0.E-12    0.E-12    0.E-12        2.1     1000.

START----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
----*----1 MOP: 123456789*123456789*1234 ---*----5----*----6----*----7----*----8
PARAM----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
   1  40      99100000000000001
           1.57788E8       -1.          A1312           9.81
      1.E2       9.E2       9.E3       9.E4       9.E5       2.E6       5.E6
     1.E-5
              100.E5                  300.
SOLVR----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
5  Z1   O0    8.0e-1    1.0e-7
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
A18 1INJ 1                        COM1         4.     4.2E5
A1312PRO 1                        DELV     4.E-12    9.65E6

FOFT ----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
A1312

ENDCY----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
INCON----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8

MULTI
    1    1    2    6
ENDCY----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
con00          CONBD
MESHMAKER1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
XYZ
       90.
NX      12        20.
NY      10        20.
NZ       1        .04


ENDFI----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
MULTI----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
    2    3    2    6
A18 1INJ 1                        COM2         4.     4.2E5
```

3 Run Segments

(1) MESH generation, followed by “hand-editing.”

(2) Obtain gravity equilibrium.

(3) Perform injection-production simulation.

3

MESH Pattern

```
**************************************************************************************
*                    CARTESIAN MESH WITH NX*NY*NZ =   12 *  10 *   1  GRID BLOCKS
**************************************************************************************
*
*                    THE MESH WILL BE PRINTED AS SLICES FOR K = 1 TO K = NZ =   1
*
*                    IN EACH MESH SLICE, ROWS WILL GO FROM  J = 1 TO J = NY =  10
*
*                    IN EACH ROW, COLUMNS WILL GO FROM      I = 1 TO I = NX =  12
*
**************************************************************************************

SLICE WITH K =   1

  COLUMN I =  1     2     3     4     5     6     7     8     9    10    11    12    1
ROWS
 J =    1   A11 1 A11 2 A11 3 A11 4 A11 5 A11 6 A11 7 A11 8 A11 9 A1110 A1111 A1112
 J =    2   A12 1 A12 2 A12 3 A12 4 A12 5 A12 6 A12 7 A12 8 A12 9 A1210 A1211 A1212
 J =    3   A13 1 A13 2 A13 3 A13 4 A13 5 A13 6 A13 7 A13 8 A13 9 A1310 A1311 A1312
 J =    4   A14 1 A14 2 A14 3 A14 4 A14 5 A14 6 A14 7 A14 8 A14 9 A1410 A1411 A1412
 J =    5   A15 1 A15 2 A15 3 A15 4 A15 5 A15 6 A15 7 A15 8 A15 9 A1510 A1511 A1512
 J =    6   A16 1 A16 2 A16 3 A16 4 A16 5 A16 6 A16 7 A16 8 A16 9 A1610 A1611 A1612
 J =    7   A17 1 A17 2 A17 3 A17 4 A17 5 A17 6 A17 7 A17 8 A17 9 A1710 A1711 A1712
 J =    8   A18 1 A18 2 A18 3 A18 4 A18 5 A18 6 A18 7 A18 8 A18 9 A1810 A1811 A1812
 J =    9   A19 1 A19 2 A19 3 A19 4 A19 5 A19 6 A19 7 A19 8 A19 9 A1910 A1911 A1912
 J =   10   A1A 1 A1A 2 A1A 3 A1A 4 A1A 5 A1A 6 A1A 7 A1A 8 A1A 9 A1A10 A1A11 A1A12

**************************************************************************************

MESH GENERATION COMPLETE --- EXIT FROM MODULE *MESHMAKER*
```

4

Semi-Analytical Heat Exchange

(Vinsome and Westerveld, 1980)

- Each boundary grid block is connected to a semi-infinite conductive half-space (block `ELEME`).
- Temperature profile is assumed as a low-order polynomial with an exponential tail (`MOP(15)`).

$$T(x,t) - T_i = \left(T_f - T_i + px + qx^2\right)\exp(-x/d)$$

- Penetration depth *d* for heat conduction is $d = \sqrt{\Theta t}/2$

$$\Theta = \lambda/(\rho C)$$

- Coefficients *p* and *q* are determined during the flow simulation from two constraints,
  - (1) energy conservation for the reservoir/caprock system
  - (2) diffusion equation for heat conduction must be satisfied at caprock boundary.

5

Invoking Semi-Analytic Heat Exchange

- Manual, Section 7.4
- Block `ELEME`, heat exchange area
- Thermal properties from last element (add dummy element at end of block `ELEME` and special rock type for this element holding properties of confining layers)
- Initial temperature for last (dummy) element (add initial conditions for dummy element)
- Block `PARAM`, `MOP(15)=1`

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Simulation Results for Heat Sweep in Vertical Fracture Problem

```
================================================================================================================================
PERFORM SEMI-ANALYTICAL HEAT EXCHANGE CALCULATION
     THERMAL PARAMETERS ARE:
     TEMPERATURE =  0.30000E+03   HEAT CONDUCTIVITY =  0.21000E+01   DENSITY =  0.26500E+04   SPECIFIC HEAT =  0.10000E+04
     DIFFUSIVITY =  0.79245E-06
================================================================================================================================


...ITERATING...  AT [   1,  1] --- DELTEX = 0.100000E+03   MAX. RES. = 0.698170E-01  AT ELEMENT A18 1  EQUATION   1
...ITERATING...  AT [   1,  2] --- DELTEX = 0.100000E+03   MAX. RES. = 0.980877E-03  AT ELEMENT A18 1  EQUATION   2
A1312(   1,  3) ST = 0.100000E+03 DT = 0.100000E+03 DX1= 0.514076E+05 DX2= 0.105693E-01 T = 300.011 P =  9702648. S = 0.000000E+00
...ITERATING...  AT [   2,  1] --- DELTEX = 0.900000E+03   MAX. RES. = 0.141105E+00  AT ELEMENT A18 1  EQUATION   2
...ITERATING...  AT [   2,  2] --- DELTEX = 0.900000E+03   MAX. RES. = 0.196414E-01  AT ELEMENT A18 1  EQUATION   1
...ITERATING...  AT [   2,  3] --- DELTEX = 0.900000E+03   MAX. RES. = 0.526790E-04  AT ELEMENT A18 1  EQUATION   1
A1312(   2,  4) ST = 0.100000E+04 DT = 0.900000E+03 DX1= 0.523779E+05 DX2= 0.265024E-02 T = 300.013 P =  9755026. S = 0.000000E+00
...ITERATING...  AT [   3,  1] --- DELTEX = 0.900000E+04   MAX. RES. = 0.150119E+01  AT ELEMENT A18 1  EQUATION   2
...ITERATING...  AT [   3,  2] --- DELTEX = 0.900000E+04   MAX. RES. = 0.497225E+00  AT ELEMENT A18 1  EQUATION   1
...ITERATING...  AT [   3,  3] --- DELTEX = 0.900000E+04   MAX. RES. = 0.192776E-02  AT ELEMENT A19 1  EQUATION   1
...ITERATING...  AT [   3,  4] --- DELTEX = 0.900000E+04   MAX. RES. = 0.128494E-04  AT ELEMENT A18 1  EQUATION   1
A1312(   3,  5) ST = 0.100000E+05 DT = 0.900000E+04 DX1= 0.147957E+05 DX2= -.104035E-01 T = 300.003 P =  9769821. S = 0.000000E+00
...ITERATING...  AT [   4,  1] --- DELTEX = 0.900000E+05   MAX. RES. = 0.123039E+02  AT ELEMENT A18 1  EQUATION   2
...ITERATING...  AT [   4,  2] --- DELTEX = 0.900000E+05   MAX. RES. = 0.588510E+01  AT ELEMENT A18 1  EQUATION   1
...ITERATING...  AT [   4,  3] --- DELTEX = 0.900000E+05   MAX. RES. = 0.344128E-01  AT ELEMENT A19 1  EQUATION   1
...ITERATING...  AT [   4,  4] --- DELTEX = 0.900000E+05   MAX. RES. = 0.423972E-03  AT ELEMENT A1A 2  EQUATION   1
A1312(   4,  5) ST = 0.100000E+06 DT = 0.900000E+05 DX1= 0.447701E+04 DX2= -.143131E-01 T = 299.989 P =  9774298. S = 0.000000E+00
...ITERATING...  AT [   5,  1] --- DELTEX = 0.900000E+06   MAX. RES. = 0.698636E+02  AT ELEMENT A18 1  EQUATION   2
...ITERATING...  AT [   5,  2] --- DELTEX = 0.900000E+06   MAX. RES. = 0.369906E+02  AT ELEMENT A1A 3  EQUATION   1
...ITERATING...  AT [   5,  3] --- DELTEX = 0.900000E+06   MAX. RES. = 0.149552E+01  AT ELEMENT A18 3  EQUATION   2
...ITERATING...  AT [   5,  4] --- DELTEX = 0.900000E+06   MAX. RES. = 0.367687E-01  AT ELEMENT A1A 3  EQUATION   1
...ITERATING...  AT [   5,  5] --- DELTEX = 0.900000E+06   MAX. RES. = 0.161956E-03  AT ELEMENT A1A 3  EQUATION   1
A1312(   5,  6) ST = 0.100000E+07 DT = 0.900000E+06 DX1= 0.151037E+04 DX2= -.245659E+00 T = 299.743 P =  9775809. S = 0.000000E+00
...
...
```

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Simulation Results for Heat Sweep in Vertical Fracture Problem

```
...
...
...ITERATING...  AT [  37,  1] --- DELTEX = 0.478800E+07   MAX. RES. = 0.101777E+01  AT ELEMENT A12 1  EQUATION   2
...ITERATING...  AT [  37,  2] --- DELTEX = 0.478800E+07   MAX. RES. = 0.814304E-01  AT ELEMENT A1112  EQUATION   1
...ITERATING...  AT [  37,  3] --- DELTEX = 0.478800E+07   MAX. RES. = 0.137360E-03  AT ELEMENT A1312  EQUATION   1
A1312(  37,  4) ST = 0.157788E+09 DT = 0.478800E+07 DX1= 0.662944E+03 DX2= -.117867E+01 T = 203.245 P =  9804004. S = 0.000000E+00

*rvf* - vertical fracture problem for EOS1

        OUTPUT DATA AFTER (  37,  4)-2-TIME STEPS                                               THE TIME IS  0.18262E+04 DAYS

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@

  TOTAL TIME   KCYC   ITER  ITERC    KON    DX1M        DX2M        DX3M                     RERM        NER    KER    DELTEX
 0.15779E+09     37      4    159      2 0.226297E+04 0.189794E+01 0.000000E+00            0.616901E-07   112      1 0.478800E+07

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@

ELEM.  INDEX     P          T          SG          SW          X1          X2       PCAP                         DG          DW
               (PA)      (DEG-C)                                                   (PA)                      (KG/M**3)   (KG/M**3)

A11 1     1 0.95547E+07 0.23076E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.14192E+02 0.83273E+03
A12 1     2 0.97248E+07 0.18326E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.55399E+01 0.88931E+03
A13 1     3 0.99054E+07 0.15080E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.26002E+01 0.92145E+03
A14 1     4 0.10094E+08 0.12962E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.14807E+01 0.94005E+03
A15 1     5 0.10289E+08 0.11607E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.99691E+00 0.95103E+03
A16 1     6 0.10493E+08 0.10749E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.76327E+00 0.95763E+03
A17 1     7 0.10708E+08 0.10223E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.64360E+00 0.96157E+03
A18 1     8 0.10948E+08 0.99278E+02 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.58345E+00 0.96378E+03
A19 1     9 0.11096E+08 0.10288E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.65745E+00 0.96128E+03
A1A 1    10 0.11269E+08 0.11178E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.87383E+00 0.95479E+03
A11 2    11 0.95537E+07 0.23141E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.14361E+02 0.83186E+03
A12 2    12 0.97235E+07 0.18550E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.58134E+01 0.88693E+03
A13 2    13 0.99034E+07 0.15447E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.28490E+01 0.91806E+03
A14 2    14 0.10090E+08 0.13402E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00           0.16733E+01 0.93635E+03
...
...
```

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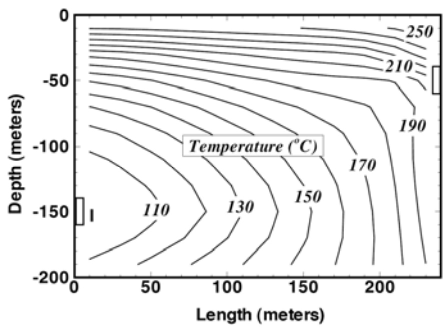
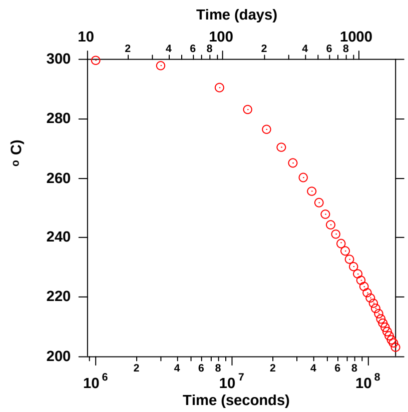
Simulation Results for Heat Sweep in Vertical Fracture Problem

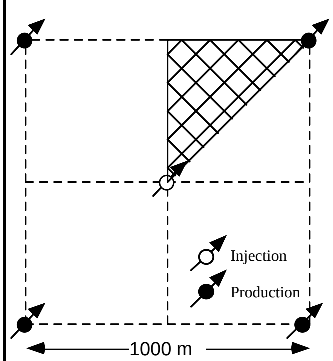


Temperature distribution in fracture plane after 5 years. Injection and production regions are marked I and P, respectively.



Produced fluid temperature versus time.

Five-Spot Geothermal Production/Injection Problem



Formation	
Rock grain density	2650 kg/m^3
Specific heat	1000 J/kgÞC
Heat conductivity	2.1 W/mÞC
Permeable volume fraction	2%
Porosity in permeable domain	50%
Impermeable blocks: cubes with side length	50m, 250 m
Permeability	6.0x10^{-15} m^2
Thickness	305 m
Relative permeability: Corey curves	
irreducible liquid saturation	0.30
irreducible gas saturation	0.05
Initial Conditions	
Temperature	300 ÞC
Liquid saturation	0.99
Pressure	85.93 bar
Production/Injection	
Pattern area	1 km^2
Distance between producers and injectors	707.1 m
Production rate*	30 kg/s
Injection rate*	30 kg/s
Injection enthalpy	500 kJ/kg

* Full well basis

Input File for Five-Spot Problem

Summary of EOS1

Components	# 1: water # 2: “water 2” (optional)
Parameter choices	
(NK, NEQ, NPH, NB) =	(1, 2, 2, 6) one water component, nonisothermal (default) (1, 1, 2, 6) only liquid, or only vapor; isothermal (2, 3, 2, 6) two-waters, nonisothermal*
molecular diffusion can be modeled by setting NK = 2, NB = 8	
Primary Variables	
single-phase conditions	(P, T, [X]) - (pressure, temperature, [mass fraction of water 2]†)
two-phase conditions	(P_g, S_g, [X]) - (gas phase pressure, gas saturation, [mass fraction of water 2]†)

* two waters cannot be run in isothermal mode, because in this case temperature is not the last primary variable

† optional, for NK = 2 only

```
*rfp* - 36 BLOCKS PARALLEL FIVE-SPOT GRID (CF. SPE-18426)
ROCKS----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
POMED          2650.       .01    6.E-15    6.E-15    6.E-15        2.1     1000.
FRACT          2650.       .50    6.E-15    6.E-15    6.E-15        2.1     1000.
MATRX          2650.    1.E-10    0.E-15    0.E-15    0.E-15        2.1     1000.

START----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
----*----1 MOP: 123456789*123456789*1234 ---*----5----*----6----*----7----*----8
PARAM----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
   1  99      9900000000000000 4 0
          1.151852E9       -1. 3.15576E7 KA 1
      1.E5
     1.E-5                                              1.E-8
                300.                0.01                 5.E5
RPCAP----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
    3     .30       .05
    1               1.
TIMES----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
    2    2
 1.57788E8 7.88940E8
GENER----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
 AA 1INJ 1                        MASS       3.75      5.0E5
 KA 1PRO 1                        MASS      -3.75

ELEME----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
 AA 1          POMED0.1906E+060.1250E+04          0.         0.          0.1525E+03
 BA 1          POMED0.7625E+060.5000E+04          0.7071E+020.           0.1525E+03
 CA 1          POMED0.7625E+060.5000E+04          0.1414E+030.           0.1525E+03
 DA 1          POMED0.7625E+060.5000E+04          0.2121E+030.           0.1525E+03
 EA 1          POMED0.7625E+060.5000E+04          0.2828E+030.           0.1525E+03
 FA 1          POMED0.7625E+060.5000E+04          0.3536E+030.           0.1525E+03
 GA 1          POMED0.7625E+060.5000E+04          0.4243E+030.           0.1525E+03
 HA 1          POMED0.7625E+060.5000E+04          0.4950E+030.           0.1525E+03
 IA 1          POMED0.7625E+060.5000E+04          0.5657E+030.           0.1525E+03
 JA 1          POMED0.7625E+060.5000E+04          0.6364E+030.           0.1525E+03
 KA 1          POMED0.1906E+060.1250E+04          0.7071E+030.           0.1525E+03
 BB 1          POMED0.7625E+060.5000E+04          0.7071E+020.7071E+020.1525E+03
 CB 1          POMED0.1525E+070.1000E+05          0.1414E+030.7071E+020.1525E+03
...
 GE 1          POMED0.7625E+060.5000E+04          0.4243E+030.2828E+030.1525E+03
 FF 1          POMED0.3812E+060.2500E+04          0.3536E+030.3536E+030.1525E+03
HTX00          POMED        0.

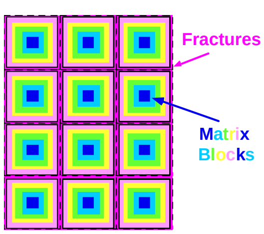
CONNE----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
 AA 1 BA 1                    10.3536E+020.3536E+020.1078E+05
 BA 1 CA 1                    10.3536E+020.3536E+020.1078E+05
 BA 1 BB 1                    20.3536E+020.3536E+020.2157E+05
 CA 1 DA 1                    10.3536E+020.3536E+020.1078E+05
...
 FE 1 GE 1                    10.3536E+020.3536E+020.2157E+05
 FE 1 FF 1                    20.3536E+020.3536E+020.2157E+05

INCON----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8

MESHMAKER1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
MINC
PART THRED     DFLT
  5  4OUT        50.
       .02       .08       .20       .35

ENDCY----1----*----2----*----3----*----4----*----5----*----6----*----7----*----8
```


MINC Preprocessing for Five-Spot Problem



MINC sub-gridding

```
************************************************************************************************************
*                  MESHMAKER - MINC: GENERATE MULTIPLE INTERACTING CONTINUA MESH FOR FRACTURED MEDIUM
************************************************************************************************************

FILE *MINC* EXISTS --- OPEN AS AN OLD FILE

CHOICE OF MATRIX-MATRIX FLOW HANDLING: "DFLT "

                      THE OPTIONS ARE: "     " (DEFAULT), NO GLOBAL MATRIX-MATRIX FLOW; GLOBAL FLOW ONLY THROUGH FRAC
                                       "MMVER", GLOBAL MATRIX-MATRIX FLOW IN VERTICAL DIRECTION ONLY
                                       "MMALL", GLOBAL MATRIX-MATRIX FLOW IN ALL DIRECTIONS



==================== GEOMETRY DATA, NORMALIZED TO A DOMAIN OF UNIT VOLUME ========================

 CONTINUUM     IDENTIFIER       VOLUME      NODAL DISTANCE      INTERFACE AREA   INTERFACE DISTANCE
                                                                                  FROM FRACTURES

 1-FRACTURES       * *          .20000E-01     .00000E+00
                                                                   .11760E+00         .00000E+00
 2-MATRIX          *2*          .80000E-01     .34984E+00
                                                                   .11111E+00         .69967E+00
 3-MATRIX          *3*          .20000E+00     .97637E+00
                                                                   .93970E-01         .26524E+01
 4-MATRIX          *4*          .35000E+00     .23051E+01
                                                                   .59197E-01         .72627E+01
 5-MATRIX          *5*          .35000E+00     .35475E+01

==================================================================================================

READ PRIMARY MESH FROM FILE *MESH*
           THE PRIMARY MESH HAS   37 ELEMENTS (   36 ACTIVE) AND   55 CONNECTIONS (INTERFACES) BETWEEN THEM

WRITE SECONDARY MESH ON FILE *MINC*
         THE SECONDARY MESH HAS  181 ELEMENTS (  180 ACTIVE) AND  199 CONNECTIONS (INTERFACES) BETWEEN THEM

************************************************************************************************************

MESH GENERATION COMPLETE --- EXIT FROM MODULE *MESHMAKER*
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Selected Output for Five-Spot Problem

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 KA 1(   1,  6) ST = 0.100000E+06 DT = 0.100000E+06 DX1= -.187193E+06 DX2= 0.199814E+00 T = 298.440 P =  8405499. S = 0.209814E+00
 KA 1(   2,  5) ST = 0.200000E+06 DT = 0.100000E+06 DX1= -.299737E+06 DX2= 0.772235E-01 T = 295.886 P =  8105763. S = 0.287037E+00
 KA 1(   3,  5) ST = 0.300000E+06 DT = 0.100000E+06 DX1= -.330969E+06 DX2= 0.266975E-01 T = 292.981 P =  7774793. S = 0.313735E+00
 KA 1(   4,  4) ST = 0.400000E+06 DT = 0.100000E+06 DX1= -.338081E+06 DX2= 0.171490E-01 T = 289.914 P =  7436712. S = 0.330884E+00
 KA 1(   5,  4) ST = 0.600000E+06 DT = 0.200000E+06 DX1= -.749332E+06 DX2= 0.325956E-01 T = 282.716 P =  6687380. S = 0.363479E+00
 KA 1(   6,  6) ST = 0.100000E+07 DT = 0.400000E+06 DX1= -.972591E+06 DX2= 0.260141E-01 T = 272.391 P =  5714789. S = 0.389494E+00
 KA 1(   7,  4) ST = 0.140000E+07 DT = 0.400000E+06 DX1= -.187123E+06 DX2= -.145613E-01 T = 270.253 P =  5527666. S = 0.374932E+00
 KA 1(   8,  4) ST = 0.220000E+07 DT = 0.800000E+06 DX1= 0.151570E+06 DX2= -.262760E-01 T = 271.989 P =  5679236. S = 0.348656E+00
 KA 1(   9,  4) ST = 0.380000E+07 DT = 0.160000E+07 DX1= 0.103832E+06 DX2= -.138883E-01 T = 273.158 P =  5783068. S = 0.334768E+00
 KA 1(  10,  4) ST = 0.700000E+07 DT = 0.320000E+07 DX1= -.384188E+05 DX2= -.573952E-02 T = 272.728 P =  5744649. S = 0.329028E+00
 KA 1(  11,  5) ST = 0.134000E+08 DT = 0.640000E+07 DX1= -.265089E+05 DX2= -.714484E-02 T = 272.429 P =  5718140. S = 0.321884E+00
 KA 1(  12,  4) ST = 0.198000E+08 DT = 0.640000E+07 DX1= 0.268056E+06 DX2= -.181049E-01 T = 275.399 P =  5986196. S = 0.303779E+00
 KA 1(  13,  5) ST = 0.326000E+08 DT = 0.128000E+08 DX1= -.452421E+03 DX2= -.184674E-02 T = 275.394 P =  5985744. S = 0.301932E+00
 KA 1(  14,  4) ST = 0.454000E+08 DT = 0.128000E+08 DX1= -.720842E+05 DX2= 0.817172E-03 T = 274.606 P =  5913660. S = 0.302749E+00
 KA 1(  15,  4) ST = 0.710000E+08 DT = 0.256000E+08 DX1= -.277187E+06 DX2= 0.741455E-02 T = 271.503 P =  5636472. S = 0.310164E+00
 KA 1(  16,  8) ST = 0.102558E+09 DT = 0.315576E+08 DX1= -.567330E+05 DX2= -.246617E-02 T = 270.854 P =  5579740. S = 0.307697E+00
 KA 1(  17,  5) ST = 0.134115E+09 DT = 0.315576E+08 DX1= -.586688E+05 DX2= -.702594E-03 T = 270.177 P =  5521071. S = 0.306995E+00
 KA 1(  18,  5) ST = 0.157788E+09 DT = 0.236728E+08 DX1= -.659228E+05 DX2= 0.861114E-03 T = 269.410 P =  5455148. S = 0.307856E+00

*rfp* - 36 BLOCKS PARALLEL FIVE-SPOT GRID (CF. SPE-18426)

        OUTPUT DATA AFTER (  18,  5)-2-TIME STEPS                                                      THE TIME IS  0.18262E+04 DAYS

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  TOTAL TIME    KCYC    ITER  ITERC     KON     DX1M          DX2M          DX3M                         RERM         NER     KER     DELTEX
 0.15779E+09      18       5     86       2 0.637088E+06 0.299967E+03 0.000000E+00                 0.496278E-08    51       2 0.236728E+08

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ELEM.  INDEX     P           T           SG          SW          X1          X2         PCAP                              DG          DW
                (PA)       (DEG-C)                                                      (PA)                          (KG/M**3)   (KG/M**3)

 AA 1      1 0.10328E+08 0.13023E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00                 0.15064E+01 0.93966E+03
2AA 1      2 0.28326E+06 0.13159E+03 0.24435E+00 0.75565E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.15648E+01 0.93320E+03
3AA 1      3 0.33065E+06 0.13689E+03 0.24068E+00 0.75932E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.18092E+01 0.92862E+03
4AA 1      4 0.48442E+06 0.15066E+03 0.23053E+00 0.76947E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.25906E+01 0.91616E+03
5AA 1      5 0.89267E+06 0.17501E+03 0.21023E+00 0.78977E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.46191E+01 0.89215E+03
 BA 1      6 0.93995E+07 0.18697E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00                 0.59990E+01 0.88513E+03
2BA 1      7 0.12159E+07 0.18856E+03 0.19746E+00 0.80254E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.62051E+01 0.87764E+03
3BA 1      8 0.13842E+07 0.19451E+03 0.19147E+00 0.80853E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.70289E+01 0.87097E+03
4BA 1      9 0.18559E+07 0.20863E+03 0.17620E+00 0.82380E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.93389E+01 0.85447E+03
5BA 1     10 0.27881E+07 0.22981E+03 0.14996E+00 0.85004E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.13948E+02 0.82757E+03
 CA 1     11 0.91035E+07 0.25422E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00                 0.21500E+02 0.79864E+03
2CA 1     12 0.43340E+07 0.25513E+03 0.11161E+00 0.88839E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.21837E+02 0.79146E+03
3CA 1     13 0.45774E+07 0.25845E+03 0.10584E+00 0.89416E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.23116E+02 0.78634E+03
4CA 1     14 0.51584E+07 0.26587E+03 0.92199E-01 0.90780E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.26214E+02 0.77455E+03
5CA 1     15 0.60265E+07 0.27584E+03 0.71923E-01 0.92808E+00 0.10000E+01 0.00000E+00 0.00000E+00                 0.30976E+02 0.75784E+03
 DA 1     16 0.89587E+07 0.28748E+03 0.00000E+00 0.10000E+01 0.10000E+01 0.00000E+00 0.00000E+00                 0.37564E+02 0.74015E+03
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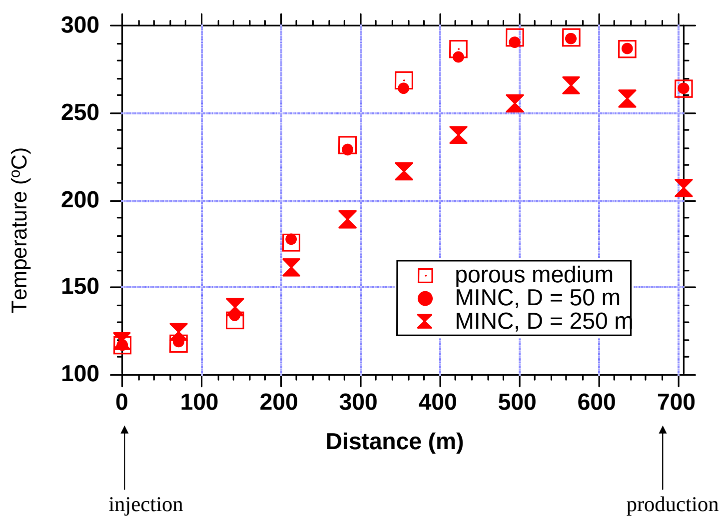
Temperature Profiles for Five-Spot after 36.5 yrs along a Line from Injection to Production Well



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