Title
RATING OF PSEMT B-5 SHELL AND TUBE EXCHANGER

Authors
Pope, William L.
Doyle, P.A.

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AUTHOR W.L. Pope/P.A. Doyle — DEPARTMENT Mechanical Engineering	LOCATION Berkeley	DATE December 5, 1979	

PROGRAM — PROJECT — JOB

GEOTHERMAL ENERGY UTILIZATION

GEOTHM DEVELOPMENT -- SIZEHX VALIDATION

TITLE

RATING OF PSEMT B-5 SHELL AND TUBE EXCHANGER

Abstract

New SIZEHX/GEOTHM shell and tube heat exchanger Rating Mode techniques have been applied to the analyses of the performance of the PSEMT exchanger, B-5, in a series of water-water calibration tests (45 runs) which were performed at LBL in Oct./Nov. 1978. This note presents the results of the Rating Mode analysis. The agreement between calculated and measured performance is extremely good (by conventional heat exchanger standards) for all the B-5 water-water calibration tests. No geometry specific experimental adjustment factors (fudge factors) were required by SIZEHX (other than backing out the fouling factor) to predict the heat transfer coefficient within 3% (conventional Nusselt relationships) or the pressure drops within 30% (10% on shell side) over a 70% change in tube side and shell side velocity.

Physical Description of PSEMT B-5

Detailed design drawings and specifications of B-5 are contained in Ref.1. The following list of physical features were used in SIZEHX to obtain the calculated results herein.

TABLE 1

Shell Inside Diameter:	Ds = 8.62 inches
Tube length:	L = 24.0 feet
No. of tubes:	62
Baffle type:	Single Segmental-horizontal cut
Baffle Spacing:	ℓ = 12.0 inches
Dia.-to-Spacing Ratio:	Ds/ℓ = 0.7183
Baffle Cut:	H = 3.50 inches
Cut-to-Diam. Ratio:	H/Ds = 0.4058
Tube Diameter:	d_o = 0.75 inches
Tube wall thickness:	t_w = 0.065 inches
Tube material:	Carbon steel
Tube pitch ratio:	s/d_o = 1.25
Matrix configuration:	equilateral triangle

Method of Analysis -- Evaluation of Fouling Factor

The overall apparent, as tested, fouling factor for the B-5 exchanger was determined as follows:

1) Calculate clean overall coefficient, U_c, with SIZEHX in the Rating Mode with tube side and shell side fouling factors set to zero (1×10^{-8} °F/Btu/hrft^2)

2) Calculate the overall apparent fouling factor, ff_{oA}, assuming all fouling exists on the tube side:

$$ff_{oA} = (U/_{meas} - 1/U_c)_{oA}/(d_o/d_i) \qquad (1)$$

With ff_{oA} from (1) determined arbitrarily from Test 3 data, the predicted as fouled performance was calculated for Tests 1 through 5 using SIZEHX in the new Rating Mode.

Discussion of B-5 Test Results

The PSEMT B-5 and B-6 exchangers (see Ref. 1 for details) were run through a series of water-water calibration tests under controlled, or laboratory-like, test conditions. These calibration tests were deemed necessary for later performance predictions when the exchangers will be used as elements of a six shell super-critical primary heater in a geothermal binary cycle with hydrocarbon mixtures as secondary working fluids (the LBL/EPRI Power Systems Equipment Module Test, PSEMT, currently underway at Magma Power Company's East Mesa site).

Table 2 lists test conditions and results of the single segmental baffled B-5 exchanger. One may note that the 5 tests (at 3 different tube side and shell side velocities (flow rates)) subjected the exchanger to a sufficient range of velocity and temperature conditions that heat transfer and pressure drop correlations could be tested for predictablitiy and geometry dependent characteristics (shell side leakage or bypassing). The low percentage error in Q_{AVG} and percent deviation in U_{OA} (averages of 8 or 9 runs for each test) are indicative of carefully planned and conducted tests. Detailed test data and results are contained in Ref. 1.

For the purpose of the SIZEHX calculations, average values (from 8 or 9 runs) of all the measured temperatures, pressures, and flow rates were used as input for each test calculation. The log mean temperature difference, Δt_{LM}, numbers listed in Table 2 were calculated from the average terminal temperatures of Table 2 and are, therefore, slightly different from those listed in Ref. 1, whereas the Q_{AVG} and the U_{oA} numbers are the same as in Ref.1.

Brief Description of the New SIZEHX Rating Mode

In the new SIZEHX/GEOTHM Rating Mode, the known number of tubes and the total tube length are specified. The known tube matrix and shell side baffle geometry are specified with the parameters listed in Table 1.

With three terminal states, one mass flow rate, and a pinch point temperature difference specified, the flow rates and duty, Q, are determined. The pressure drops are also determinable from the fixed geometric proportions, known properties, and determined flow rates, but must be calculated (the tube length is a function of U which can be calculated from the foregoing).

In the SIZEHX Rating Mode, the "Objective Function," FCN, is specified as:

$$FCN = ABS\left[\text{tube length (spec)} * \text{no. shells in series} - \text{total length (calc.)}\right] \quad (2)$$

FCN is minimized using GEOTHM's Minuits optimizer routines (Simplex) with the pinch point temperature difference, Δt_{pp}, as the only independent "optimizable" parameter (See Ref.2). The optimizer is "tricked" in these iterative calculations by overwriting the guessed tube side and shell side pressure drops by calculated values (in SIZEHX) as the optimization proceeds toward convergence on the specified tube length. This normally takes about 40-50 FCN iterations.

Convergence was assumed when the calculated tube length (Equation 2) is determined within 1 in 10,000. In these calculations, the SIZEHX heat balance convergence criteria $(\delta Q/Q)_j$ was set at $.001*(\Delta t_M)_j$ for each zone, j. Pressure drop convergence was assumed when successive values of $\delta G/G$ was less than .001. Typical cycle tim e for SIZEHX calculations (5 zone exchanger) was 0.040 seconds or less. Running on the LBL computer with a "rush" priority (12), a typical rating mode calculation costs about $14.00 or less.

Discussion of SIZEHX/GEOTHM Rating Mode Results

Table 3 lists some of the input thermodynamic parameters for the SIZEHX Rating Mode calculations (complete input and output details for Test 3 are shown in the Appendix).

It may be noted from Table 3 that the input parameters were varied radically (different "known side" assumptions, different pinch point guesses, and different tube and shell side pressure drop guesses) to verify the functional performance of the new SIZEHX Rating Mode optimization techniques. No difficulties were encountered.

The calculated results show that both the heat transfer and the pressure drop are very well predicted for the B-5 exchanger by the SIZEHX/GEOTHM code with no experimentally adjustable factors required. The most complex part of the simulation -the shell side pressure drop - is exceptionally well characterized by the LBL modification (Ref. 3) of the pressure drop correlation developed by A.P. Fraas based on methods originally developed by T. Tinker (See Ref.4 and 5.)

The tube side pressure drop deviation was higher than expected (Test 1), however Test 1' (which assumes the shell side fluid is the "known fluid") shows that experimental error in the measured flow rates contributed to the calculated deviation in pressure drop. A more accurate representation of the Test-to-Calculated pressure drop deviation is shown in Figure 1.

Conclusions

1. The SIZEHX/GEOTHM Rating Mode optimization techniques work well and converge quickly to realistic physical results.

2. The GEOTHM fluid property routines are adequate to predict the performance of water-water units.

3. The SIZEHX zoned analysis routines, utilizing conventional Nusselt/Sieder-Tate heat transfer correlations and A.P. Fraas' (Ref. 4) shell side pressure drop correlation (as modified by LBL) appear to be entirely adequate to predict the performance of commercial size, subcritical shell and tube exchangers with single segmental baffles with no experimentally adjusted coefficients (except the fouling, of course).

References

1. Doyle, P.T., "Water to Water Heat Exchanger Calibration Test at Lawrence Berkeley Laboratories, Final Report, March 9, 1979.
2. Pope, W.L. et al, Section 8.2, "Conceptual Design Optimization" from Sourcebook on the Production of Electricity from Geothermal Energy, J. Kestin (Brown University) Editor, DOE/DGE Publication, in press.
3. Pope, W.L., "Development of a Heat Exchanger Design Program, SIZEHX, for GEOTHM," LBL Mechanical Engineering Note GT1802, M5002, Berkeley, CA, December, 1976.
4. Fraas, A.P. and Ozisik, M.N., Heat Exchanger Design (Chapter 8), John Wiley and Sons, Inc., New York, 1965.
5. Tinker, T., "Shell Side Characteristics of Shell-and-Tube Heat Exchangers," Trans. ASME, Vol. 80, 1958, p. 36.

TABLE 2 PSEMT B-5 EXCHANGER WATER-WATER CALIBRATION TEST-AVERAGE CONDITIONS AND MEASURED PERFORMANCE (SEE REF. 1 FOR DETAILS)

PARAMETERS		PSEMT B-5 TEST DATA. PARAMETERS FOR EACH TEST ARE AVG. FOR 8-9 RUNS				
TEST CONDITIONS		TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
Tube Side $\dot{m}$	(lb/sec)	24.110	31.700	39.865	39.898	40.023
Shell Side $\dot{m}$	(lb/sec)	25.751	26.321	26.452	35.169	43.716
Tube Tin	(°K)	316.74	312.28	311.22	308.49	307.18
Tube Tout	(°K)	302.81	302.48	302.97	300.41	299.09
Shell Tin	(°K)	290.96	291.02	290.71	290.75	290.67
Shell Tout	(°K)	303.66	302.76	303.02	299.72	297.90
Min. Temp. Diff.	(K°)	11.85	9.52	8.20	8.77	8.42
Tube ΔP	(bar)	0.0529	0.1045	0.1733	0.1601	0.1590
Shell ΔP	(bar)	0.4432	0.4301	0.4383	0.8060	1.1864
ff_{oa}	(°F/Btu/hrft^2)	?	?	?	?	?
OUTPUT RESULTS		RESULTS-MEASURED OR CALCULATED FROM TEST DATA				
Q_{AVG} Percent error	(Btu/hr x 10^{-6})	2.169 (0.384)	2.0123 (0.55)	2.1090 (1.06)	2.065 (1.97)	2.0724 (2.28)
ΔT_{LM}	(F°)	22.4188	18.8281	18.1697	16.5741	15.9175
ΔT_{min}	(F°)	21.330 (C.E.)	17.136 (H.E.)	14.760 (H.E.)	15.786 (H.E.)	15.156 (C.E.)
U_{OA} Percent Deviation	(Btu/hrft^2°F)	331.052 (±0.443)	364.621 (±0.689)	396.73 (±1.614)	426.735 (±0.647)	445.028 (±2.339)

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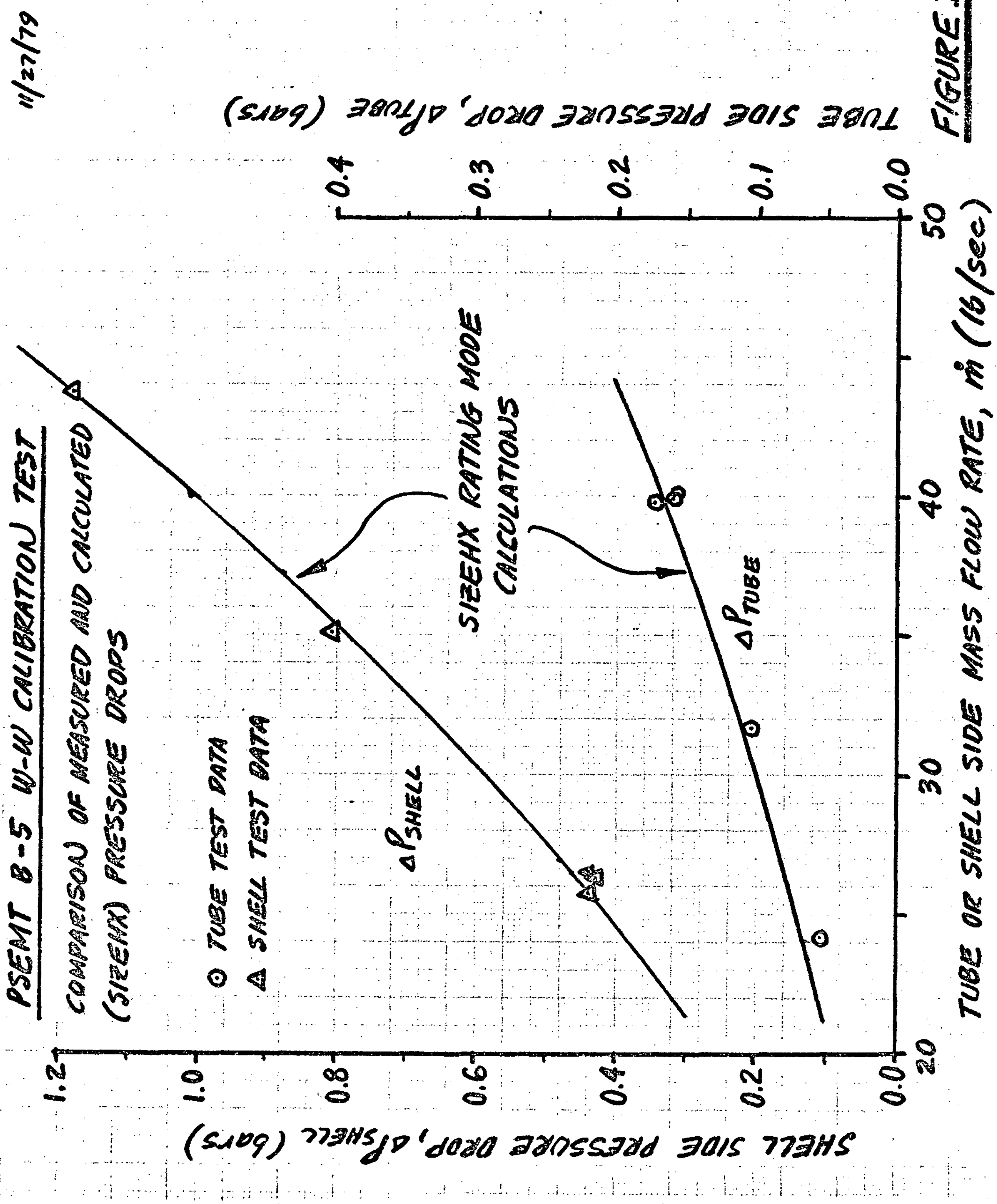
W.L. Pope/P.A. Doyle	Mechanical Engineering	90/1070H	December 5, 1979

Table 3 SIZEHX/GEOTHM RATING MODE COMPUTED RESULTS AND COMPARISON WITH PSEMT B-5 MEAS. TEST RESULTS

PARAMETERS		SIZEHX/GEOTHM RATING MODE INPUT DATA					
INPUT ASSUMPTIONS		TEST 1	TEST 1'	TEST 2	TEST 3	TEST 4	TEST 5
Tube Side $\dot{m}$	(lb/sec)	24.110	?	31.700	39.8494	39.8973	?
Shell Side $\dot{m}$	(lb/sec)	?	25.751	?	?	?	43.716
Tube Tin	(°K)	316.74	316.74	312.28	311.22	308.49	307.18
Tube Tout	(°K)	302.81	?	302.48	302.97	300.41	?
Shell Tin	(°K)	?	290.96	291.02	290.71	290.75	290.67
Shell Tout	(°K)	303.66	303.66	?	?	?	297.90
Pinch ΔT guess	(K°)	8.00	7.00	7.00	5.00	7.00	6.00
ΔPTube guess	(bar)	0.0529	0.0529	0.1045	0.3000	0.1601	0.200
ΔPshell guess	(bar)	0.4432	0.4432	0.4301	0.6000	0.8060	1.1864

FOULING FAC. ff_{oA}(°F/Btu/hrft^2) 1.964×10^{-5} CALC.FROM CLEAN RATING TEST 3' (U_c = 400.505)

OUTPUT PARAMETERS		RATING MODE CALCULATED RESULTS					
Q_{TOT}	(Btu/hr x 10^{-6})	2.172663	2.119349	2.009910	2.126966	2.086336	2.049753
Test Deviation	(%)	(-0.169)	(-2.29)	(-0.119)	(0.852)	(1.033)	(-1.093)
ΔT_M	(F°)	22.640	22.382	18.877	18.298	16.873	16.096
Test Deviation	(%)	(0.987)	(-0.164)	(0.260)	(0.706)	(1.803)	(1.121)
ΔT_{MIN}	(F°)	21.750	21.251	17.221	14.975	16.365	15.501
Test Deviation	(%)	(1.970)	(-0.370)	(0.496)	(1.46)	(3.67)	(2.276)
U_{OA}	(Btu/hrft^2°F)	328.336	323.946	364.261	397.687	423.021	435.681
Test Deviation	(%)	(-0.820)	(-2.15)	(-0.099)	(0.241)	(-0.870)	(-2.100)
Unknown $\dot{m}$	(lb/sec)	25.927	23.449	26.528	26.926	37.214	40.100
Test Deviation	(%)	(0.682)	(-2.74)	(0.786)	(1.792)	(5.81)	(-0.192)
Unknown Temp.	(°K)	290.727	302.766	302.713	302.900	299.398	299.281
Test Deviation	(%)	(-0.080)	(-0.0145)	(-0.016)	(-0.040)	(-0.107)	(0.064)
ΔPTube	(bar)	.06611	.06284	0.1096	0.1666	0.1685	0.1708
Test Deviation	(%)	(25.0)	(18.8)	(4.88)	(-3.87)	(5.25)	(7.42)
ΔPshell	(bar)	0.4473	0.4419	0.4671	0.4795	0.8774	1.187
Test Deviation	(%)	(0.925)	(-0.293)	(8.60)	(9.40)	(8.86)	(0.050)
Tube in Velocity	(ft/sec)	2.999	2.916	3.936	4.946	4.947	4.969



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PSEMT B-5 W-W CALIBRATION TEST
COMPARISON OF MEASURED AND CALCULATED (SIZEHX) PRESSURE DROPS
⊙ TUBE TEST DATA
△ SHELL TEST DATA
ΔP SHELL
ΔP TUBE
SIZEHX RATING MODE CALCULATIONS
TUBE SIDE PRESSURE DROP, ΔP TUBE (bars)
0.0
0.1
0.2
0.3
0.4
SHELL SIDE PRESSURE DROP, ΔP SHELL (bars)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
TUBE OR SHELL SIDE MASS FLOW RATE, ṁ (lb/sec)
20
30
40
50

FIGURE 1

APPENDIX A

The following pages contain tables of the complete input specifications for PSEMT B-5 TO THE SIZEHX/GEOTHM code in the Rating Mode, and the computed output results (TEST 3). Documentation: POPEØØZ (12/3/79).

TABLE A-1 Input Specifications to GEOTHM. The "P" parameters (lines 9, 10, & 11) not listed have assumed default conditions (see Table A-7).

```
*** CYCLE LIST ****

*PSEMT B-5 TEST 3 FOULED (NWXT3F) FAR OUT FIRST GUESS

01. GP AATC=43.3 WBTC=26.7
02. FS=10 F=WATER MF=16075.29 I=SOURCE
03. FS=20 F=WATER
04. SP=10,10 T=311.22 P=4.032
05. SP=10,20 T=302.97 P=3.732
06. SP=20,10 T=290.71 P=1.6721
07. E=HED TYPE=5 IN=10,10 IN=20,10 OUT=10,20 OUT=20,20 PP=8.20
08. DP=0.3000,0.6000
09. P2=.7183 P3=.4056 P7=1 P13=.95 P17=0. P25=17.
10. P14=1375.95 P27=1.
11. P18=.19640 P24=.0001
```

TABLE A-2 Input specifications to Minuits Optimization Routines.

```
*********************
*   D506   MINUITS  *
*   VERSION  8.75   *
* DATA BLOCK NO. 1  *
**********************************************************************************************
HEAT EXCHANGER, RATING MODE OPTIMIZATION,HEFT ,1 PARAM (RATH                         TIME   .005
**********************************************************************************************
**********************************************************************************************
    1       UTMIN        5.000000          .900000           .4000E+01       .1225E+02
**********************************************************************************************
```

TABLE A-3 Computed state point properties based on Input first guess information.

INITIAL THERMODYNAMIC CONDITIONS

TITLE =PBEMT B-5 TEST 3 FOULED (NFXT3F) FAR OUT FIRST GUESS

STATE POINT TABLE

L	K	T (DEG K)	P (BAR)	H (J/G)	S (J/GK)	V (CC/G)	Q	NACL PCT
10	10	311.220	4.032	54.615	.178	1.007	-1.000	-INDEF
10	20	302.970	3.732	20.151	.066	1.004	-1.000	-INDEF
20	10	290.710	1.672	-31.154	-.107	1.001	-1.000	-INDEF
20	20	0.	0.	0.	0.	0.	-INDEF	-INDEF

L	G (KG/SEC)	FLUID NUMBER	FLUID DESCRIPTION
10	18.07529	1	WATER (DI-HYDROGEN OXIDE)
20	0.	1	WATER (DI-HYDROGEN OXIDE)

TABLE A-4 Computed values of the Objective Function, FCN, optimizable parameter, DTMIN, and ΔP_{Tube} (TRICK1) and ΔP_{shell} (TRICK2) during last 3 Minuits (Simplex) optimization iterations.

```
CN VALUE =        .2481866E+03
          ELAPSED TIME          .038
        G2RATIO=        1.00000
TMIN=  .8319652E+01
                                          TRICK1=  .1665816E+00
                                          TRICK2=  .4794626E+00
                                          SCOOP=  .7315224E+01
CN VALUE =        .9466644E+03
          ELAPSED TIME          .038
        G2RATIO=        1.00000
TMIN=  .8319671E+01
                                          TRICK1=  .1665814E+00
                                          TRICK2=  .4794833E+00
                                          SCOOP=  .7315214E+01
FCN VALUE =        .1010536E+03
SIMPLEX MINIMIZATION HAS CONVERGED
          ELAPSED TIME          .038
        G2RATIO=        1.00000
DTMIN=  .8319671E+01
                                          TRICK1=  .1665814E+00
                                          TRICK2=  .4794833E+00
                                          SCOOP=  .7315214E+01
FCN VALUE =        .1010598E+03
```

FCN VALUE	CALLS	TIME	EDM	INT.EXT.		PARAMETER	VALUE	ERROR	INTERN.VALUE
.1010536E+03	47	.037	.15E+03	1	1	DTMIN	.83197E+01	.13625E-02	.47210E-01

```
                                          ERRORS CORRESPOND TO FUNCTION CHANGE OF 100000.000
**********
***  4*****EXIT
**********
CALL TO FCN WITH IFLAG = 3
```

TABLE A-5 Output Results – SIZEHX computed details

PRESSURE BALANCE CONVERGENCE

ΔP_{TUBE}		ΔP_{SHELL}		
.1666E+05	.1666E+05	.4795E+05	.4795E+05	.7409
(input)	(calc.)	(input)	(calc.)	

BETTER VALUES FOR GUESS BLOCK - NEXT TIME (Zone Heat Balance)

1	.4390	.4603	.0091	.0915	.0000	1.0000
2	.4379	.4598	.0093	.0930	.0000	1.0000
3	.4369	.4592	.0094	.0945	.0000	1.0000
4	.4358	.4587	.0096	.0959	.0000	1.0000
5	.4347	.4582	.0097	.0974	.0000	1.0000

ELEMENT, AREA, TUBE PRESS, SHELL PRESS, AREA SUM, Q S UM (PER PARALLEL BANK)

ELEMENT	AREA	TUBE PRESS	SHELL PRESS	AREA SUM	Q SUM
1	4.811	3.880	1.629	4.811	.1246E+06
2	5.070	3.911	1.541	9.882	.2492E+06
3	5.373	3.945	1.446	15.25	.3738E+06
4	5.731	3.977	1.350	20.99	.4984E+06
5	6.158	4.013	1.246	27.14	.6229E+06

TOT NO OF HB ITERATIONS ARE 1

TOT NO OF HB ITERATIONS FOR 5 ELEMENTS ARE 20

ELAPSED TIME .042

G2RATIO= 1.00000

LBID 149 M5438

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HEAT EXCHANGER PARAMETERS

TABLE A-6 SIZEHX COMPUTED RESULTS OF PSEMT B-5 EXCHANGER (TEST 3) FROM RATING MODE SOLUTION.

*** RATING MODE ***

SPECIFIED NO. OF TUBES PER SHELL = 62.00

SPECIFIED TOTAL TUBE LENGTH PER SHELL = 7.3152

SPECIFIED NO. IN SERIES = 1

OBJ.(MINIMIZE)=ABS(DESLEN X NHXS-LENG(CALC))= .0000

TOTAL HEAT TRANSFERRED	.623	(MW)	2126.966	(K-BTU/HR)
TOTAL HEAT TRANSFER AREA	.027	(K-M**2)	.292	(K-FT**2)
OVERALL MEAN DELTA T.	10.165	(DEG C)	18.296	(DEG F)
OVERALL HEAT TRANSFER COEFFICIENT U(O)	2257.668	(W/M**2/C)	397.687	(BTU/FT**2/HR/F)
PINCH POINT DELTA T.	8.320	(DEG C)	14.975	(DEG F)
TUBE SIDE MASS FLOW RATE	18.075	(KG/SEC)	39.856	(LB/SEC)
SHELL SIDE MASS FLOW RATE	12.211	(KG/SEC)	26.926	(LB/SEC)
TOTAL NO. OF EXCHANGERS	1			
NO. IN PARALLEL	1			
NO. IN SERIES	1			
MAXIMUM TUBE SIDE PRESSURE	4.032	(BAR)	58.479	(PSI)
MAXIMUM SHELL SIDE PRESSURE	1.672	(BAR)	24.252	(PSI)
TOTAL TUBE SIDE PRESSURE DROP	.167	(BAR)	2.416	(PSI)
TOTAL SHELL SIDE PRESSURE DROP	.479	(BAR)	6.954	(PSI)
EXCHANGER TUBE LENGTH	7.315	(METER)	24.000	(FT)
NO. OF TUBES PER EXCHANGER	62			
SHELL OUTSIDE DIAMETER	23.539	(CM)	9.267	(IN)
TUBE OUTSIDE DIAMETER	1.905	(CM)	.750	(IN)
TUBE INSIDE DIAMETER	1.575	(CM)	.620	(IN)
MINIMUM SHELL WALL THICKNESS	.021	(CM)	.008	(IN)

HEAT EXCHANGER T-Q DETAILS

	QSH(I) (MW)	Q(I) (MW)	LOCAL AREA(O) (M**2)	T TU FL (DEG K)	T SH FL (DEG K)	T WALL (DEG K)	DELTA T. MEAN (DEG K)	LOCAL U (W/M**2/K)	LOCAL HI (W/M**2/K)	LOCAL HO (W/M**2/K)
1	.06	.12	4.81	303.80	291.93	297.94	11.86	2183.26	6016.04	4742.54
2	.19	.12	5.07	305.45	294.36	299.96	11.08	2218.56	6128.67	4824.76
3	.31	.12	5.37	307.10	296.80	302.02	10.29	2253.91	6240.95	4908.05
4	.44	.12	5.73	308.75	299.24	304.06	9.50	2288.31	6352.12	4988.34
5	.56	.12	6.16	310.40	301.68	306.10	8.71	2322.77	6463.61	5069.21

TOTAL CONDUCTANCE RATIO (TUBE/SHELL)= 1.029

TABLE A-7 Exchanger Configuration parameters assumed in SIZEHX computations. * Values are specified input – remainder are default values.

PARAM NO.	NUMERICAL VALUE
1	3.000000
2	.716300 *
3	.405800 *
4	1.250000
5	.019050
6	.001651
7	1.000000 *
8	1.000000
9	1.000000
10	1.000000
11	43.260000
12	.000794
13	.950000 *
14	1376.950000 *
15	1793000.000000
16	2.000000
17	0. *
18	.196400 *
19	.950000
20	.900000
21	.600000
22	1.000000
23	1.000000
24	.000100 *
25	17.000000 *
26	2.286000
27	1.000000 *

TABLE A-8 Final Computed state point table for PSEMT B-5 exchanger (TEST 3). GEOTHM/OPRA7.

IDEAL THERMODYNAMIC CYCLE NO LOSSES
TITLE =PSEMT B-5 TEST 3 FOULED (MAXTSF) FAR OUT FIRST GUESS

STATE POINT TABLE

L	K	T (DEG K)	P (BAR)	H (J/G)	S (J/GK)	V (CC/G)	Q
10	10	311.220	4.032	54.615	.178	1.007	-1.000
10	20	302.970	3.665	20.151	.066	1.004	-1.000
20	10	290.710	1.672	-31.154	-.107	1.001	-1.000
20	20	302.900	1.193	19.860	.066	1.004	-1.000

L	G (KG/SEC)	FLUID NUMBER AND FLUID DESCRIPTION	
10	16.07529	1	WATER (DI-HYDROGEN OXIDE)
20	12.21123	1	WATER (DI-HYDROGEN OXIDE)

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