Los Alamos

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memorandum

TO: Distribution

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MAIL STOP/TELEPHONE: J981/7-4318

SYMBOL: ESS-DOT

SUBJECT: EXPERIMENTAL HEAT TRANSFER COEFFICIENTS WITH THE NITROGEN BLANKET
(EXPERIMENT 2028) AND MODELING OF THE 1.5 M GALLON PUMP IN EE-3

Summary: The experimental determination of the nitrogen blanket heat transfer coefficient was a great success. Analysis of the data lead to the discovery of two rather subtle input errors in the code WBHT. These errors involved using wrong mean areas to evaluate the thermal resistance and using two-sided resistances instead of a single-sided one across the void (annulus) space.

The results could be modeled using a nitrogen blanket heat transfer coefficient of between 15-20 $\frac{W}{m^2 \cdot ^\circ C}$ (because of the mentioned input

error, the preliminary runs were made with a heat transfer coefficient of 1.6 $\frac{W}{m \cdot ^\circ C}$). The literature gives a maximum coefficient of about

10 $\frac{W}{m \cdot ^\circ C}$; however, the data was limited to low mean temperatures

(100°F). In the experiment the temperature differences were several times the literature values and the mean temperature was about twice the literature value. These larger temperature values would result in more free convection and thus a larger heat transfer coefficient.

With application to the 1.5 M gallon pump the new results indicate an average temperature drop in the casing of 18°C. This is over the established redline of 15°C.

The Experiment: Table I shows the temperature time history provided by Hugh Murphy and Robert Hendron. Figures 1 and 2 show temperature time plots at 1200 m (3940 ft) and 1300 m (4265 ft). The tool was parked at 1220 m (4000 ft). The two curves are given because the back flow during the filling of the annulus warmed the pipe, even though the 1200 m case is closer to the tool depth, the 1300 m case is nearer to the initial temperature experienced by the tool. The asterisks in both figures represent the experimental data. It may be seen that the best fits lie somewhere

between 15 and $20 \frac{W}{m^2 \cdot ^\circ C}$.

Figures 3, 4 and 5 present simulation of the temperature history during the 1.5 M gallon pump using the worse case estimate of the heat transfer coefficients of $20 \frac{W}{m^2 \cdot ^\circ C}$. Old results are also presented on the same figures for comparison purposes. Of particualr note is Figure 3 which indicates an average temperature drop of $18^\circ C$ in the casing from 0-5000 ft. This is over the established redline of $15^\circ C$ for this section of pipe.

Figures 6-10 show simulated results for the proposed 1 M gallon flow profile for Experiment 2027, with variable flow rate including a 30 BPM pulse.

Distribution

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ESS-4 File

TABLE I

Time	Min	Temp (°F)	Temp (°C)	Pump 42 gpm $\pm$ 4
08:55	0	219	103.9	Inlet 25.4°C
	4	218	103.3	P _{frontside} = 5300 psi
	8	215	101.7	P _{backside} = 2500 psi
	12	212	100	Tool @ ~4000 ft (1219m)
	14	208	97.8	
	18	204.5	95.8	N ₂ level ~5700 - 5900 ft
	22	199.5	93.1	start finish
	26	193	89.4	
	30	188	86.7	
	34	193	89.4	
	40	187.5	86.4	
	45	183.6	84.2	
	50	181.5	83.1	
	64	177.5	80.8	
	70	175	79.4	
	80	172.5	78.1	
	92	171	77.2	
	97	172	77.8	
	102	173.5	78.6	
	107	181	82.8	
	112	185	85.0	
	120	190	87.8	
	126	192.5	89.2	
	132	196	91.1	
	142	198	92.2	
	158	202	94.4	
12:25	0(210)	200	13.3	
	5(215)	182	83.3	
	7(217)	155	68.3	
	8(218)	144	62.2	
	9(219)	135	57.2	
	10(220)	125	51.7	
	11(221)	121	49.4	
	12(222)	119	48.3	
	15(225)	111	43.9	

TABLE I (cont.)

16(226)	109	42.8
18(228)	108	42.2
21(231)	19 7	41. 7
23(233)	106.5	41.1
25(235)	106	41.1
33(243)	105.5	40.8

Fig. 1

Fig. 2

Experiment 2028: Nitrogen blanket test, coefficients of 11, 15 and 19

Fig 3

Fig 4

Fig 5

Old and new coefficients

Old coefficients

New coefficients

Fig 6

Fig 7

Fig 8

Fig 9

Fig 10