Box 2792 · Odessa, Texas 79760

February 1, 1987

SECTION: 500
TECHNICAL BULLETIN
No. 130, Revision 2

INDIRECT HEATER - CHOKE LOCATION

In order to determine the effect of the choke location on the operation of an indirect heater, we have assumed a set of typical gas conditions. Calculations have then been made using a standard gas production unit to determine what the gas temperatures will be throughout the coil in the heater.

Gas Conditions:
- Gas Flow Rate - 5.0 MMSCFD
- Gas Sp Gr - 0.70
- Inlet Flowing Pressure - 2000 psi
- Inlet Gas Temperature - 71°F (Hydrate Temp. for 2000 psi)
- Separator Pressure - 700 psi
- Hydrate Temperature at 700 psi - 60°F

Gas Production Unit:
- Unit Model - HSU-7C
- Heater Firebox Rating - 750,000 BTU/hr
- Heater Coil - 12 - 2" X-Hvy tubes, 88.2 sq ft coil area

Five examples have been worked out to show the effect of choke location and resulting temperatures on indirect heater operation. The following basic heat transfer equation was used.

$$Q = U_o\ (A)\ (t_m)$$

Where:
- Q = Heat transfer required, BTU/hr
- U_o = Overall film coefficient - 118 BTU/hr - sq ft - °F for gas conditions used
- A = Coil area in heater, sq ft
- t_m = Mean temperature difference between gas and water bath, °F

Since the heat transfer area available in a long nose choke is so small, compared to the area in the coil, the amount of area in the preheat and expansion loops will have a far greater effect on the heater operation, than the type of choke used.

EXAMPLE NO. 1:

Assume there is a single pass coil in the heater with a regular choke on the outlet of the heater coil. The heater is operated to maintain the gas temperature after choking at 65°F (5°F above the hydrate temperature). See the attached chart for Example No. 1. The gas must be heated to 131°F before choking. The total heat required is 530,000 BTU/hr and the water bath temperature will be 152°F. Note that in this example the gas temperature is never allowed to fall below the hydrate temperature of gas.

EXAMPLE NO. 2:

Assume there is a split pass coil with 10 tubes upstream of the choke or preheat coil (73.5 sq ft coil area) and 2 tubes downstream or expansion coil (14.7 sq ft coil area). A long nose heater choke is installed between the coils. This heater is also operated to maintain the gas at 65°F leaving the heater or 5°F above the hydrate temperature. The gas will be heated to 112°F in the preheat coil and drop to 42°F after choking. It will be reheated to 65°F in the expansion coil. The total heat required is 522,000 BTU/hr (380,000 BTU/hr in preheat coil, 142,000 BTU/hr in expansion coil) and the water bath temperature will be 135°F. Note on the chart for Example No. 2 that the gas is below the hydrate temperature after choking and most of the way through the expansion coil.

EXAMPLE NO. 3:

This example uses the same coil construction as Example No. 2, except the unit is operated to allow the gas temperature to drop only to 50°F after choking or 10°F below the hydrate temperature. The gas must be heated to 120°F in the preheat coil and will be reheated to 73°F in the expansion coil. The total heat required is 586,000 BTU/hr (440,000 BTU/hr in preheat coil, 146,000 BTU/hr in expansion coil) and the water bath temperature will be 146°F. Note on the chart for Example No. 3 that the gas is only below the hydrate temperature for a portion of the way thru the expansion coil. However, the outlet gas temperature will be raised to 73°F which will somewhat lower the liquid recovery in the separator from that which would be obtained in Examples No. 1 or 2.

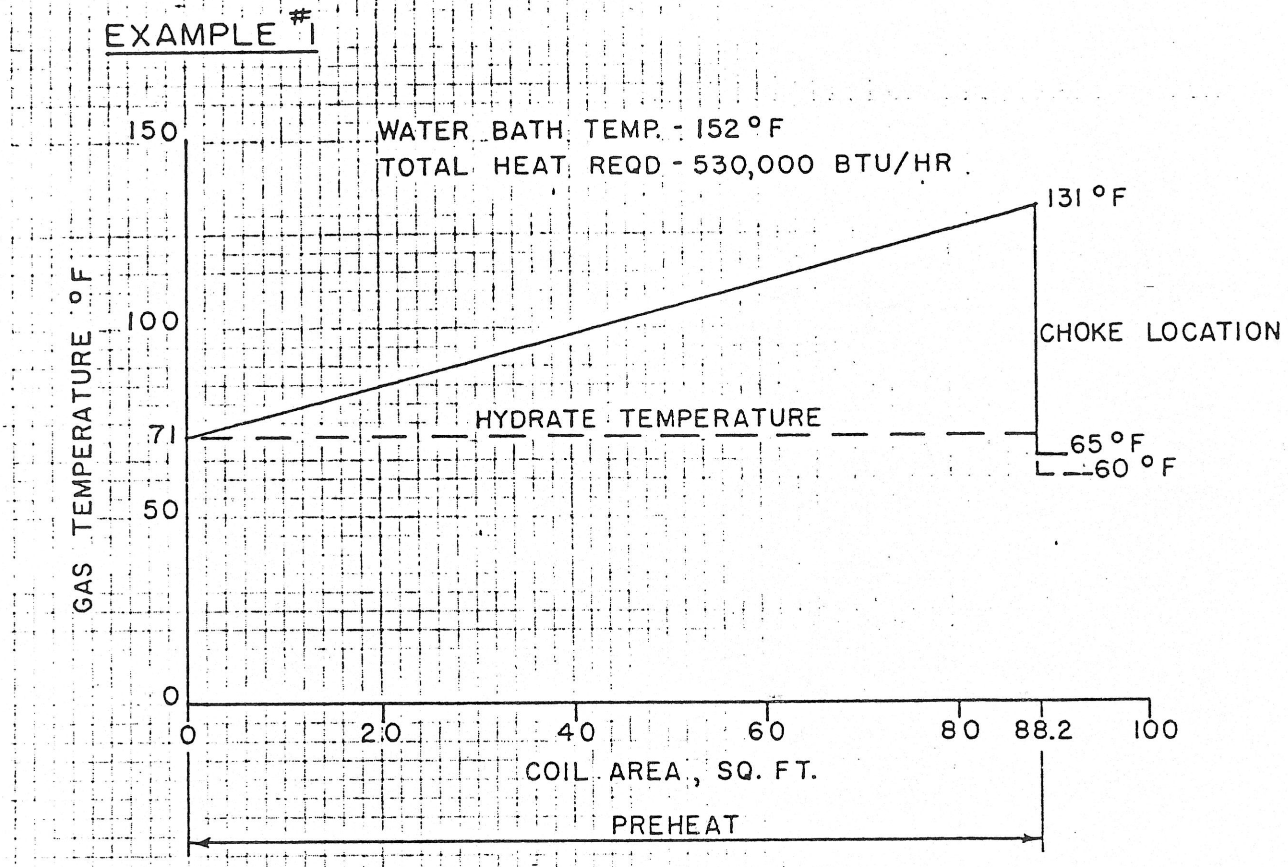
EXAMPLE NO. 4:

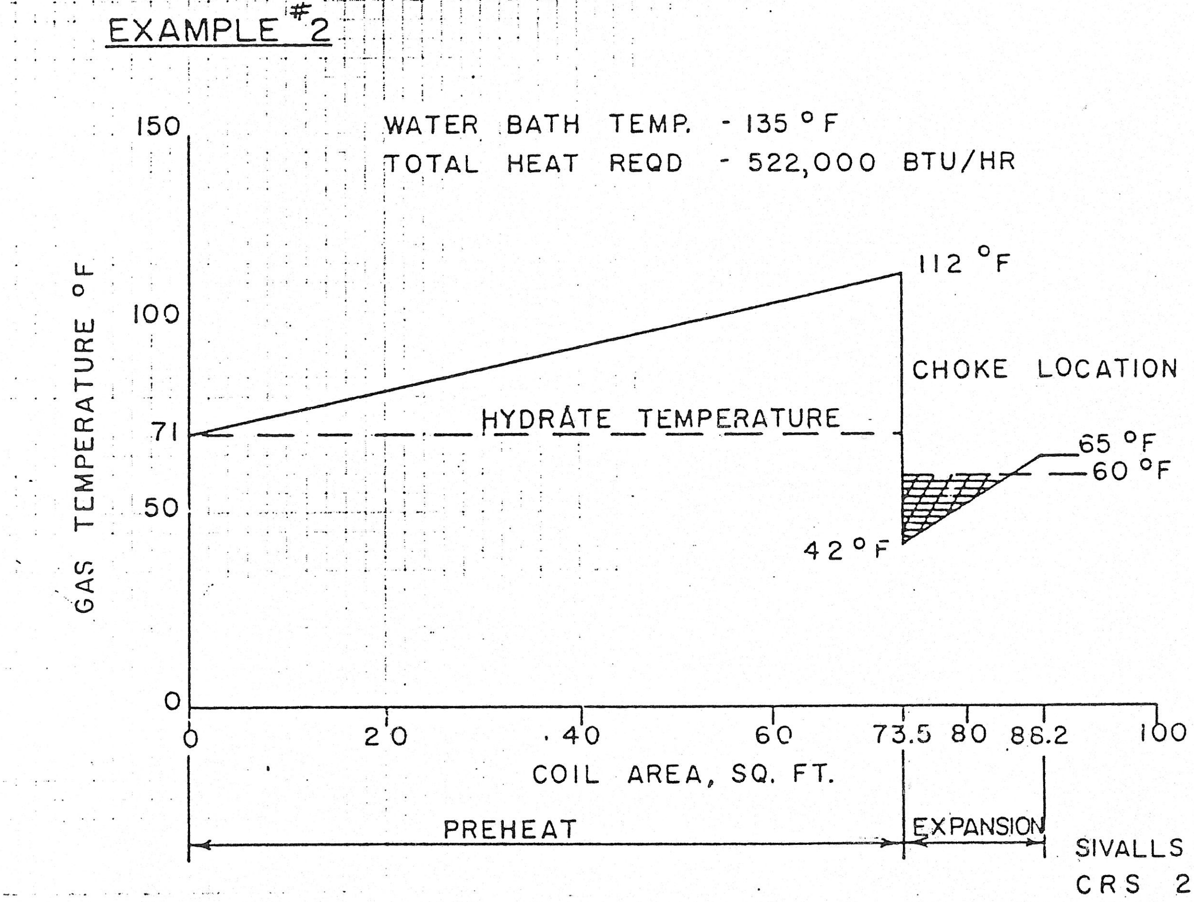
Assume there is a split pass coil with 2 tubes upstream of the choke or preheat coil (14.7 sq ft coil area) and 10 tubes downstream in the expansion coil (73.5 sq ft coil area.) A long nose choke would be installed between the coils. The heater is operated to maintain the gas at 65°F leaving the heater as in Examples No. 1 and 2. The gas will be heated to 75°F in the preheat coil before choking. However, the gas temperature will drop to -2°F after choking. As can be seen on the chart for Example No. 4 the gas temperature will be far below the hydrate temperature most of the way thru the heater. The total heat required is 527,000 BTU/hr (75,000 BTU/hr in preheat coil, 500,000 BTU/hr in expansion coil) and the water bath temperature will be 89°F. It is doubtful that the heater could be operated to maintain a 65°F outlet gas temperature without hydrates forming and freezing off the coil.

EXAMPLE No. 5:

This example uses the same coil construction as Example No. 4 except the heater is operated to allow the gas temperature to drop to only 15°F after choking. The gas must be heated to 90°F in the preheat coil before choking. After choking the gas will be reheated in the expansion coil to 128°F. The total heat required is 913,000 BTU/hr (138,000 BTU/hr in the preheat coil, 775,000 BTU/hr in the expansion coil) and the water bath temperature will be 160°F. Note on the chart for Example No. 5 the gas temperature is below the hydrate temperature for less time than in Example No. 4, but is still dangerously below the hydrate temperature after choking. Freezing may still be incurred. Also, the outlet gas temperature of 128°F will be appreciably cut down on the liquid recovery that could be obtained in Examples No. 1, 2, or 3. The total heat required is also above that available with the standard firebox in the unit of 750,000 BTU/hr.

In summary, it can be seen from the examples that with the choke on the heater outlet or in a split pass coil with a small expansion loop, the heater can be operated to give the lowest outlet gas temperature, and therefore, the highest liquid recovery in the separator. This can be done without allowing the gas temperature to fall below the hydrate temperature as in Example No. 1 or only slightly below as in Examples 2 and 3. However, with the choke on the inlet or after a small preheat coil, the outlet gas temperature must be carried much highe in order to prevent freezing in the choke. This will, of course, cut down considerably on the liquid recovery in the separator downstream from the heater.





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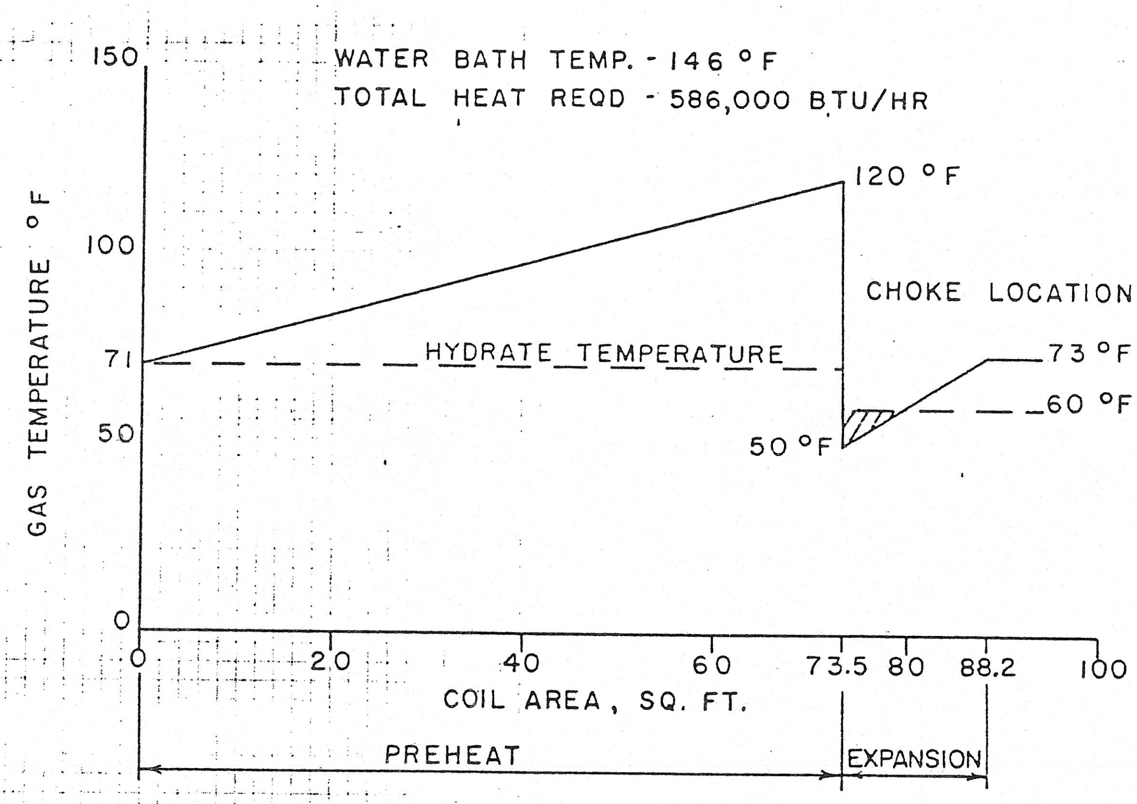
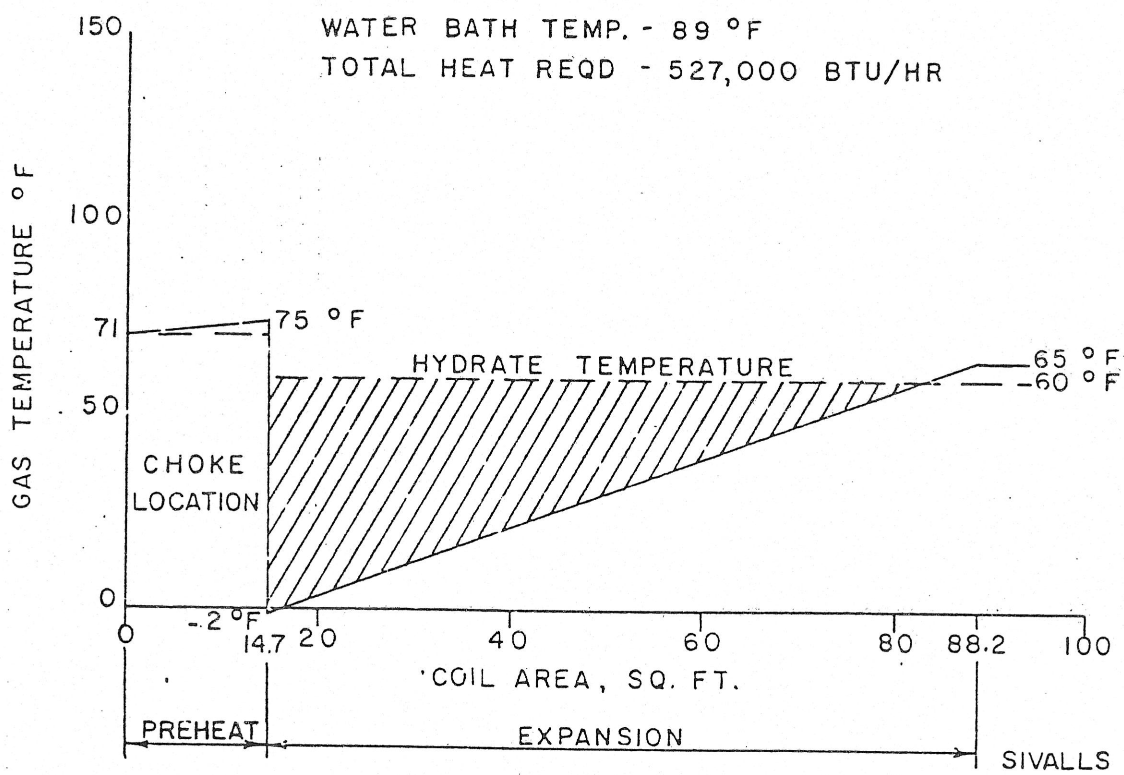
EXAMPLE #3



EXAMPLE #4



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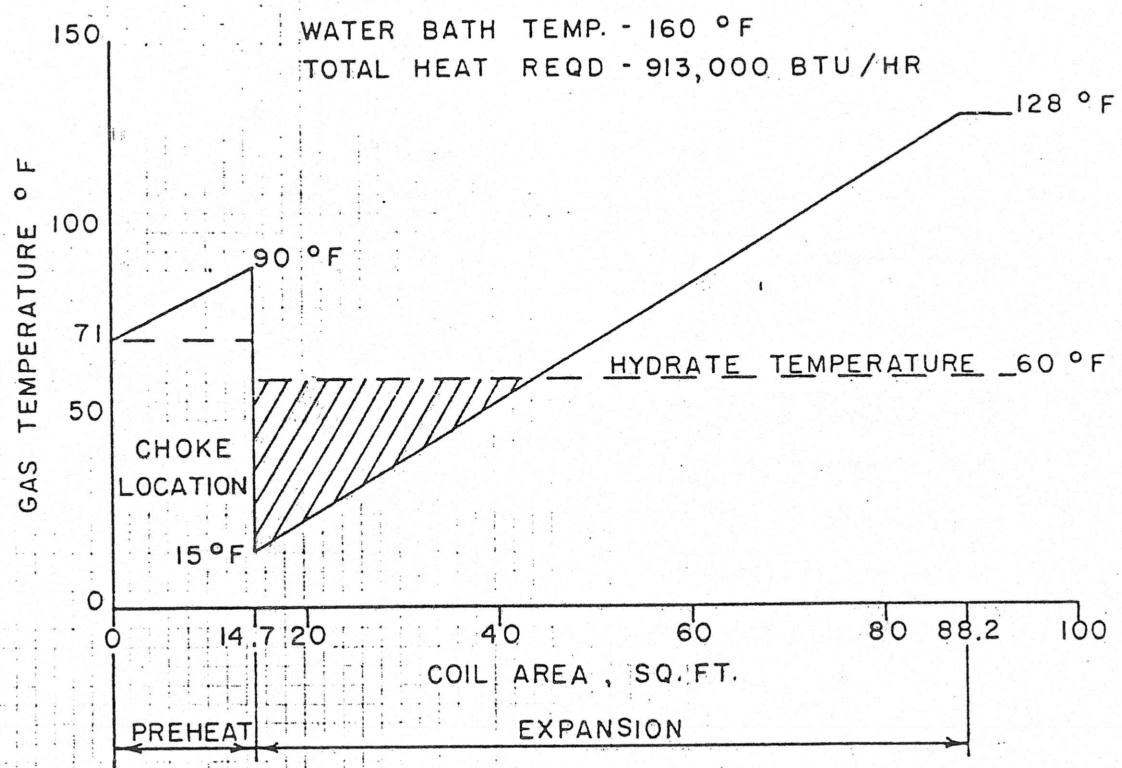
<u>EXAMPLE #5</u>



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