

**MEMORANDUM**

**DATE: August 26, 2009**

**TO: Laboratory Group A**

**FROM: Tony Butterfield**

**Engineering Training Supervisor**

**SUBJECT: Double Pipe Heat Exchanger**

Our lab’s double pipe heat exchanger has been offline for a number of years, but has recently been brought back to working order. Thirteen years ago, I was assigned to determine the heat transfer capacity of this same piece of equipment. My lab group’s data from 1996 were as follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Run | Steam (psig) | Cold Flow (gpm) | Tcold, in (°F) | Tcold, out (°F) | Condensed Steam Collected (g) | Time of Condensate Collection (min:sec) |
| 1 | 10.3 | 22 | 85.0 | 100.9 | 3019 | 1:51 |
| 2 | 10.9 | 10 | 80.1 | 106.1 | 3056 | 2:06 |
| 3 | 10.5 | 15 | 81.6 | 102.6 | 3446 | 2:12 |
| 4 | 5.5 | 22 | 82.9 | 97.2 | 3227 | 2:08 |
| 5 | 6.3 | 15 | 79.7 | 99.3 | 3290 | 2:15 |
| 6 | 7.0 | 10 | 77.6 | 102.4 | 3483 | 2:29 |

We are curious how this piece of equipment has changed over the years in order to gain some understanding of the aging of the double pipe heat exchanger.

Please run the heat exchanger at a variety of steam pressures and cold side flow rates, and ultimately determine if you can find any evidence of physical change in the heat exchanger over the years.

You may assume the heat exchanger is perfectly insulated, with fully developed flow. On the cold side, you may assume the heat capacity is a constant within the temperature range. On the hot side, you will be condensing steam at various pressures and may use the mass flow rate of condensate out of the hot side and the heat of vaporization to determine the rate of heat transferred.

In your analysis, please determine if the rate of heat transferred from the steam is within error of the value you find for the heat transferred to the cold water. Also, determine the overall heat transfer coefficient at each operating condition and compare it to the coefficients obtained using the data from 1996.

Because we are interested in how the heat transfer properties of this heat exchanger have changed over the years, you should attempt to determine the convection coefficients on both the water and steam side. You may find the equations in Incropera necessary to estimate the Nussult number for flow inside tubes for the cold side (note that the equation you should use depends on the Reynolds number). For the steam you will need to calculate the hydraulic diameter and read the section titled “The Concentric Tube Annulus”, assuming your edition of Incropera is the same as mine (if you cannot find it, I will help you).

Report if you find any evidence of fouling. To be able to say fouling has occurred, the sum of the theoretical resistances to heat transfer (convection from the steam, conduction through the inner pipe, and convection into the cold water) should not be within the error of the inverse of the overall heat transfer coefficient. That difference should represent the resistance to heat transfer due to such mechanisms as scale buildup (assuming there is less heat transferred than theory predicts). In your report, please recommend if we should attempt to remove scale buildup. Could we realize significantly improve heat transfer efficiency? Also, be sure to comment on what feel your findings, compared to my 13 year old findings, can tell us about the aging of this double pipe heat exchanger.

If you have any question regarding this project or what is expected of you, please feel free to contact me at any time. I look forward to our meeting on or before Wednesday, September 9th, 2009.