ME 332 Project 2
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Assumptions:

- Counterflow
- Neglect friction in coil
- Copper evaluated at 300K
- Water evaluated at 325K
- Uniform surface temperature
- Pure Copper

Short Essay 1:

When designing the size of the heat exchanger tubing I would consider using a lower wall thickness “thin walled” allowing more heat to transfer faster to optimize the performance of the system. Having a “thin walled” inner tube would mean that there would be no wall resistance thus increasing the heat transfer coefficient and yielding a higher q value. The tradeoffs of having a “thin walled” heat exchanger thickness would be possible structural shear stress problems with a small wall thickness unable to handle the force of the fluid flow in the pipe.

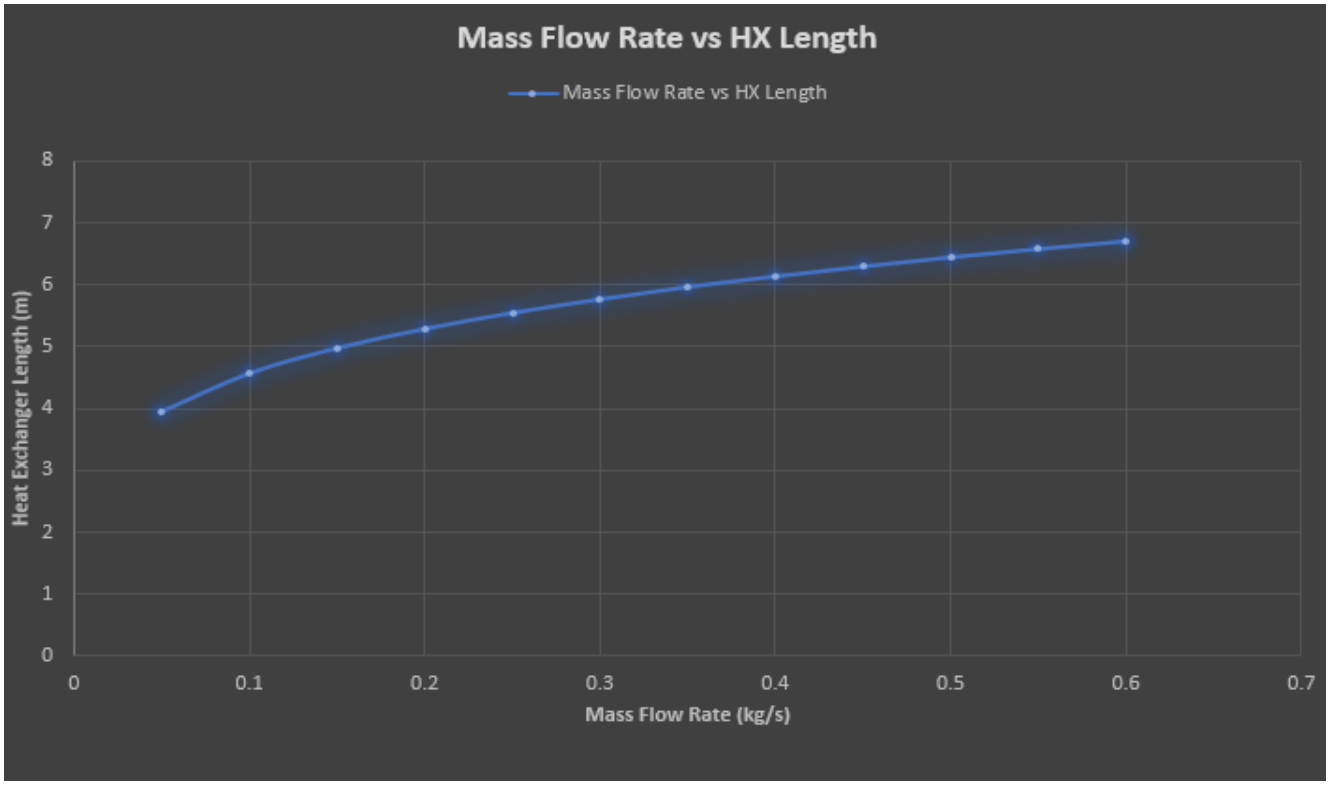
If the mass flow rate of cold water in the outside tube of the heat exchanger is increased, then the required length of the heat exchanger would be reduced. This is because the faster flowing cold water helps bring heat away from the hot water in the inner tube faster thus reducing the required length of the heat exchanger in order to reach the desired exit temperatures. However the trade-off with this design is that a pump might be needed in order to reach a specified mass flow rate which would require more power and take away some value of the reduced cost of the water purifier compared to boiling.

Decreasing the diameter of the coil tubing would decrease the size and length of the heat exchanger and copper tube which would save on material costs. However, in order to maintain the same mass flow rate and heat transfer rate there would need to be a powerful pump which would increase the power consumption. If the same mass flow rate can’t be produced, then the amount of water that can be purified in a given amount of time would be reduced. In order to ensure that this design consideration would actually optimize performance there would need to be some cost-benefit analysis.

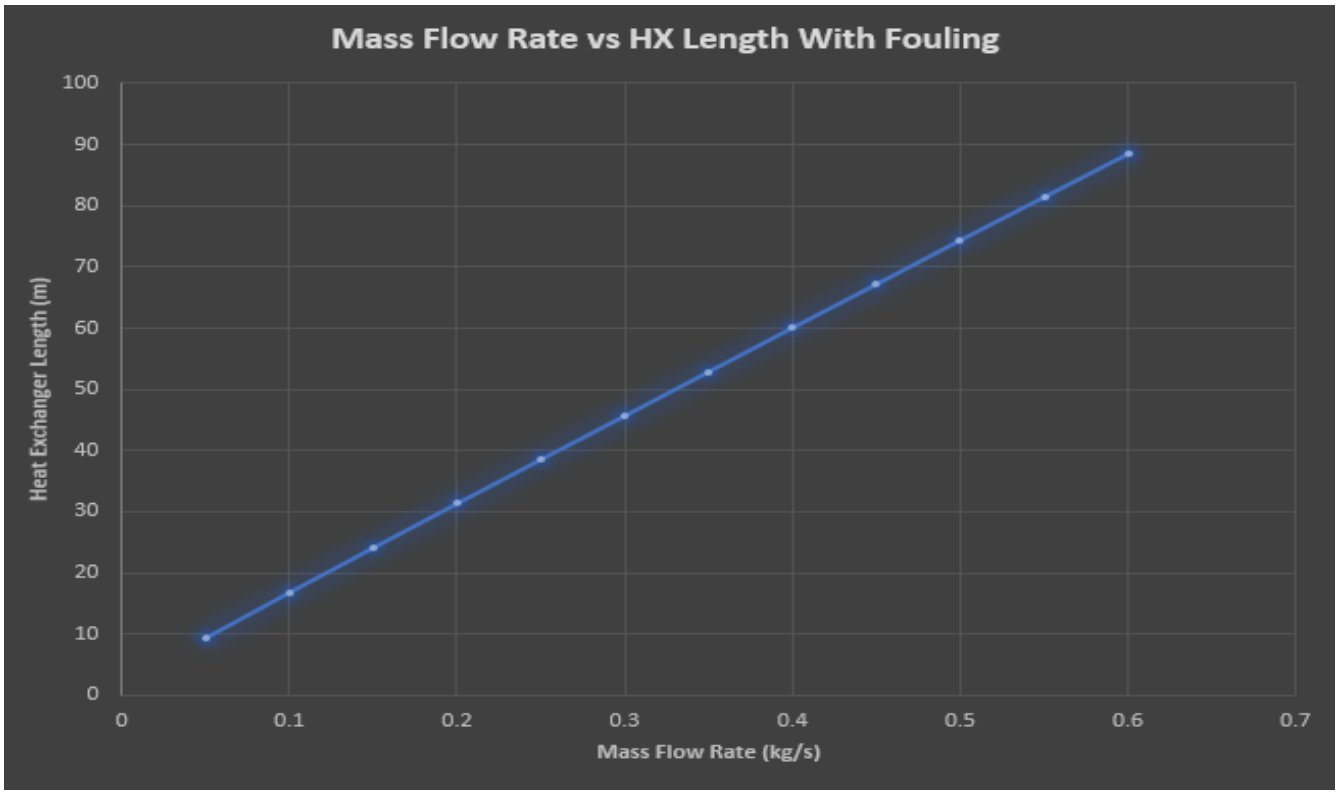
Short Essay 2:

A factor of safety can be applied to a couple of parameters involved in the design of the water purifier to ensure that the water is safely pasteurized. These parameters include the required length of the HX and the required length of the coil. Increasing the length beyond what is “required” would ensure that the fluid has enough time or distance inside the heat exchanger and pot to reach the desired temperature of heating and cooling in order for the water to be purified. A factor of safety of 2 is common in reality and would apply to this product as well. As listed before, a pump would ensure that the cooling rate inside the heat exchanger is adequate and it would help control the mass flow rate which is subject to high variability. If the mass flow rate varies too much then the water might not have enough time or travel a far enough distance within the tubes to reach the desired temperatures as designed. Increasing the desired temperature of the water that is brought into the kill chamber would ensure that the water is being pasteurized and would leave more room for errors in calculations or sensor data. However, all these safety considerations would increase the cost of the product because of more material being required and more power consumption due to the pump.

Plot 1:


Mass Flow Rate vs HX Length
Mass Flow Rate vs HX Length
Heat Exchanger Length (m)
0
1
2
3
4
5
6
7
8
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Mass Flow Rate (kg/s)

Plot 2:


Mass Flow Rate vs HX Length With Fouling
Heat Exchanger Length (m)
0
10
20
30
40
50
60
70
80
90
100
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Mass Flow Rate (kg/s)