ME 4465

Design Problem #2 Thermal Fluids Systems Design Fall 2018

Due Thursday, 18 October 2018 by 5:00pm (IF students upload to Moodle as a pdf file, Poc students submit project to the office in LEL (must have a time stamp). No projects will be accepted after the deadline.

Given the schematic diagram below of a proposed pump loop:

1. Design the piping system to handle the corresponding pressure drop of the design. The given design point of this system (Q*) is to be capable of overcoming the pressure drop of the system that includes a 100 psi pressure drop in the test section at a flow rate of 700 gpm (a plot of the pressure drop as a function of flow rate is given below). The flow velocity should not exceed 15 ft/s. Schedule 40 steel pipe is to be used.

2. Select and size a pump to handle the given flow rate and discharge pressure needed. Do not forget to consider the $NPSH_A$ versus $NPSH_R$, assuming that the water level open to atmospheric pressure (assume 12.5 psia) is at the top of the standpipe. You will need to provide the pump performance curves for the selected pump, showing the point of operation (you may use a straight edge and pen to show the point). Links to the Bell & Gosset are provided below. **For commonality of design, use a centrifugal pump**. If another pump manufacturer is used, you must provide the same documentation.

3. Determine the time required for the pump to heat the water from 50 °F to 140 °F, neglecting heat losses due to natural convection to the surroundings. For example, the power consumed by the pump in the form of hydraulic power has to be dissipated into the water – how long does it take this power to heat the water 90 °F. Do not forget to include the volume of water in the piping.

As part of the deliverable for this problem, include:

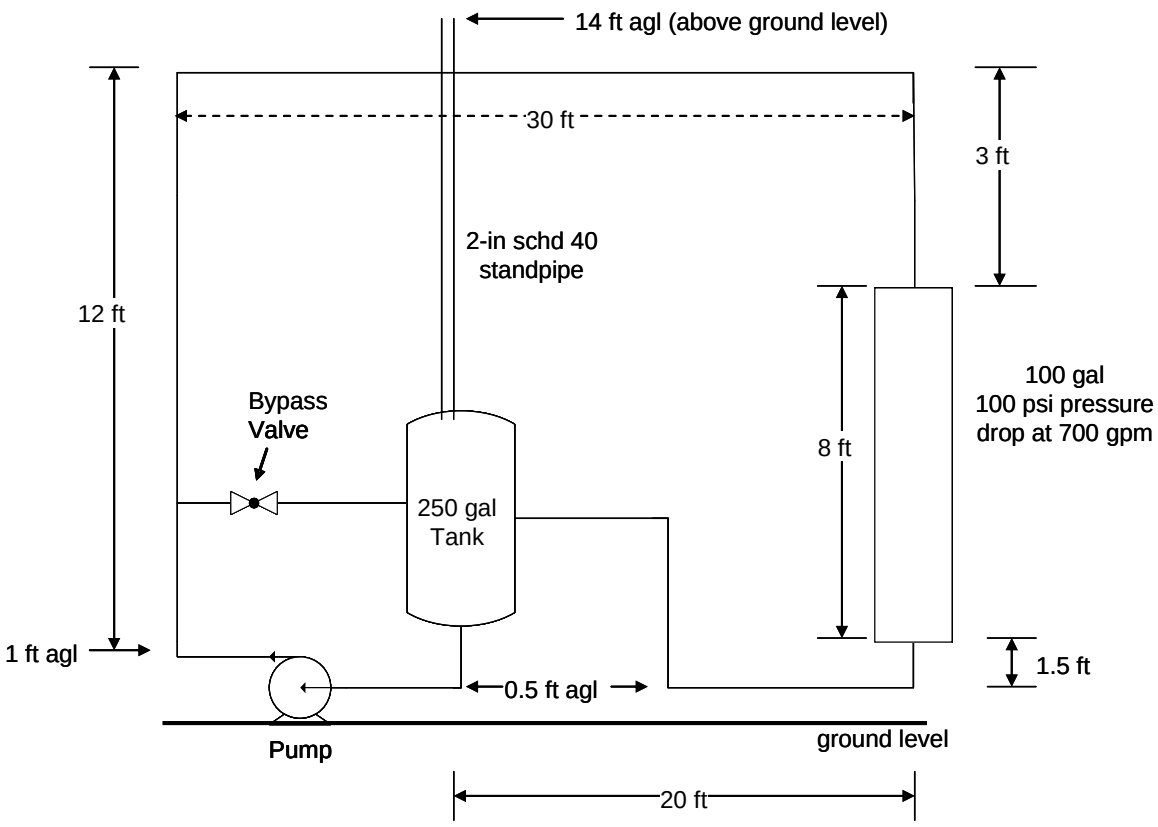
- A layout of your piping design (in P&ID format)
- Verification of maximizing efficiency and minimizing the power to the pump. Use the Bell and Gossett selection charts (link below) and compare at least two different pumps. Include the charts in your report.
- A table of loss coefficients (K values) for all fittings & components for the pump chosen. Remember you need to match inlet and exit diameters and type (flanged, screwed, etc).
- Information needed to find and verification of the pipe friction factor (via coded equations).
- Adequate references for all values (e.g., fluid properties, K values, etc.)
- Adequate calculated proof demonstrating that your design meets the requirements.

Use of computer tools (SW, Matlab, Maple, Excel, Engineering Toolbox, etc) is required for the project. No hand sketches. Include any programs developed.

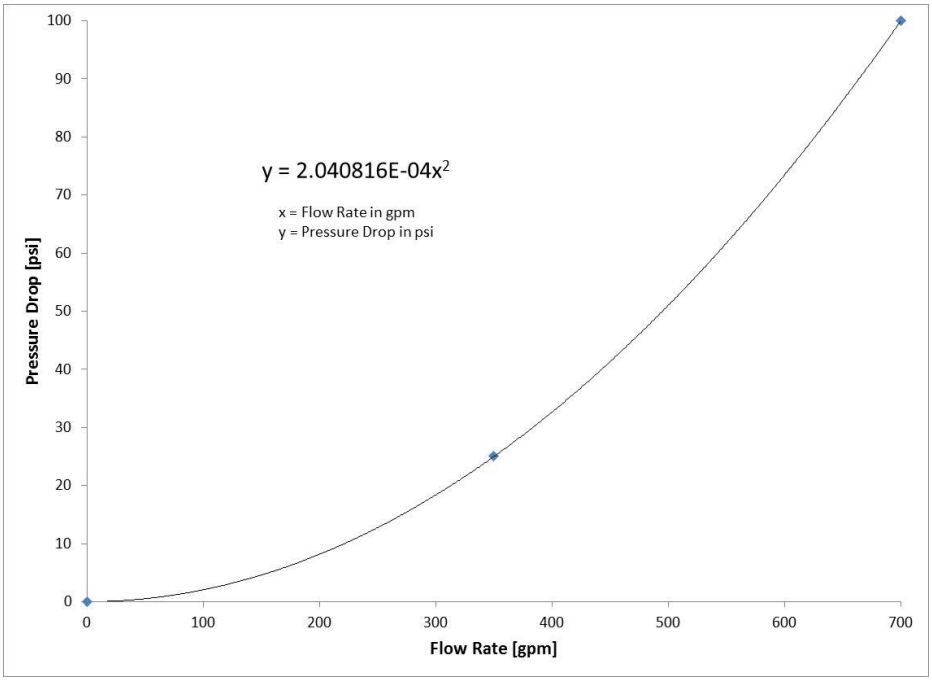
Summarize your design in a memo report. Provide proof of your design validity (i.e. calculations using Matlab or Excel and sample hand calcs to verify code.) and show the system curve relative to the pump performance curve. Your objective should be to maximize efficiency and minimize the power consumption by the pump. **Please refer to the grading rubric for required project elements.**

Bell and Gosset: http://bellgossett.com/pumps-circulators/
Bell and Gosset Selection Charts:

Series e-1510 - http://bellgossett.com/pumps-circulators/end-suction-pumps/e-1510/#product-tab-curves


14 ft agl (above ground level)
30 ft
3 ft
2-in schd 40
standpipe
12 ft
Bypass
Valve
250 gal
Tank
8 ft
100 gal
100 psi pressure
drop at 700 gpm
1 ft agl
0.5 ft agl
1.5 ft
Pump
ground level
20 ft

(not to scale)


y = 2.040816E-04x2
x = Flow Rate in gpm
y = Pressure Drop in psi
Pressure Drop [psi]
Flow Rate [gpm]
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700