CM3215 Assignment 6:
System-head Curves for a Proposed Piping System
Under Conditions of Different Needle-Valve Positions

Due: Friday 30 October 2015 10:05am in Homework Box A
This is an individual assignment. Note the due time.

Complete all calculations described below; you may verbally consult with any of your classmates, but you must submit individual assignments that represent your own work; you may not exchange papers or electronic files. Deliver your submission with a memo of transmittal that clearly lists where to find your submitted answers to the four assigned objectives. You must submit only your own work.

Overall objective: Determine the equations for the system-head curves for a flow loop under three different operating conditions (three different needle valve settings) The three different systems are described below. Plot these curves as instructed.

In a future laboratory, you will predict the performance of a particular pump (the laboratory Lossy® pump) when it is installed to provide the flow energy against the three systems described here. Week 12 you will “build” this system, “install” the Lossy® pump, and check the accuracy of your Assignment 5 predictions by measuring the actual performance of the Lossy® pump against the three systems.

1. Sketch the following system using Visio or by hand (make the sketch 8.5 by 11 inches, approximately). The system is a subset of our laboratory station.

The systems:
The three systems are three different metering valve settings for a flow loop containing:

- Source tank: 12.5 inch inner diameter; discharge through the bottom to 1” nominal copper tubing, type L
- 36.25 inches of 1” nominal, type L copper tubing; this tubing leads from the bottom of the source tank to the suction side of where the pump will be installed.
- Three, 90° elbows, 1” nominal, copper tubing
- A position for a constant-speed pump (1” connection available on suction side, ½” connection available on the discharge side)
- 98.5 inches of ½” nominal, type L copper tubing; this tubing conducts water from the discharge side of the pump through the rest of the system until exiting to the air above the destination tank.
- Two, ½ inch, 3-way ball valves
- Six 90° elbows, ½” nominal, type L copper tubing
• Destination tank: 12.5 inch inner diameter; receives efflux from the discharge of ½'' nominal type L copper tubing discharging to air; the discharge point is 5'' above the surface of the water in the tank. The tank is open to air.

• One Swagelock Integral-Bonnet Needle Valve, 18 series needle valve, regulating stem, 0.375'' orifice, set to the three different positions described in note 2 (note: the valve orifice size is part of the specifications of the needle valve; the valve is not an orifice meter and has nothing to do with an orifice meter).

2. We are interested in three positions of the needle valve, ½ turns open, 1 turn open, and 2 turns open (a turn is 360°). For the Swagelock needle valve in brand-new condition, you need to determine the friction coefficient $K_f$ for the three requested valve positions: ½ turn open, 1 turns open, and 2 turns open. Dr. Morrison’s handout shows how this calculation is done, and the answer at one valve position is given in her notes: [www.chem.mtu.edu/~fmorriso/cm3215/Cv_control_valves_2013.pdf](http://www.chem.mtu.edu/~fmorriso/cm3215/Cv_control_valves_2013.pdf)

3. Calculate system head versus capacity for the three flow systems. Determine equations (curve fits) for the system-head curves $H_{system}(Q)$ for the flow loop metered by the Swagelock Needle Valve in the following three positions: ½ turn open, 1 turns open, 2 turns open. Give a table indicating the values of friction coefficients $K_f$ you used for each of the fittings you included in your calculations. Give head in units of $ft$ and capacity in units of $gpm$.

4. On a single graph, plot the three system-head curves from item 3 as a function of capacity (volumetric flow rate in $gpm$, which is gallons per minute). When choosing your plotting limits, for the flow rate use $0 \leq Q \leq 4gpm$. As always, include appropriate captions in your figures and tables. We are interested in system head of at most 100 $ft$; limit your $y$-axis to 100 $ft$.

Deliver your submission with a memo of transmittal that clearly lists where to find your submitted answers to the four assigned objectives.