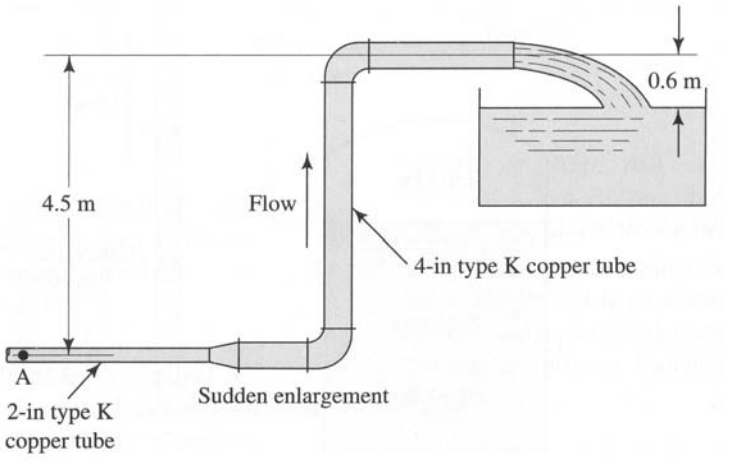
10.303 & 14.301 Fluid Mechanics

Homework Assignment #11 Fall 2006

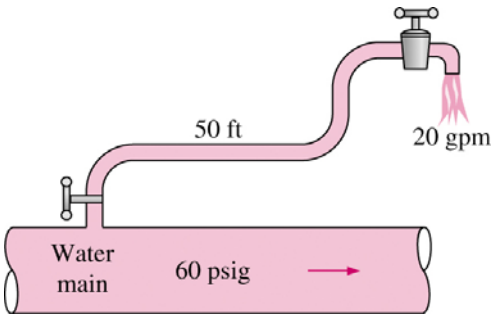
Viscous Flow and Pump Applications

1. At a ski resort, water at 5 C is pumped through a 3'' Sch 40 steel pipe (ID = 7.79 cm and ε = 0.046 mm) from a pond at an elevation of 1300 m to a snow-making machine at an elevation of 1425 m at a flow rate of 0.01 m^3/sec. The total length of pipe is 610 m. The desired gauge pressure at the snow-making machine is 1.25 MPa. Neglecting minor losses and assuming a pump efficiency of 70%, what pump power (in Watts) is needed for this application?

2. Oil with sg = 0.93 and $\mu = 9.5 \times 10^{-3}$ N-s/m^2 is flowing into the open tank as shown. The total length of 2" tubing is 30 m (ID = 0.4976 m). For the 4" tubing (ID = 0.9797 m), the total length is 100 m. The two 90° bends are standard flanged elbows. Determine the volume flow rate in m^3/s into the tank if the pressure at point A is 175 kPa.



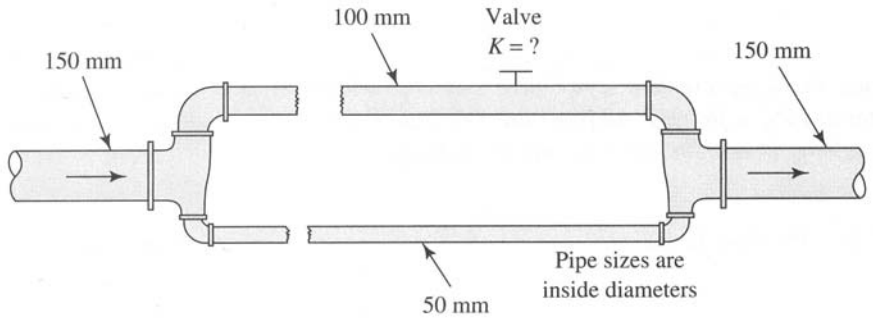
3. A water fountain is to be installed at a remote location by attaching a cast iron pipe directly to the large water main through which water is flowing at 70 F and 60 psig. The entrance to the pipe is sharp edged, and the 50 ft long piping system involves three 90° miter bends without vanes, a fully open gate valve, and an angle valve with a loss coefficient of 5 when fully open.



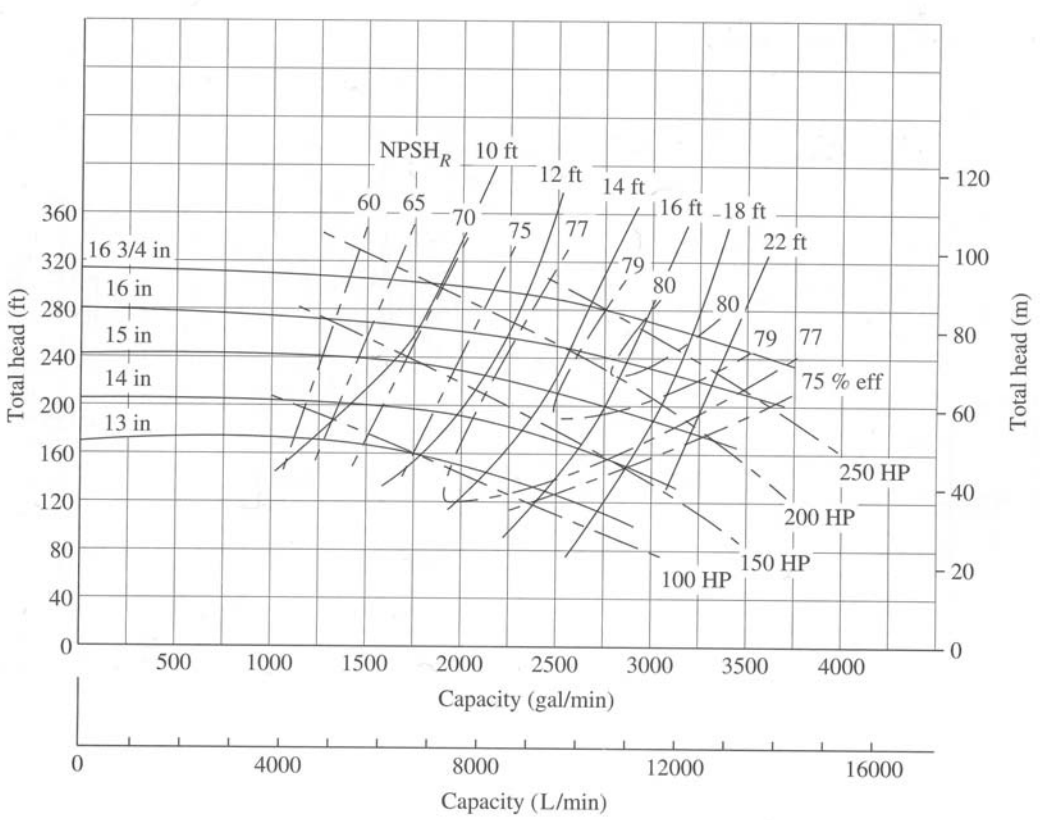
If the system is to provide water at a minimum rate of 20 gal/min and the elevation difference between the pipe and the fountain is negligible, determine the minimum diameter of the cast iron piping system.

4. A 150 mm pipe branches into a 100 mm and a 50 mm pipe as shown below. Both pipes are copper and 30 m long. The fluid is water at 10 C.

Determine the resistance coefficient K of the valve needed to obtain equal volume flow rates of 500 L/min in each branch. Assume that each elbow has a resistance coefficient of K = 0.3.



5. Consider the centrifugal pump curves shown below.



A specific pump from this family with a 15" impeller is to be used to move water at 60 F from a stream to a reservoir whose surface is 150 ft above the level of the stream. The pipe from the pump to the reservoir is an 8" Sch 40 steel pipe 2500 ft long (ID = 0.6651 ft and $\varepsilon = 1.5 \times 10^{-4}$ ft).

Neglecting losses in the short suction line and the minor losses in the discharge line, what is the approximate flow rate (gal/min) for this system? Also, at this operating point, determine the power added to the fluid, the pump efficiency, and the total pump power (brake horsepower).