November 30, 2015

NAME

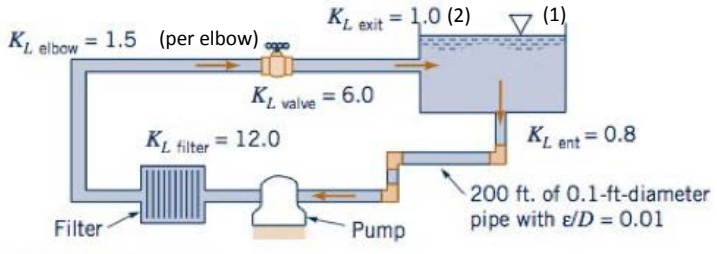
Fluids-ID

Quiz 14. Water is circulated from a large tank, through a filter and a back to the tank with L=200 ft long pipe system as shown in Figure. The power added to the water by the pump, P, is 200 ft·lb/s.(ρ = 1.94 slugs/ft^3; μ= 2.34×10^{-5} lb·s/ft^2; g = 32.2 ft/s^2; 1 hp = 550 ft·lbf/s)

Energy Equation

$$\frac{p_1}{\rho g}+\frac{V_1^2}{2g}+z_1+h_p=\frac{p_2}{\rho g}+\frac{V_2^2}{2g}+z_2+\frac{V^2}{2g}\left(\frac{fL}{D}+\sum K_L\right)$$

Where V is the average velocity throught the pipe



Friction Factor Equation (The Haaland eq.)

$$\frac{1}{\sqrt{f}}=-1.8\log\left[\left(\frac{\varepsilon/D}{3.7}\right)^{1.11}+\frac{6.9}{Re}\right]$$

a) Simplify energy equation using the given conditions and determine velocity, *V*, as a function of friction factor, *f*. (Hints: Apply the energy equation beginning from the reservoir surface (1) and end at the same reservoir surface (2). You will also need to use eq. $P=\rho g Q h_p$)

b) Use the given conditions and determine Reynolds number, $Re=\rho VD/\mu$, as a function of velocity, *V*.

c) Determine velocity *V* by following the steps listed below

   1) Assume f = 0.04 as your first guess and find *V* using the equation from (a)
   2) Find *Re* using the equation from (b) and the *V* from the previous step
   3) Find a new *f* using the Haaland equation and *Re* from step 2)
   4) Find a new *V* using the *f* from step 3) and the equation from (a)
   5) Repeat the steps 2) through 4) until *f* is converged to the thousandth decimal point

d) Determine the flowrate through the filter.

Note: Attendance (+2 points), format (+1 point)