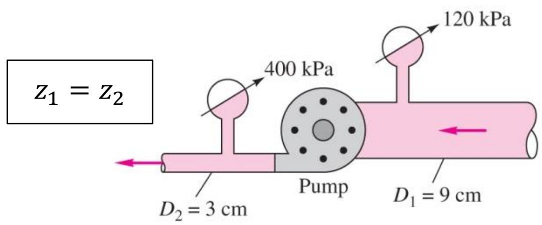
Name :______________________ **Quiz: No. 4** **Time: 20 minutes**

Course: ME 5160, Fall 2024

The exam is closed book and closed notes.

The horizontal pump in the Figure below discharges water at 57 m^3/h. The losses between 1 and 2 are given by $h_f = K\frac{V_1^2}{2g}$, where $K \approx 7.5$ is a dimensionless loss coefficient. Take the kinetic energy correction factor $\alpha \approx 1.06$ for both sections 1 and 2 and find the power delivered to the water by the pump (water density is 1000 kg/m^3).



Energy Equation (for incompressible steady flow):

$$\left(\frac{p}{\rho g} + \frac{\alpha V^2}{2g} + z\right)_1 = \left(\frac{p}{\rho g} + \frac{\alpha V^2}{2g} + z\right)_2 + h_{turbine} - h_{pump} + h_{friction}$$

Hint: $P_{pump} = \rho g Q h_{pump}$

Name :_________________ **Quiz: No. 4** **Time: 20 minutes**

(2)

Course: ME 5160, Fall 2024

Solution

KNOWN: Q, h_f, α

(1) FIND: pump power P_p

ASSUMPTIONS: incompressible, steady flow, one inlet one outlet

ANALYSIS:

Steady flow energy equation:

$$V_1 = \frac{Q}{A_1} = \frac{57/3600}{\pi(0.045)^2} = 2.49\ \frac{m}{s};\quad V_2 = \frac{Q}{A_2} = \frac{57/3600}{\pi(0.015)^2} = 22.4\ \frac{m}{s}$$ (1)

$$\frac{p_1}{\rho g} + \frac{\alpha V_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{\alpha V_2^2}{2g} + z_2 + h_f - h_p$$ (3)

$$h_f = (7.5)\frac{(2.49)^2}{2\times 9.81} = 2.37\ m$$ (0.5)

$$\frac{120\times 1000}{1000\times 9.81} + \frac{(1.06)(2.49)^2}{2(9.81)} + 0 = \frac{400\times 1000}{1000\times 9.81} + \frac{(1.06)(22.4)^2}{2(9.81)} + 0 + 2.37 - h_p$$ (1)

$$\Rightarrow h_p = 57.69\ m$$ (0.5)

Then the power by the pump is:

$$P_p = \rho g Q h_p = (1000)(9.81)\left(\frac{57}{3600}\right)(57.69)$$ (0.5)

$$= 8960.7\ W = 8.9\ kW$$ (0.5)