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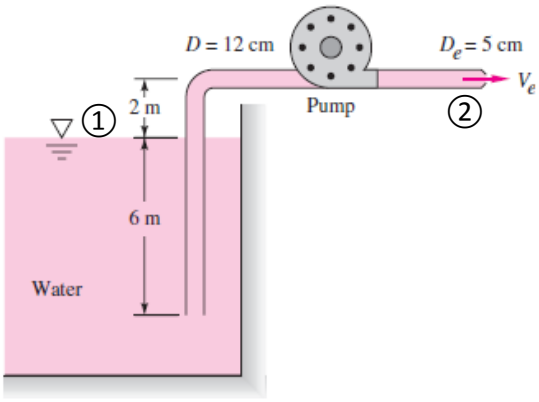
NAME

Fluids-ID

Quiz 9. When the pump in the figure draws 220 m^3/h of water at 20 °C from the reservoir, the total friction head loss is 5 m. The flow discharges through a nozzle to the atmosphere. Estimate the pump power in kW delivered to the water.



Hint.

1) gravity, $g = 9.81 m/s^2$
2) density, $\rho = 998\ kg/m^3$
3) $\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + z_1 + h_p = \frac{p_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_L$
4) Pump power, $P = \rho g\, Q h_p$

Solution

Let 1 be at the reservoir surface and 2 be at the nozzle exit.

$$V_2 = \frac{Q}{A_2} = \frac{\frac{220}{3600}}{\pi(0.025)^2} = 31.12 m/s$$

(+2 points)

Assume $V_1 = 0$ if the reservoir is sufficiently large.

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

(+5 points)

Thus,

$$0 + 0 + 0 = 0 + \frac{(31.12)^2}{2(9.81)} + 2 + 5 - h_p$$

$$h_p = 56.4\ m$$

(+1 points)

The pump power, P,

$$P = \rho g\, Q h_p = (998)(9.81)\left(\frac{220}{3600}\right)(56.4) = 33.7\ kW$$

(+2 points)