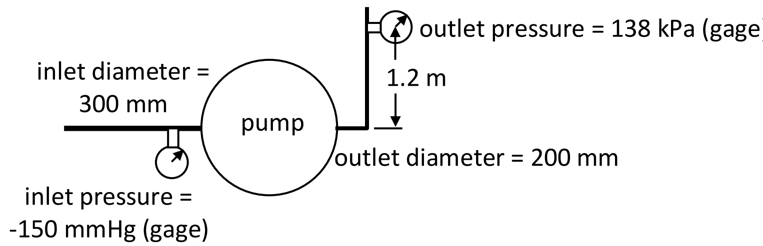
Brine, with a specific gravity of 1.2, passes through an 85% efficient pump at a flow rate of 125 L/s. The centerlines of the pump's 300 mm diameter inlet and 200 mm diameter outlet are at the same elevation. The inlet suction gage pressure is 150 mm of mercury (specific gravity of 13.6) below atmospheric pressure. The discharge pressure is measured 1.2 m above the centerline of the pump's outlet and indicates 138 kPa (gage). Neglecting losses in the pipes, what is the input power to the pump?



SOLUTION:

The power into the pump may be found from the head rise across the pump, the flow rate through the pump, the brine properties, and the pump efficiency:

$$\eta = \frac{W_{\text{into fluid}}}{W_{\text{into pump}}} \Rightarrow W_{\text{into pump}} = \frac{W_{\text{into fluid}}}{\eta} \quad (1)$$

where

$$W_{\text{into fluid}} = \rho Q g H \quad (2)$$

and

$$H = \left(\frac{p_{\text{outlet}} - p_{\text{inlet}}}{\rho g}\right) + \left(\frac{V_{\text{outlet}}^2 - V_{\text{inlet}}^2}{2\text{g}}\right) + \left(z_{\text{outlet}} - z_{\text{inlet}}\right) \quad (3)$$

Using the given data:

η	= 85%	
ρ	= (1.2)(1000 kg/m^3) = 1200 kg/m^3	(4)
g	= 9.81 m/s^2	
$z_{\text{outlet}} - z_{\text{inlet}}$	= 1.2 m	
p_{outlet}	= 138*10^3 Pa (gage)	
p_{inlet}	= $\rho_{Hg} g h$ = -(13.6)(1000 kg/m^3)(9.81 m/s^2)(0.150 m) = -20000 Pa (gage)	(5)
Q	= 125 L/s = 0.125 m^3/s	
D_{outlet}	= 0.200 m	
D_{inlet}	= 0.300 m	
V_{outlet}	= $Q/\left(\frac{\pi}{4} D_{\text{outlet}}^2\right)$ = 3.98 m/s	(6)
V_{outlet}	= $Q/\left(\frac{\pi}{4} D_{\text{inlet}}^2\right)$ = 1.77 m/s	(7)

$\Rightarrow H$ = 15.3 m

$\Rightarrow W_{\text{into fluid}} = 22.5\text{ kW}$

$\therefore \boxed{W_{\text{into pump}} = 26.4\text{ kW}}$