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8.2. It is proposed to pump 10,000 kg/h of toluene at 114°C and 1.1 atm abs pressure from the reboiler of a distillation tower to a second distillation unit without cooling the toluene before it enters the pump. If the friction loss in the line between the reboiler and pump is 7 kN/m^2 and the density of toluene is 866 kg/m^3, how far above the pump must the liquid level in the reboiler be maintained to give a net positive suction head of 2.5 m?

$F = \frac{\Delta P}{\rho} = \frac{7000}{866} = 8.08$ $\quad \therefore P_a' = P_v = 1.1\ atm$

$NPSH \equiv \frac{1.1 \times 101370}{866} - \frac{8.08}{g} - (z_a - z_a') - \frac{P_v}{\rho g}$

$z_a = -2.5 - \frac{8.08}{9.8} = -3.32\ (m)$

$\therefore$ 3.32 above the pump suction.

8.8. A horizontal venturi meter having a throat diameter of 20 mm is set in a 75-mm-ID pipeline. Water at 15° C is flowing through the line. A manometer containing mercury under water measures the pressure differential over the instrument. When the manometer reading is 500 mm, what is the flow rate in m^3/h? If 12 percent of the differential is permanently lost, what is the power consumption of the meter?

$P_a - P_b = \rho g h = 0.5(13.6-1)\ 999 \times 9.8 = 61678\ N/m^2$

$C_D = 0.98$

$A_b = \frac{1}{4}\pi (0.02)^2 = 3.14 \times 10^{-4}$

$G = \frac{C_D A_b}{\sqrt{1-\beta^4}} \sqrt{2\rho(P_a - P_b)}$ $\quad \beta = \frac{D_b}{D_a} = \frac{20}{75} = 0.0056 \ll 1$

$= 0.98 \times (3.14 \times 10^{-4}) \sqrt{2 \times 999 \times 61678} = 3.146 = \frac{\dot{V} \cdot 999}{3600}$

$\dot{V} = 12.31\ m^3/h$ ✱

Power loss : $0.12 \times G \times \frac{\Delta P}{\rho} = 0.12 \times 3.146 \times \frac{61678}{999}$

$= 23.3\ W$ ✱