3.160 The air-cushion vehicle in Fig. P3.160 brings in sea-level standard air through a fan and discharges it at high velocity through an annular skirt of 3-cm clearance. If the vehicle weighs 50 kN, estimate (a) the required airflow rate and (b) the fan power in kW.
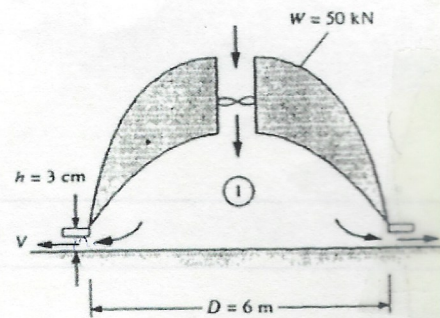

Fig. P3.160

Bernoulli:

$$P_1 + \frac{1}{2}\rho V_1^2 = P_e + \frac{1}{2}\rho V_e^2 \qquad V_1 = 0 \quad \text{neglect airflow in air cushion}$$
$$P_e = P_{atm}$$

$$P_1 - P_{atm} = \frac{W}{A} = \frac{50,000 \text{ N}}{\pi 3^2 \text{ m}^2} = \frac{1}{2}\rho V_e^2$$

$$\underbrace{\qquad\qquad}_{1768 \text{ Pa}} = \frac{1}{2}(1.205)V_e^2$$

$$V_e = 54.2 \text{ m/s}$$

$$Q = A_e V_e = \pi 6 \times .03 \times 54.2$$
$$= 30.6 \frac{m^3}{s}$$

$$P = \Delta P Q = Q_e \Delta P = 30.6 \times 1768$$
$$= 54,000 \text{ W}$$

$$= FV$$
$$= F Q$$
$$\quad \cancel{A}$$
$$= \Delta P Q$$