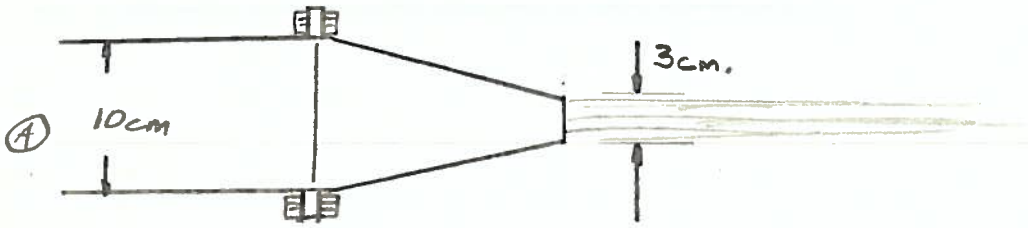
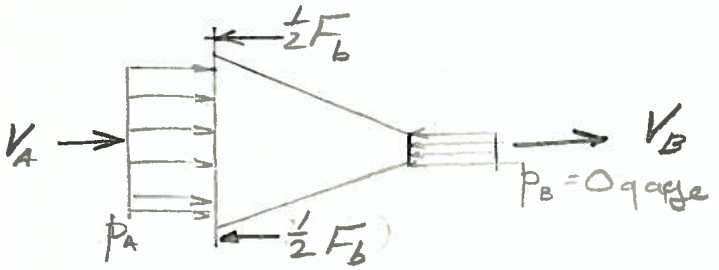
EXAMPLE (MOMENTUM)



10 cm. FIRE HOSE DISCHARGES 1.5 m^3/min TO THE AIR. FIND THE FORCE EXERTED BY THE FLANGE BOLTS TO HOLD THE NOZZLE TO THE HOSE. ASSUME FRICTIONLESS FLOW.

p_A = 620,000 Pa



CONTINUNITY

$A_A V_A = A_B V_B$ (INCOMPRESSIBLE, STEADY FLOW)

$$A_A = \frac{\pi d^2}{4} = \frac{\pi (0.10m)^2}{4} = 0.00785 m^2$$

$$A_B = \frac{\pi d^2}{4} = \frac{\pi (0.03m)^2}{4} = 0.000706 m^2$$

$$V_A = \frac{Q}{A_A} = \frac{1.5 m^3/min}{0.00785 m^2} = 191.082 m/min = 3.2 m/s$$

$$V_B = \frac{Q}{A_B} = \frac{1.5 m^3/min}{0.000706 m^2} = 2122 m/min = 35.4 m/s$$

MOMENTUM

MOMENTUM IN: $-\rho V_A^2 A_A = -\left(1000 \frac{kg}{m^3}\right)\left(3.2 \frac{m}{s}\right)^2 (0.00785 m^2)$

$= -80.38 \frac{kg \cdot m}{s^2} = -80.38 N$

MOMENTUM OUT: $\rho V_B^2 A_B = \left(1000 \frac{kg}{m^3}\right)\left(35.4 \frac{m}{s}\right)^2 (0.000706 m^2)$

$= 884.73 \frac{kg \cdot m}{s^2} = 884.73 N$

$\left.\frac{d\,\text{MOMENTUM}}{dt}\right|_{C.V.} = 0$

$\Sigma F_x = -F_b + \int dp_a A_A = \underbrace{\int_{C.S} \rho V (V \cdot n)\, dA}_{\text{NET MOMENTUM ENTERING C.V.}}$

$p_A A_A - \int_{C.S} \rho V (V \cdot n)\, dA = F_b$

$(620{,}000)(0.00785) - 884.73N + 80.38N = F_b$

$4867N - 884.73N + 80.38N = F_b$

$4062 N = F_b$ ←

$(\approx 915\ 16f.!)$