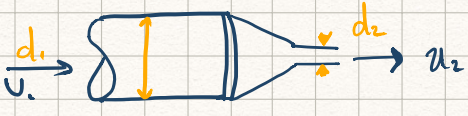
Q_1



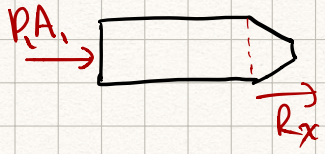
Known

$d_1 = 0.1\ m$
$d_2 = 0.02 m$
Temp $= 15°C$
$u_2 = 25\ m/s$

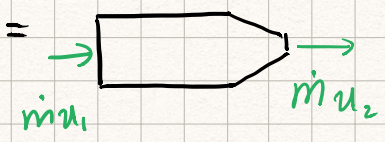
Find

$P_1 =$
$R_x =$

1 - FD



2 - Momentum



Solu

CE

$$Q_1 = Q_2$$

$$A_1V_1 = A_2V_2$$

$$V_1 = \frac{A_2V_2}{A_1} = \left(\frac{0.02}{0.1}\right)^2 \times 25 = 1\ m/s$$

Momentum

$$\dot{m}_1 = \dot{m}_2$$

$$\rho Q_1 = \rho Q_2 = (999)\left(\frac{\pi}{4}(0.02)^2\right) \times 25 = 7.85\ \frac{kg}{s}$$

Bernoulli

$$\frac{P_1}{\gamma} + \cancel{z_1} + \frac{V_1^2}{2g} = \frac{P_2}{\gamma}^{0 = atm} + \cancel{z_2} + \frac{V_2^2}{2g} \qquad z_1 = z_2$$

$$P_1 = -\frac{\rho V_1^2}{2} + \frac{\rho V_2^2}{2} = \frac{999}{2}(25^2 - 1^2)$$

$$P_1 = 311\ P_a$$

Momentum Eq:

$$\Sigma F_{ext} = \frac{d}{dt}\int_{cv} u_x \rho\, d\forall^{0} + \Sigma \dot{m}_{out} u_{out} - \Sigma \dot{m}_{in} u_{in}$$

$$\Sigma F_x = \dot{m}_{out} u_{out} - \dot{m}_{in} u_{in}$$

$$F_x = \dot{m}(u_{out} - u_{in}) \quad \text{---(1)}$$

$$\Sigma F_x = R_x + P_1 A_1 \quad \text{... (2)}$$

① = ②

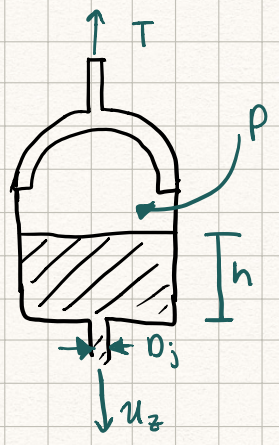
$$R_x + P_1 A_1 = \dot{m} (u_{out} - u_{in})$$

$$R_x = \dot{m} (u_{out} - u_{in}) - P_1 A_1$$

$$= (7.85)(25 - 1) - \left(311700 \times \frac{\pi}{4} (0.1)^2\right)$$

$$= -2259.7$$

Q2.

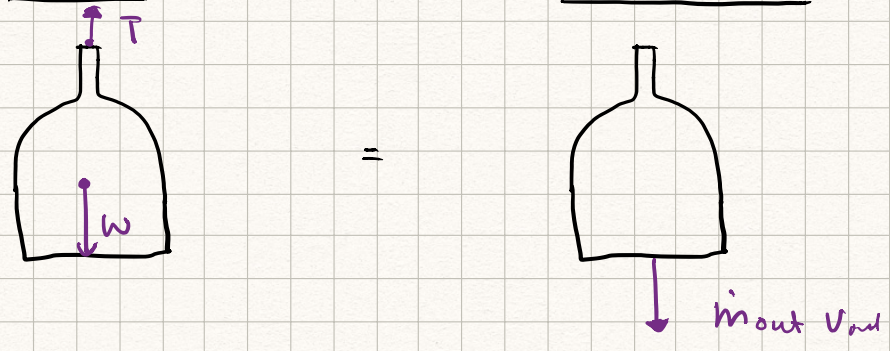


Known

Temp = 15°C
W = 200N
h = 425mm = 0.452m
D_j = 0.012m
T = 10 N (Tension)

Find

p



Sol'n

$$\Sigma F_{ext} = \cancel{M a_{cc}}^{\,0} + \sum_{cs} \dot{m}_{out} v_{out} - \cancel{\sum_{cs} \dot{m}_{in} v_{in}}^{\,0}$$

$$F_z = \dot{m}_{out}(-v_y) = \rho Q v_z$$
$$= -\rho A v_z^2$$

Sum of forces

$$\Sigma F_z = T - W$$

Sub

$$T - W = \rho Q v_z^2 \Rightarrow 10 - 200 = 999\left(\frac{\pi}{4}(0.012)^2\right) u_z^2$$

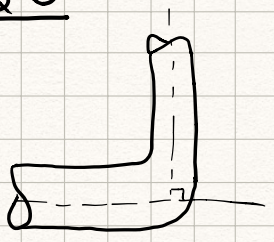
$$v_z = 41.01 \text{ m/s} \quad \text{(downward)}$$

BE:

$$p_1 + \cancel{\rho g z} + \frac{\rho u_1^2}{2}^{\,0} = \cancel{p_2}^{\,0} + \rho g z_2 + \frac{\rho u_2^2}{2}$$

$$p_1 = -\rho g(h) + \rho \frac{v_z^2}{2} = 835.9 \text{ kPa}$$

Q3



Known

$P = 300\,kPa$

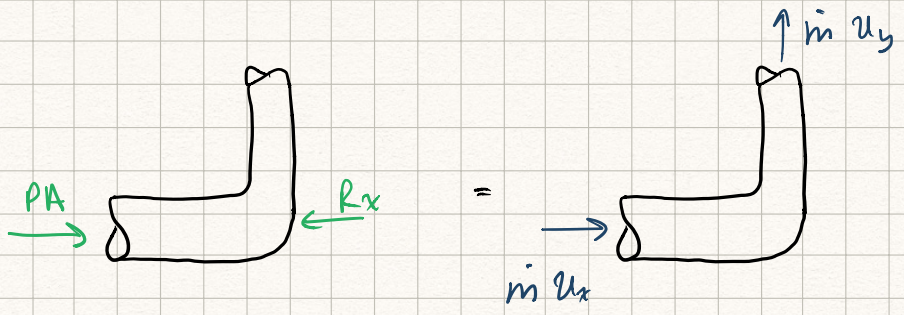
$D_{pipe} = 1\,m$

$Temp = 10°C$

$Q = 10\,m^3/s$

Find

R_x



Sum of forces

$$\Sigma F_x = P_1 A + R_x \quad (1)$$

Momentum Eq:n

$$\Sigma F_x = \frac{d}{dt}\int_{cv} acc \; dV + \Sigma \dot{m}_{out} u_{out} - \Sigma \dot{m}_{in} u_{in}$$

(0 out in x)

$$F_x = -\rho Q u_x$$

$$u_x = \frac{Q}{A} = \frac{10}{\frac{\pi}{4}(1)^2} = 12.73\ m/s$$

$$R_x + P_1 A = -\rho (10)(12.73)$$

$$R_x = -362.9\,kN$$