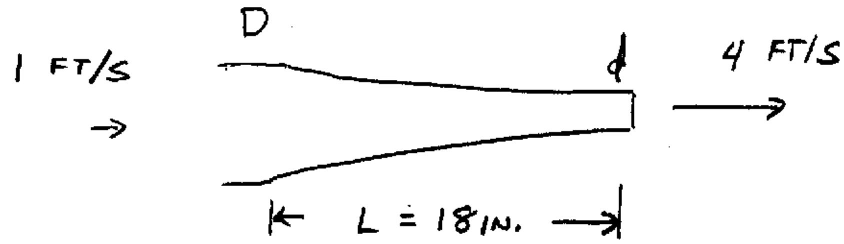
4.22 GIVEN: NOZZLE WITH LINEAR VARIATION OF VELOCITY FROM BASE TO TIP.



FIND: CONVECTIVE ACCELERATION MIDWAY BETWEEN BASE AND TIP

SOLUTION: THE ONLY NON-ZERO TERM IN EQUATION 4.11 IS:

$$a_x = u \frac{\partial u}{\partial x}$$

SINCE THE VELOCITY VARIATION IS LINEAR

$$a_x = u \frac{\Delta u}{\Delta x} = \frac{4 \frac{FT}{S} - 1 \frac{FT}{S}}{\frac{18}{12} FT} u$$

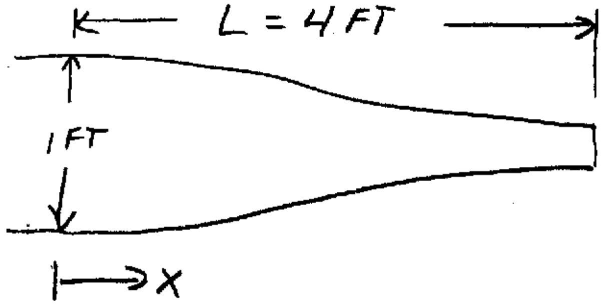
AT THE MIDPOINT BETWEEN THE BASE AND THE TIP: $u = \frac{1+4}{2} = 2.5 \frac{FT}{S}$

$$a_x = \frac{3 \frac{FT}{S}}{\frac{18}{12} F} \left(2.5 \frac{FT}{S}\right)$$

$$\boxed{a_x = 5 \frac{FT}{S^2}}$$

4.26 GIVEN: NOZZLE WITH VELOCITY:

$$V = \frac{2t}{(1 - 0.5\,\frac{x}{L})^2} \quad \left(\frac{FT}{S}\right)$$



FIND: LOCAL AND CONVECTIVE ACCELERATION

AT $x = 0.5\,L$ AND $t = 3\,S$

SOLUTION: LOCAL ACCELERATION $\rightarrow$ $a_L = \frac{\partial u}{\partial t} = \frac{\partial V}{\partial t}$

$$a_L = \frac{2}{(1 - 0.5\,\frac{x}{L})^2} \quad \frac{FT}{S^2}$$

$$x = 0.5L \rightarrow a_L = \frac{2}{(1 - 0.5 \cdot 0.5)^2} = 3.56\ \frac{FT}{S^2}$$

CONVECTIVE ACCELERATION $\longrightarrow$ $a_c = u\,\frac{\partial u}{\partial x}$

$$\frac{\partial u}{\partial x} = \frac{\partial V}{\partial x} = \frac{\partial}{\partial x}\left[2t\,(1 - 0.5\,\tfrac{x}{L})^{-2}\right]$$

$$= -4t\,(1 - 0.5\,\tfrac{x}{L})^{-3}\left(-\tfrac{.5}{L}\right)$$

$$= \frac{2t}{L}\left(1 - 0.5\,\frac{x}{L}\right)^{-3}$$

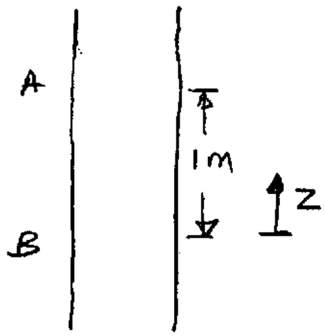
AT $x = 0.5\,L$ AND $t = 3\,S$

$$\frac{\partial u}{\partial x} = \frac{6}{4}\,(1 - .25)^{-3}$$

$$u = V = \frac{6}{.75^2} = 10.7\ \frac{FT}{S} \qquad \frac{\partial u}{\partial x} = 3.56\ \frac{1}{S}$$

$$a_c = (10.7)(3.56) \qquad a_c = 38\ \frac{FT}{S^2}$$

4.29 GIVEN: FLOW IN A VERTICAL TUBE WITH NEGLIGIBLE FRICTION EFFECTS. $\gamma = 10\ kN/m^3$ AND $p_B - p_A = 12\ kPa$.



FIND: DIRECTION OF FLOW.

SOLUTION: THE EULER EQN. BECOMES:

$$-\frac{\partial}{\partial z}(p + \gamma z) = \rho a_z$$

$$a_z = -\frac{1}{\rho}\left(\frac{\partial p}{\partial z} + \gamma\right)$$

$$a_z \approx -\frac{1}{\rho}\left(\frac{p_A - p_B}{z_A - z_B} + \gamma\right)$$

$$a_z \approx -\frac{1}{\rho}\left(\frac{-12\ kPa}{1\ m} + 10\ \frac{kN}{m^3}\right)$$

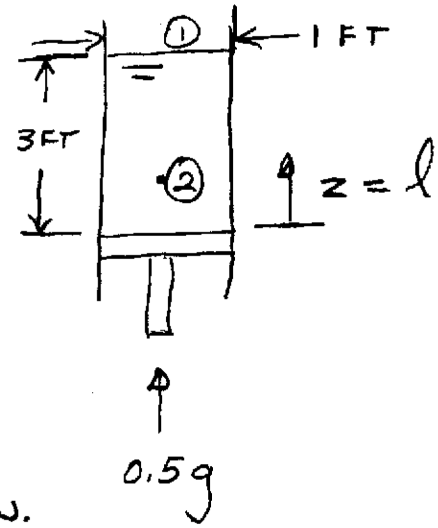
$$a_z \approx -\frac{1}{\rho}\left(-12\ \frac{kN}{m^3} + 10\ \frac{kN}{m^3}\right)$$

$$a_z \approx -\frac{1}{\rho}\left(-2\ \frac{kN}{m^3}\right) = \frac{1}{\rho}\left(2\ \frac{kN}{m^3}\right)$$

$a_z > 0$

FLOW IS ACCELERATING IN UPWARD DIRECTION.

4.30 GIVEN: A PISTON AND WATER ARE ACCELERATED UPWARD AT 0.5 g.



FIND: PRESSURE AT A DEPTH OF 2 FT IN WATER COLUMN.

SOLUTION: START WITH EULER EQN.

$$-\frac{\partial}{\partial l}(p + \gamma z) = \rho\left(\frac{\partial V_l}{\partial t} + \underbrace{V_l \cancel{\frac{\partial V_l}{\partial l}}}_{0}\right)$$

0 UNIFORM FLOW

$l = z$, $\frac{\partial}{\partial l} = \frac{\partial}{\partial z}$, p IS ONLY A FUNCTION OF Z. $\Rightarrow \frac{\partial p}{\partial z} = \frac{dp}{dz}$

$$-\frac{dp}{dz} - \gamma = \rho \frac{\partial V}{\partial t}, \quad \frac{\partial V}{\partial t} = 0.5g$$

$$-\frac{dp}{dz} - \gamma = 0.5\rho g \qquad \rho g = \gamma$$

$$-\frac{dp}{dz} = 1.5\gamma$$

$$\int_2^1 dp = \int_{z=1\,FT}^{z=3\,FT} -1.5\gamma\, dz$$

$$\underbrace{\cancel{p_1}}_{0\ \text{GAGE}} - p_2 = -1.5\gamma(3\,FT - 1\,FT)$$

0 GAGE

$$p_2 = 1.5\left(62.3\ \frac{LBf}{FT^3}\right)(2\,FT)$$

$$\boxed{p_2 = 187\ PSFG}$$