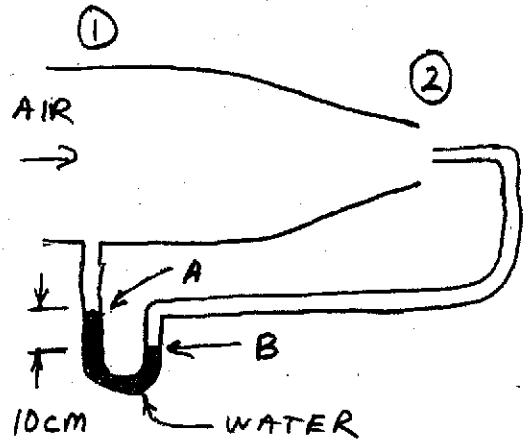
4.51 GIVEN: FLOW METERING DEVICE AS SHOWN.

$V_2 = 2V_1$, AIR DENSITY IS $1.2 \frac{kg}{m^3}$.

FIND: VELOCITY AT (2).




SOLUTION: THE DEFLECTION OF MANOMETER WILL BE GIVEN BY THE PIEZOMETRIC EQN:

$$\frac{p_1}{\gamma_w} + Z_A = \frac{p_s}{\gamma_w} + Z_B$$, WHERE $p_s$ IS THE STAGNATION PRESSURE AT (2) AND $p_1$ IS THE STATIC PRESSURE AT (1).

THE STATIC PRESSURE AT (2) IS 0 GAGE.

WRITE THE BERNOULLI EQUATION FROM (1) TO (2)

$$\frac{p_1}{\gamma_A} + \frac{V_1^2}{2g} + \cancel{Z_1} = \cancel{\frac{p_2}{\gamma_A}}^{\,0} + \frac{V_2^2}{2g} + \cancel{Z_2} = \frac{p_s}{\gamma_A}$$

$$\frac{p_1}{\gamma_A} = \frac{V_2^2 - V_1^2}{2g} \quad \text{AND} \quad V_2 = 2V_1$$

4.51 CONTINUED

$$\frac{p_1}{\gamma_A} = \frac{3}{2}\frac{V_1^2}{2g}$$

PUT $\frac{p_1}{\gamma_N}$ AND $\frac{p_3}{\gamma_w}$ INTO PIEZOMETRIC EQUATION

$$\left(\frac{\gamma_A}{\gamma_w}\right)\frac{3}{2}\frac{V_1^2}{2g} + Z_A = \left(\frac{\gamma_A}{\gamma_w}\right)\frac{5}{2}\frac{V_1^2}{2g} + Z_B$$

$$\frac{V_1^2}{2g} = \frac{\gamma_w}{\gamma_A}(Z_A - Z_B)$$

$$V_1^2 = 2(9.8)\left(\frac{998}{1.2}\right)(.1)$$

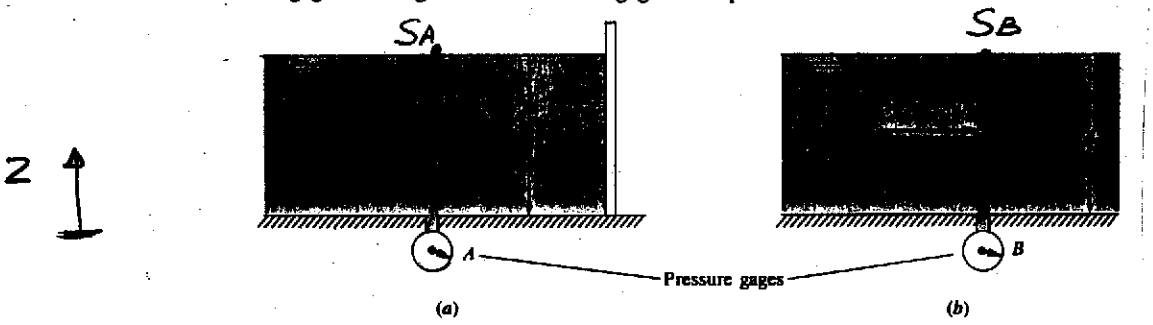
$$V_1 = 40.4 \text{ m/s}$$

$$V_2 = 2V_1$$

$$\boxed{V_2 = 80.7 \frac{m}{s}}$$

4.63

Water in a flume is shown for two conditions. If the depth $d$ is the same for each case, will gage $A$ read greater or less than gage $B$? Explain.




WE HAVE DISCUSSED TWO CAUSES OF PRESSURE VARIATION IN A FLUID FLOW.

1. WEIGHT OF FLUID
2. ACCELERATION

USE LOCATION (S) AS A REFERENCE LOCATION $\therefore S_A = S_B = 0$ GAGE.

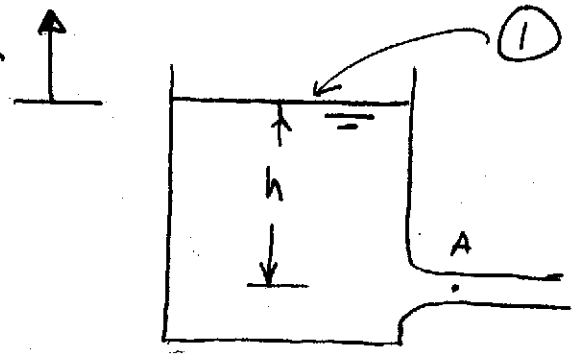
THE PRESSURE VARIATION FROM $S_A$ TO A CAN BE CALCULATED WITH THE PIEZOMETRIC EQN.: $p_A = \gamma d$

THE PRESSURE VARIATION FROM $S_B$ TO B CAN ALSO BE CALCULATED WITH THE PIEZOMETRIC EQN. BECAUSE THERE IS NO ACCELERATION IN THE Z-DIRECTION.

$p_B = \gamma d$

$\boxed{p_A = p_B}$

4.103 GIVEN: THE VELOCITY IN THE OUTLET PIPE FROM A RESERVOIR IS 6 m/s AND $h = 15\ m$.




FIND: THE PRESSURE AT POINT (A)

SOLUTION: APPLY BERNOULLI EQUATION FROM RESERVOIR WATER SURFACE TO (A). LABEL WATER SURFACE AS (1).

$$p_1 + \frac{1}{2}\rho V_1^2 + \gamma z_1 = p_A + \frac{1}{2}\rho V_A^2 + \gamma z_A$$

PICK DATUM AT WATER SURFACE,

$p_1 \rightarrow 0$ GAGE; $V_1 \rightarrow 0$ ~ RESERVOIR; $z_1 \rightarrow 0$

$$p_1 + \frac{1}{2}\rho V_1^2 + \gamma z_1 = p_A + \frac{1}{2}\rho V_A^2 + \gamma z_A$$

$$p_A = -\frac{1}{2}\rho V_A^2 - \gamma z_A$$

TABLE A.5 FOR WATER: $\rho = 998\ \frac{kg}{m^3}$, $\gamma = 9790\ \frac{N}{m^3}$

$$p_A = -\frac{1}{2}(998)(6)^2 - 9790(-15)$$

$$p_A = 129{,}000\ \frac{N}{m^2}\ \text{GAGE} = 129\ kPa\ \text{GAGE}$$