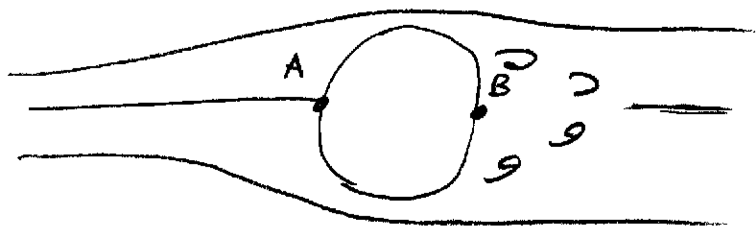
4.65 GIVEN: A SPHERICAL GAS VELOCITY PROBE

THE PRESSURE COEFFICIENTS AT (A) AND (B) ARE 1.0 AND -0.4. $p_A - p_B = 4\ kPa$

GAS DENSITY IS $1.5\ \frac{kg}{m^3}$.

FIND: GAS VELOCITY



SOLUTION: $C_{PA} = \frac{p_A - p_0}{\frac{1}{2}\rho V_0^2}$, $C_{PB} = \frac{p_B - p_0}{\frac{1}{2}\rho V_0^2}$

$$C_{PA} - C_{PB} = \frac{p_A - p_B}{\frac{1}{2}\rho V_0^2}$$

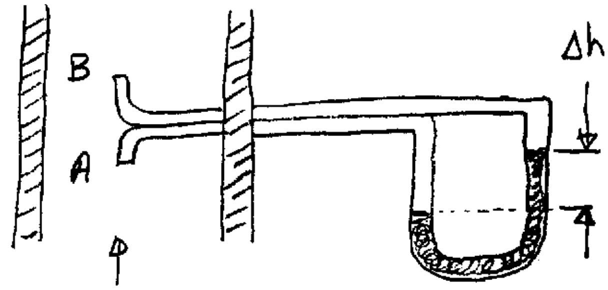
$$\frac{1}{2}\rho V_0^2 = \frac{p_A - p_B}{C_{PA} - C_{PB}}$$

$$V_0 = \sqrt{\frac{2(p_A - p_B)}{\rho(C_{PA} - C_{PB})}}$$

$$V_0 = \sqrt{\frac{2(4000)}{1.5(1.0 - (-0.4))}}$$

$$V_0 = 61.7\ \frac{m}{s}$$

4.66



GIVEN: STACK GAS VELOCITY MEASUREMENT TUBE AS SHOWN. $C_{pA} = 1.0$ AND $C_{pB} = -0.3$. WATER AT 20° IN MANOMETER, $\Delta h = 0.8\text{ cm}$

STACK GAS PROPERTIES: $p = 101\text{ kPa}$, $T = 250°C$, AND $R = 200 \frac{J}{kg-K}$.

FIND: STACK GAS VELOCITY

SOLUTION: ① $C_{pA} = \dfrac{p_A - p_0}{\frac{1}{2}\rho V_0^2}$, ② $C_{pB} = \dfrac{p_B - p_0}{\frac{1}{2}\rho V_0^2}$

AND ③ $p_A - p_B = \gamma_{H_2O}\Delta h$. THREE EQUATIONS WITH THREE UNKNOWNS, p_A, p_B AND V_0.

COMBINE ① & ②.

$$C_{pA} - C_{pB} = \frac{p_A - p_B}{\frac{1}{2}\rho V_0^2}$$

$$\gamma_{H_2O} = 9800 \frac{N}{m^3}$$

COMBINE THIS WITH ③

$$\rho = \frac{p}{RT} = \frac{101,000}{(200)(523)}$$

$$C_{pA} - C_{pB} = \frac{\gamma_{H_2O}\Delta h}{\frac{1}{2}\rho V_0^2}$$

$$\rho = 0.966 \frac{kg}{m^3}$$

$$V_0 = \left[\frac{2\gamma_{H_2O}\Delta h}{\rho(C_{pA} - C_{pB})}\right]^{\frac{1}{2}}$$

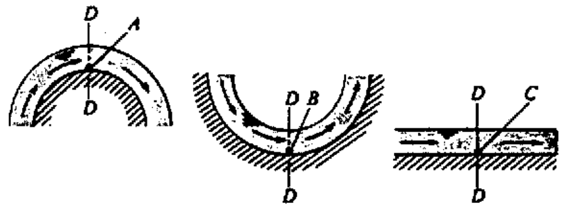
$$V_0 = \left[\frac{2(9800)(.008)}{(0.966)(1.0 + 0.3)}\right]^{\frac{1}{2}}$$

$$V_0 = 11.2\text{ m/s}$$

4.73

Consider the flow of water over the surfaces shown below. For each case the depth of water at section *D–D* is the same (1 ft), and the mean velocity is the same and equal to 10 ft/s. Which of the following statements are valid?

a. $p_B < p_C < p_A$
b. $p_A < p_B < p_C$
c. $p_A = p_B = p_C$
d. $p_C > p_B > p_A$
e. $p_B > p_C > p_A$

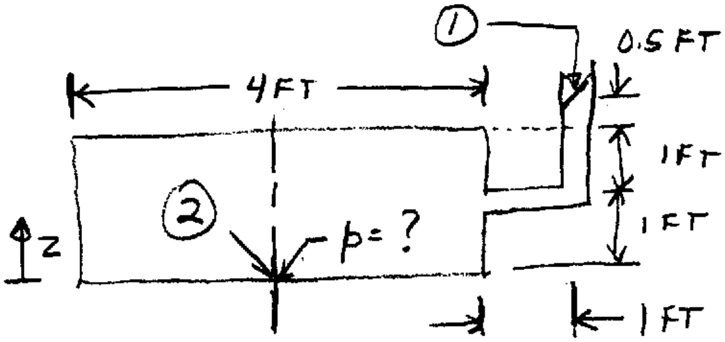


THE DEPTH IS THE SAME AT POINTS (A), (B), AND (C), SO THE ONLY FACTOR LEFT TO INFLUENCE PRESSURE VARIATION IS THE CURVED STREAMLINES.

PRESSURE DECREASES TOWARD THE CENTER OF CURVATURE, SO p_A WILL BE THE LOWEST PRESSURE.

e. $p_B > p_C > p_A$

4.80



GIVEN: TANK AS SHOWN SPINNING AROUND VERTICAL AXIS AT $\omega = 15$ RAD/S.

FIND: PRESSURE AT THE CENTER OF THE BOTTOM OF THE TANK.

SOLUTION:

$$p = \frac{1}{2}\rho r^2 \omega^2 - \gamma z + C_1$$

NEED TO EVALUATE CONSTANT, C_1.

WE KNOW THE PRESSURE AND ELEVATION AT THE FREE SURFACE OF THE PIEZOMETER.

$$p(r_1 = 3\text{ FT},\ z_1 = 2.5\text{ FT}) = 0 \text{ GAGE}$$

$$p(r_1, z_1) = 0$$

$$0 = \frac{1}{2}\rho r_1^2\omega^2 - \gamma z_1 + C_1 \Rightarrow C_1 = \gamma z_1 - \frac{1}{2}\rho r_1^2 \omega^2$$

$$p = \frac{1}{2}\rho\omega^2(r^2 - r_1^2) + \gamma(z_1 - z), \quad \rho = \frac{\gamma}{g}$$

$$p = \frac{1}{2}\left(\frac{62.4\ \frac{LBf}{FT^3}}{32.2\ \frac{FT}{S^2}}\right)\left(15\ \frac{RAD}{S}\right)^2\left[0 - (3\text{FT})^2\right] + 62.4\ \frac{LBf}{FT^3}\left(2.5\text{ FT} - 0\right)$$

$$p = -1806 \text{ PSFG} = -12.5 \text{ PSIG}$$