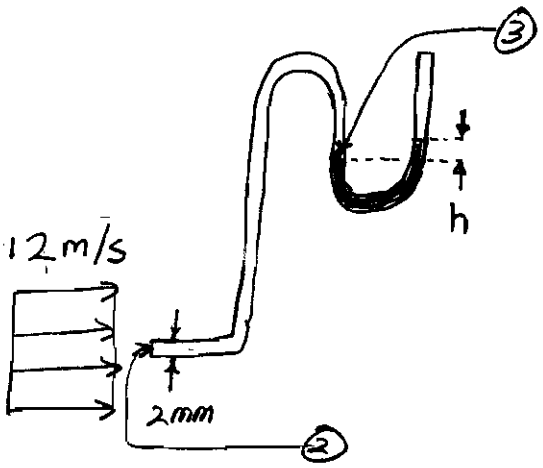
13.4 (1)



GIVEN: STAGNATION TUBE AND MANOMETER AS SHOWN. $p_a = 98\ kPa$ AND $T_a = 10^\circ C$.

FIND: DEFLECTION OF MANOMETER.

SOLUTION: I WILL SHOW <u>TWO</u> SOLUTION APPROACHES.

(a) APPLY BERNOULLI EQN. FROM ① TO ②

$$\frac{1}{2}\rho_a V_1^2 + \cancel{\gamma z_1} + p_1 = \frac{1}{2}\rho_a \cancel{V_2^2}^{\,0} + \cancel{\gamma z_2} + p_2$$

CANCEL

$$V_1 = \sqrt{\frac{2(p_2 - p_1)}{\rho_a}}, \quad p_1 = p_a$$

$$\rho_a = \frac{p_a}{RT_a}$$

$$\rho_a = \frac{98{,}000}{(287)(283)}$$

$$\rho_a = 1.207$$

p_2 IS MEASURED WITH THE MANOMETER

$p_3 = p_2$ NEGLECT WEIGHT OF AIR IN TUBE FROM ② TO ③

$$p_3 = \gamma_w h - p_a$$

$$V_1 = \sqrt{\frac{2\gamma_w h}{\rho_a}} \qquad h = \frac{\frac{1}{2}\rho_a V_1^2}{\gamma_w} = \frac{\frac{1}{2}(1.207)(12)^2}{9800}$$

$$h = 0.00887m = 8.9\ mm$$

(b) $C_p = \dfrac{p_2 - p_1}{\frac{1}{2}\rho_a V_1^2}$ OBTAIN C_p FOR STAGNATION TUBE FROM FIGURE 13.1.

13.4 (2)

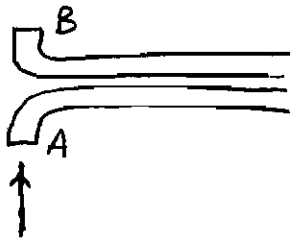
$$Re = \frac{V_1 d}{\nu} = \frac{(12)(.002)}{1.41 \times 10^{-5}} = 1702$$

$$C_p = 1.00 \Rightarrow V_1 = \sqrt{\frac{2(p_2 - p_1)}{\rho a}}$$

THIS GIVES THE SAME ANSWER AS METHOD (a)

THERE WILL ONLY BE A SIGNIFICANT DIFFERENCE BETWEEN METHODS -- (a) AND (b) IF $Re < 100$.

13.6



GIVEN: STACK TUBE AS SHOWN.

$C_{pA} = 1.0$, $C_{pB} = -0.4$,

$T_o = 300°C$, $p_o = 100\ kPa$, AND $R = 410\ \frac{J}{kg \cdot K}$.

THE STACK TUBE IS CONNECTED TO A WATER MANOMETER AND A 1.0 cm DEFLECTION IS MEASURED.

FIND: STACK-GAS VELOCITY.

SOLUTION:

$$C_{pA} = \frac{p_A - p_o}{\frac{1}{2}\rho_o V_o^2}, \quad C_{pB} = \frac{p_B - p_o}{\frac{1}{2}\rho_o V_o^2}$$

$$p_A - p_B = \gamma_w (\Delta h) \leftarrow \text{PIEZOMETRIC HEAD EQN. FOR MANOMETER}$$

$$C_{pA} - C_{pB} = \frac{p_A - p_B}{\frac{1}{2}\rho_o V_o^2}$$

$$\frac{1}{2}\rho_o V_o^2 = \frac{p_A - p_B}{C_{pA} - C_{pB}}$$

$$V_o = \sqrt{\frac{2(p_A - p_B)}{\rho_o (C_{pA} - C_{pB})}} = \sqrt{\frac{2\gamma_w \Delta h}{\rho_o (C_{pA} - C_{pB})}}$$

$$\rho_o = \frac{p_o}{RT_o} = \frac{100{,}000}{(410)(573)} = 0.4257\ \frac{kg}{m^3}$$

$$V_o = \sqrt{\frac{2(9800)(0.01)}{(0.4257)(1.4)}}$$

$$\boxed{V_o = 18.1\ \frac{m}{s}}$$

13.8

GIVEN: WATER IS DIVERTED INTO A TANK FOR 5 MINUTES. THE VOLUME OF WATER MEASURES $80\,m^3$.

FIND: DISCHARGE (VOLUME FLOW RATE) IN CMS, GPM, AN CFS.

SOLUTION: $$Q \equiv \frac{\Delta \forall}{\Delta t} = \frac{80\,m^3}{300\,S}$$

$$Q = 0.267 \text{ CMS}$$

USE CONVERSION FACTORS ON THE INSIDE OF THE BOOK COVER

$$1 \text{ GPM} = 6.309 \times 10^{-5} \text{ CMS}$$

$$Q = 4227 \text{ GPM}$$

$$1 \text{ CFS} = 0.02832 \text{ CMS}$$

$$Q = 9.42 \text{ CFS}$$