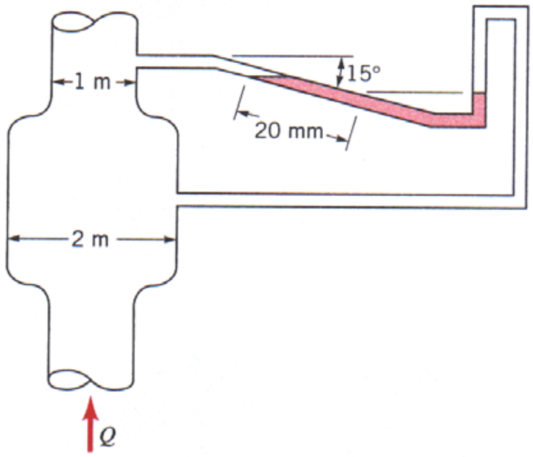
1. 空氣在標準狀態(密度=1.2 kg/m^3)流經如圖二所示的圓柱型管，各尺寸如圖二所示，假設忽略摩擦效應，而傾斜 U 型管內的的流體為水(密度=1000 kg/m^3)，請問流經圓柱型管中空氣的體積流率, Q=?



圖二

3.70

3.70 Air at standard conditions flows through the cylindrical drying stack shown in Fig. P3.70. If viscous effects are negligible and the inclined water-filled manometer reading is 20 mm as indicated, determine the flowrate.

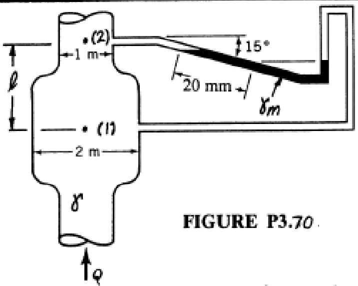


FIGURE P3.70

$$\frac{p_1}{\gamma}+\frac{V_1^2}{2g}+z_1=\frac{p_2}{\gamma}+\frac{V_2^2}{2g}+z_2$$

where $z_1=0$, $z_2=\ell$ and $V_2=\frac{A_1}{A_2}V_1=\left(\frac{D_1}{D_2}\right)^2V_1=\left(\frac{2m}{1m}\right)^2V_1=4V_1$

Thus,

$$\frac{p_1}{\gamma}+\frac{V_1^2}{2g}=\frac{p_2}{\gamma}+\frac{(4V_1)^2}{2g}+\ell$$

or

$$\frac{15V_1^2}{2g}=\frac{p_1-p_2}{\gamma}-\ell \qquad (1)$$

However, $p_2+\gamma\ell_2+\gamma_m h=p_1-\gamma(\ell-h-\ell_2)$ where $h=(20mm)\sin 15$

or $$\frac{p_1-p_2}{\gamma}=\left(\frac{\gamma_m}{\gamma}-1\right)h+\ell \qquad (2)$$

By combining Eqs. (1) and (2)

$$\frac{15V_1^2}{2g}=\left(\frac{\gamma_m}{\gamma}-1\right)h$$

or

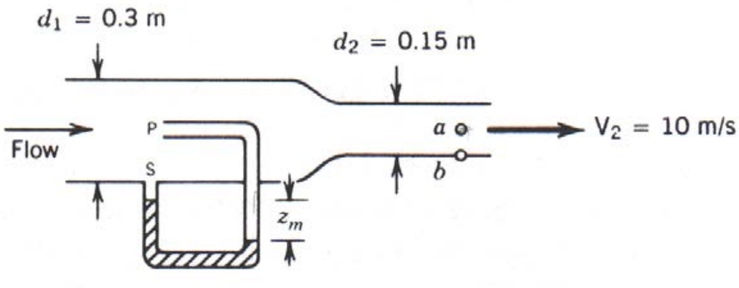
$$V_1=\sqrt{\frac{2g\left(\frac{\gamma_m}{\gamma}-1\right)h}{15}}=\sqrt{\frac{2\left(9.81\frac{m}{s^2}\right)\left(\frac{9.80\times10^3\frac{N}{m^3}}{12.0\frac{N}{m^3}}-1\right)(0.02\sin 15)}{15}}$$

$$=2.35\ \frac{m}{s}$$

Thus,

$$Q=A_1V_1=\frac{\pi}{4}D_1^2V_1=\frac{\pi}{4}(2m)^2\left(2.35\frac{m}{s}\right)=\underline{\underline{7.38\ \frac{m^3}{s}}}$$

2　考慮水在 10 ºC（密度=1000 kg/m^3)的狀態流經一水洞的管嘴(nozzle)，各尺寸如圖五所示。假設水洞的出口(*a* 點)速度, V_2= 10 m/s, 一皮托管連接一 U 型管用來量測停滯壓(P 點)與靜壓(S 點)的壓差，U 型管內的流體為水銀(比重=13.55)，請問 Z_m=?



圖五

① $\frac{P_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = \frac{P_p}{\gamma} + z_p + \frac{V_p^2}{2g}$ $(V_p = 0)$

$\Rightarrow \frac{P_p - P_1}{\gamma} = \frac{V_1^2}{2g}$ — (1)

② $P_1 + \gamma h + \gamma_m z_m - \gamma \cdot z_m - \gamma h = P_p$

$\Rightarrow P_p - P_1 = (\gamma_m - \gamma) z_m$ — (2)

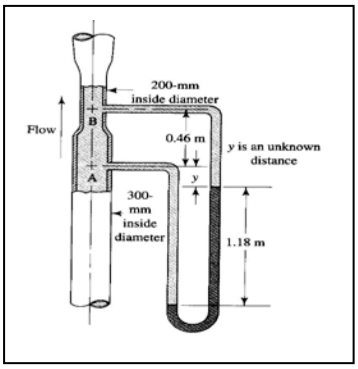
③ Combing (1) with (2) we have:

$(\frac{\gamma_m}{\gamma} - 1) z_m = \frac{V_1^2}{2g} \Rightarrow z_m = \frac{V_1^2/2g}{\gamma_m/\gamma - 1}$ — (3)

④ $V_1 A_1 = V_2 A_2 \Rightarrow V_1 = V_2 (\frac{A_2}{A_1}) = \frac{1}{4} V_2 = 2.5$

$\therefore$ (3) $\Rightarrow z_m \doteq 0.0234$ m #

3. The venturi meter shown in Fig. 1 carries water at 60 °C (The specific weight γ = 9.65 kN/m^3). The specific gravity of the gage fluid in the manometer is 1.25. Calculate the velocity of flow at section A and the volume flow rate of water.



3. ① Bernoulli eq :

$$\frac{P_A}{\gamma} + z_A + \frac{V_A^2}{2g} = \frac{P_B}{\gamma} + z_B + \frac{V_B^2}{2g}$$

$$\Rightarrow \frac{P_A - P_B}{\gamma} + z_A - z_B = \frac{V_B^2 - V_A^2}{2g} \quad -(a)$$

② $P_A + \gamma y + \gamma h_2 - \gamma_g h_2 - \gamma y - \gamma h_1 = P_B$

$$\Rightarrow P_A - P_B = \gamma(h_1 - h_2) + \gamma_g h_2 \quad -(b)$$

substuting (b) into (a)

We can get : $\frac{\gamma(h_1 - h_2) + \gamma_g h_2}{\gamma} + z_A - z_B = \frac{V_B^2 - V_A^2}{2g}$

$$\Rightarrow V_B^2 - V_A^2 = 2g(h_1 - h_2) + 2g\frac{\gamma_g}{\gamma}h_2 + 2g(z_A - z_B) = 6.26 \quad -(c)$$

③ $V_A A_A = V_B A_B \Rightarrow V_B = 2.25\, V_A \quad -(d)$

$\Rightarrow$ (c) . (d) $\Rightarrow V_A = 1.24$ m/s

$\therefore Q = V_A A_A = 8.77 \times 10^{-2}$ m^3/s