101 年特種考試地方政府公務人員考試／環工四等／流體力學

一、【參考題解】

設泥沙密度爲ρ_s, 直徑爲 d_s, 體積爲 $\forall_S$, 泥沙顆粒投影面積爲 A, 泥沙下降的終端速度爲 V, 阻力係數爲 C_D, 水密度爲ρ_w

由力平衡知：　$W = F_b + F_D$　(1)

其中泥沙重 W= $\gamma_s \forall_S = \rho_S g \forall_S = \rho_S g \frac{\pi}{6} d_s^3$

$=(2400)(9.8)\frac{\pi}{6}(0.001)^3$

$=0.0000123$ N　(2)

浮力 $F_b = \gamma_w \forall_s = \rho_w g \forall_s = \rho_w g \frac{\pi}{6} d_s^3$

$=(1000)(9.8)\frac{\pi}{6}(0.001)^3$

$=0.00000513$ N　(3)

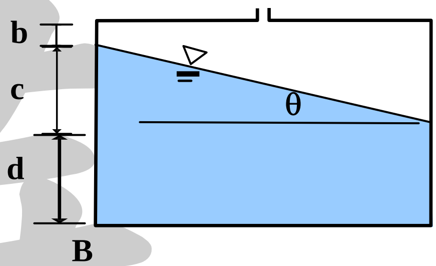
阻力 $F_D = \frac{1}{2}\rho_w V^2 A C_D$

$= \frac{1}{2}(1000)V^2 \frac{\pi}{4}(0.001)^2(0.45)$

$= 0.000177V^2$ N　(4)

(2)(3)(4)代入(1)得 V= 0.2 m/sec

二、【參考題解】



a = g tanθ

則 $\tan\theta = \frac{3}{9.8} = \frac{c}{10}$

得 c = 3.06m

設水未溢出 ,故移動前油槽內之空氣體積等於移動後油槽內之空氣體積

$$2(\frac{\pi}{4})(10)^2 = b\frac{\pi}{4}(10)^2 + \frac{3.06}{2}\frac{\pi}{4}(10)^2$$

得 b = 0.47m

故 d = 6 –b –c =6 -0.47- 3.06 = 2.47m

所以 油槽最大壓力爲 $P_B = \rho_{油} g(c+d)$=0.84(9.8)(3.06+2.47) = 45.5KPa

三、【參考題解】

平滑圓管的達西-威士巴哈（Darcy-Weisbach）式為

$$h_\ell = f\frac{\ell}{D}\frac{V^2}{2g} = \frac{0.316}{R_e^{1/4}}\frac{\ell}{D}\frac{V^2}{2g}$$

管流的水力梯度為 $i = \frac{h_\ell}{\ell} = \frac{0.316}{R_e^{1/4}}\frac{1}{D}\frac{V^2}{2g} = kD^a Q^b$ (1)

$$V = \frac{Q}{A} = \frac{4Q}{\pi D^2} \quad (2)$$

$$Re^{1/4} = (\frac{\rho VD}{\mu})^{1/4} = (\frac{1}{\nu})^{1/4}V^{1/4}D^{1/4} = (\frac{1}{\nu})^{1/4}(\frac{4Q}{\pi D^2})^{1/4}D^{1/4} \quad (3)$$

(2)(3)代入(1)得

$$i = \frac{h_\ell}{\ell} = 0.316(\frac{1}{\nu})^{-1/4}(\frac{4Q}{\pi D^2})^{-1/4}D^{-1/4}D^{-1}\frac{1}{2g}\frac{16Q^2}{\pi^2 D^4} = kD^a Q^b$$

即 $0.316(\frac{1}{\nu})^{-1/4}4^{-1/4}Q^{-1/4}\pi^{1/4}D^{1/2}(D^{-1/4})D^{-1}\frac{1}{2g}(16)Q^2D^{-4}\frac{1}{\pi^2} = kD^a Q^b$

各因次合併　$K D^{-19/4}Q^{7/4} = kD^a Q^b$

得係數 $a = \frac{-19}{4}$　，　$b = \frac{7}{4}$　　K 為常數係數

四、【參考題解】

由 N-S 方程式及 B.C (y=0, u=0 , y=d, u=0)

得速度分布方程式 $u(y) = \frac{1}{2\mu}\frac{\partial p}{\partial x}y^2 - \frac{d}{2\mu}\frac{\partial p}{\partial x}y$

流量 $Q = \int_0^d u(y)(dy \bullet 1) = \frac{1}{12\mu}(\frac{-\partial p}{\partial x})d^3$

平均流速 $\overline{V} = \frac{Q}{d\bullet 1} = \frac{1}{12\mu}(\frac{-\partial p}{\partial x})d^2$

當 $y = \frac{d}{2}$ 時，$\frac{du}{dy} = 0$，所以 $U_0\frac{\pi}{d}\cos\frac{\pi}{d}y = 0$ ，故 $y = \frac{d}{2}$ 時有最大流速 u_{max}

$$u_{max} = U_0 = \frac{1}{8\mu}(\frac{-\partial p}{\partial x})d^2$$

$$\frac{\overline{V}}{u_{max}} = \frac{\overline{V}}{U_0} = \frac{2}{3}$$

故 $\overline{V} = \frac{2}{3}U_0 = \frac{2}{3}(0.08) = 0.053m/s$

$$R_e = \frac{\overline{V}}{\nu}d = \frac{(0.053)(0.04)}{1\times 10^{-5}} = 212$$