流体力学 第十三周. 周五作业 参考答案

1. 解: (1). 10°C 时水的运动黏性系数 $\nu = 1.31\times10^{-6}\ m^2/s$.

管内雷诺数 $Re = \frac{vd}{\nu} = \frac{1\times0.025}{1.31\times10^{-6}} = 19083 > 2000$. 故管中水流为紊流.

(2). 管内保持层流状态的最大流速和临界流速.

由 $Re_c = \frac{v_c d}{\nu} = 2000$ 可得: $v_c = \frac{2000\times1.31\times10^{-6}}{0.025} = 0.105\ m/s$.

故管内保持层流状态的最大流速 $v_c = 0.121\ m/s$.

2. 解: 一次折大时. $h_{j1} = \frac{(v_1^2 - v_2^2)^2}{2g}$

两次折大时.

$$h_{j2} = \frac{(v_1 - v)^2}{2g} + \frac{(v - v_2)^2}{2g} = \frac{v_1^2 + v_1^2 + 2v^2 - 2v(v_1+v_2)^2}{2g}$$

令 $\frac{dh_{j2}}{dv} = 0 \Rightarrow v = \frac{v_1+v_2}{2}$. 此时 h_{j2} 取极小值, 且.

$$h_{j2min} = \frac{1}{2}\frac{(v_1-v_2)^2}{2g} = \frac{1}{2}h_{j1}.$$

3. 解: 列 1. 2 断面的伯努利方程, 忽略沿程水头损失有:

$$z_1 + \frac{p_1}{\rho g} + \frac{v_1^2}{2g} = z_2 + \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + h_j$$

因管段直径不变, 由连续方程知, 两断面平均流速相等. 故.

$$h_j = z_1 - z_2 + \frac{p_1 - p_2}{\rho g} \quad (1)$$

设截面 2-2 右侧四氯化碳液面高差为 Δh. 因为左侧四氯化碳液面的水平面为等压面, 左右两侧压强相等, 有:

$$p_1 + \rho g(z_1 - z_2 + h + \Delta h) = p_2 + \rho g h + \rho' g \Delta h$$

$$z_1 - z_2 + \frac{p_1 - p_2}{\rho g} = \left(\frac{\rho'}{\rho} - 1\right)\Delta h = 0.042\ m \quad (2)$$

将(2)代入(1)有: $h_j = \zeta\frac{v^2}{2g} = 0.042$. 又因 $v = \frac{4Q}{\pi d^2} = 0.815\ m/s$

$$\Rightarrow \zeta = 1.235.$$

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4. 解: 对水平和喷嘴部列伯努利方程.

$$\frac{P_a}{\rho g}+H=\frac{v_c^2}{2g}+\frac{P_c}{\rho g} \Rightarrow 10.33+3=\frac{v_c^2}{2\times 9.8}+2.5 \Rightarrow v_c=14.569\ m/s$$

$$q_v=v_c\cdot\pi\left(\frac{d}{2}\right)^2=14.569\times 3.14\times\left(\frac{0.04}{2}\right)^2=0.0183\ m^3/s$$

对水面和出口到伯努利方程:

$$\frac{P_a}{\rho g}+H=\frac{v_1^2}{2g}+\frac{P_a}{\rho g}+0.2\cdot\frac{v_c^2}{2g}\left(1-\frac{A_1}{A_2}\right)^2$$

$$\Rightarrow H=\frac{v_1^2}{2g}+0.2\cdot\frac{v_c^2}{2g}\cdot\left(1-\frac{v_1}{v_2}\right)^2$$

$$\Rightarrow 3=\frac{v_1^2}{2\times 9.8}+0.2\times\frac{14.569^2}{2\times 9.8}\times\left(1-\frac{v_1}{14.569}\right)^2$$

$$\Rightarrow v_1=6.84\ m/s.$$

$$v_c\pi\left(\frac{d}{2}\right)^2=v_1\pi\left(\frac{d_1}{2}\right)^2 \Rightarrow 14.569\times 0.04^2=6.84\cdot d_1^2$$

$$\text{即 } d_1=0.0583\ m.$$