416工程流体力学答案

一、简述题

1. 某一点的流速：①风速仪．②皮托管+U形管．皮托管对准来流方向．

阻力 = $H_2 - H_1$，H为总水头，即同时测量1、2两个断面的总水头。

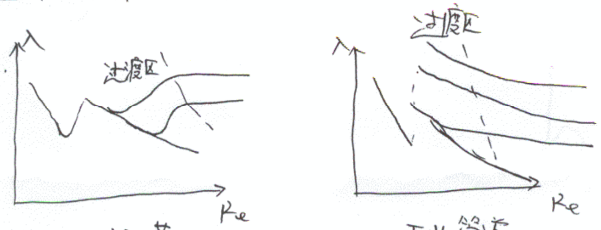
2. ①如将突扩（缩）管改为渐扩（缩）管．

② 增大弯管的曲率半径．

③ 管道入口改为流线形

④ 三通管的角度合理．

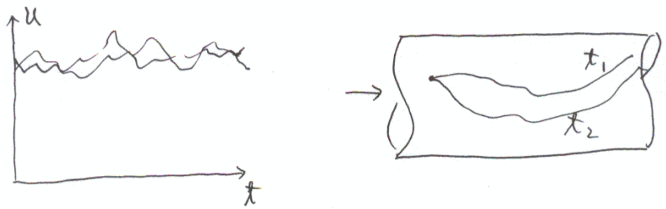
3. 不能．



尼古拉茨　　　　工业管道

由上图可以看出，尼古拉茨过渡区内的变化趋势完全不同于工业管道．

4.



① 随机性：任意两次的速度测量结果不重复．过一点不同时间的轨迹线不重合．

② 速度线不可用某一函数来表达，轨迹线不可用某一函数来表达

③ 时均速度为常数（恒定常流动下）。

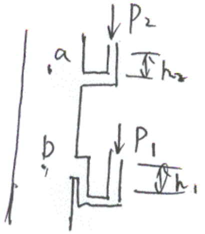
5. 三种：前弯、后弯、径向。

前弯叶片对流体做功能力最大，后弯最小。

……的效率最低，后弯最高

……的……噪声最大，……小。

二、



$$p_b = p_a + \gamma_G H \Rightarrow p_b - p_a = \gamma_G H$$

$$\begin{cases} p_b = p_1 + h_1\gamma_水 - h_1\gamma_G \\ p_a = p_2 + h_2\gamma_水 - h_2\gamma_G \end{cases}$$

$$\Rightarrow p_b - p_a = p_1 - p_2 + h_1\gamma_水 - h_1\gamma_G - h_2\gamma_水 + h_2\gamma_G$$

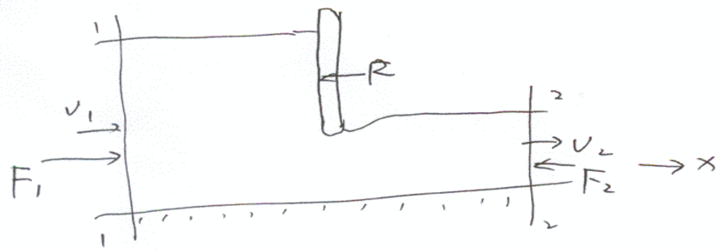
$$\Rightarrow \gamma_G H = p_1 - p_2 + h_1\gamma_水 - h_1\gamma_G - h_2\gamma_水 + h_2\gamma_G$$

又 $p_1 - p_2 = \gamma_A H$

$$\Rightarrow h_2(\gamma_水 - \gamma_G) = \gamma_A H + h_1(\gamma_水 - \gamma_G) - H\gamma_G$$

$$h_2 = h_1 + \frac{\gamma_A - \gamma_G}{\gamma_水 - \gamma_G} H = 125.3\,mm\,H_2O$$

三、



$$z_1+\frac{p_1}{\gamma}+\frac{\alpha v_1^2}{2g}=z_2+\frac{p_2}{\gamma}+\frac{\alpha_2 v_2^2}{2g}+h$$ ↗ 0

$$H+\frac{v_1^2}{2g}=h+\frac{v_2^2}{2g} \quad (1)$$

由 $H\cdot 2 v_1 = h\cdot 2\cdot v_2 \Rightarrow v_2 = 2v_1 \quad (2)$

由 (1)、(2) 得 $\begin{cases} v_1 = 2.557\ m/s \\ v_2 = 5.114\ m/s \end{cases}$

由动量方程：

$$\Sigma F_x = \rho Q(\alpha_{02} v_2 - \alpha_{01} v_1)$$

$$F_1 - F_2 - R = \rho 2h\cdot v_2(v_2 - v_1)$$

$$R = F_1 - F_2 - 2h\rho v_2\cdot v_1 \quad (3)$$

$$F_1 = p_c\cdot A_1 = \gamma\cdot\frac{H}{2}\cdot H\cdot 2 = \gamma H^2$$

$$F_2 = p_c A_2 = \gamma\cdot\frac{h}{2}\cdot h\cdot 2 = \gamma h^2$$

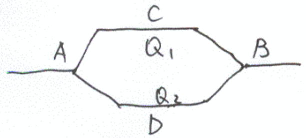
代入(3)式得：

$$R = \gamma(H^2 - h^2) - 2h\rho v_2 v_1$$

$$= 9807\times 3 - 2\times 1\times 1000\times 2.557\times 5.114$$

$$= 3.268\times 10^3\ N$$

四.



$$h_{fACB} = \lambda \frac{51}{d_1}\cdot\frac{V_1^2}{2g} = 60\cdot\frac{V_1^2}{2g}$$

$$h_{fADB} = \lambda \frac{52}{d_2}\frac{V_2^2}{2g} = 36\frac{V_2^2}{2g}$$

由 $h_{fACB} = h_{fADB}$ 得

$$60V_1^2 = 36V_2^2 \Rightarrow V_1 = 0.7746V_2 \quad (1)$$

由 $\frac{\pi}{4}d_1^2 V_1 + \frac{\pi}{4}d_2^2 V_2 = Q \quad (2)$

得 $\begin{cases} V_2 = 1.4357\ m/s \\ V_1 = 1.1121\ m/s \end{cases}$

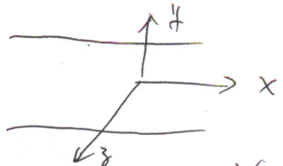
$$Q_1 = \frac{\pi}{4}d_1^2 V_1 = 0.035\ m^3/s$$

$$Q_2 = \frac{\pi}{4}d_2^2 V_2 = 0.045\ m^3/s$$

$$h_f = \lambda\frac{51}{d_1}\frac{V_1^2}{2g} = 3.786\ m/s$$

五. $u_y = u_z = 0$

$u_x = u_x(y)$



$$\frac{\partial u_x}{\partial t} + u_x\frac{\partial u_x}{\partial x} + u_y\frac{\partial u_x}{\partial y} + u_z\frac{\partial u_x}{\partial z} = g_x - \frac{1}{\rho}\frac{\partial p}{\partial x} + \nu\left(\frac{\partial^2 u_x}{\partial x^2} + \frac{\partial^2 u_x}{\partial y^2} + \frac{\partial^2 u_x}{\partial z^2}\right)$$

$0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0$

$$\frac{1}{\rho}\frac{\partial p}{\partial x} = \frac{d^2u_x}{dy^2} \qquad \frac{du_x}{dy} = \frac{1}{\rho}\frac{\partial p}{\partial x}y + C$$

由 $\frac{du_x}{dy}\Big|_{y=0} = 0$ 得 $C = 0$

$$\frac{du_x}{dy} = \frac{1}{\rho}\frac{\partial p}{\partial x}y \qquad u_x = \frac{1}{2\rho}\frac{\partial p}{\partial x}y^2 + C_1$$

由 $u_x|_{y=h}=0$ 得 $C_1=-\frac{1}{2\rho}\frac{\partial p}{\partial x}h^2$

$\therefore u_x=\frac{1}{2\rho}\frac{\partial p}{\partial x}(y^2-h^2)$

六 由 $Re_m = Re_p$

$\frac{l_m v_m}{\nu_m}=\frac{l_p v_p}{\nu_p}$ $l_m=\frac{v_p}{v_m}\cdot\frac{\nu_m}{\nu_p}\cdot l_p$

$=\frac{3}{18}\cdot\frac{15.2\times10^{-6}}{1.007\times10^{-6}}\times1.5$

$=3.77m$

$b_m=\frac{3}{18}\cdot\frac{15.2\times10^{-6}}{1.007\times10^{-6}}\times0.3=0.75m$

由 $\frac{F_m}{\rho_m l_m^2 v_m^2}=\frac{F_p}{\rho_p l_p^2 v_p^2}$

$F_m=\frac{\rho_m}{\rho_p}\frac{l_m^2}{l_p^2}\frac{v_m^2}{v_p^2}F_p=\frac{1.227}{1000}\cdot(\frac{3.77}{1.5})^2\times(\frac{18}{3})^2\cdot14$

$=3.9N$

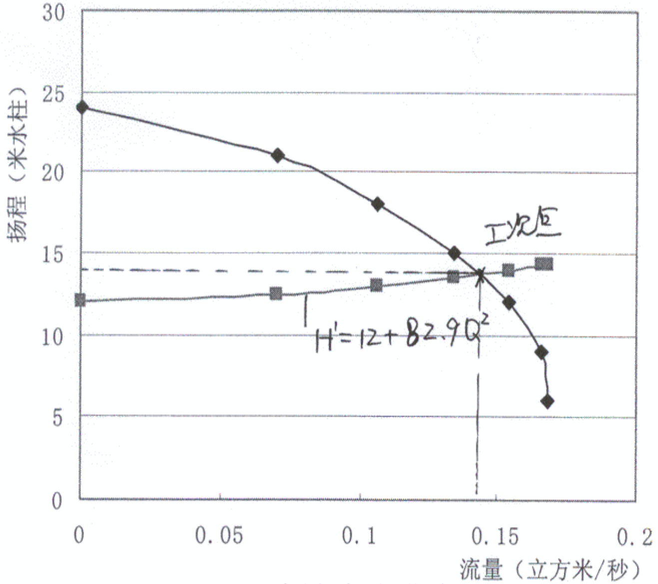
$\rho_m=\frac{P_m}{R_m T_m}=1.227\ kg/m^3$

七. $z_1+\frac{p_1}{\gamma}+\frac{\alpha_1 v_1^2}{2g}+H'=z_2+\frac{p_2}{\gamma}+\frac{\alpha_2 v_2^2}{2g}+h$

(0, 0, 0; H, 0, 0)

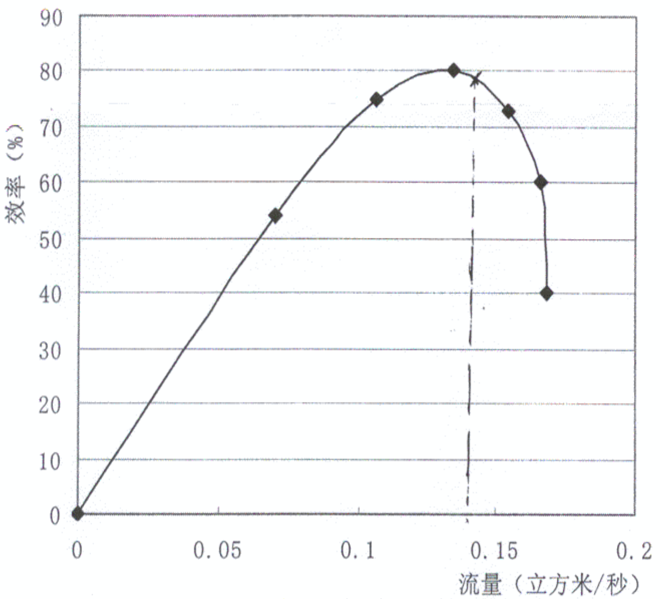
$H'=H+h$

$h=\lambda\frac{l}{d}\frac{v^2}{2g}+\xi\frac{v^2}{2g}=(\lambda\frac{l}{d}+\xi)\frac{Q^2}{(\frac{\pi}{4}d^2)^2\cdot2g}$



流量-扬程曲线

工况点：
$Q = 0.1417\ m^3/s$
$H = 13.44m$
$\eta = 78\%$



流量-效率曲线