Q.P Code : 50697.

FM-II (CBCS) 8/6/2018

1a. Let L_1, L_2, L_3 = Length of 3 pipes.

d_1, d_2, d_3 = Diameters of 3 pipes.

H = Total head loss.

L = Length of eqv. pipe.

d = dia. of eqv. pipe.

$$L = L_1 + L_2 + L_3.$$

$$H = \frac{4f_1L_1v_1^2}{d_1 \times 2g} + \frac{4f_2L_2v_2^2}{d_2 \times 2g} + \frac{4f_3L_3v_3^2}{d_3 \times 2g}.$$

or $$H = \frac{4 \times 16 f Q^2}{\pi^2 \times 2g}\left[\frac{L_1}{d_1^5} + \frac{L_2}{d_2^5} + \frac{L_3}{d_3^5}\right]. \quad \& \quad H = \frac{4fLv^2}{d \times 2g}.$$

So $$H = \frac{4 \times 16 f Q^2}{\pi^2 \times 2g}\left[\frac{L}{d^5}\right] = \frac{4 \times 16 f Q^2}{\pi^2 \times 2g}\left[\frac{L_1}{d_1^5} + \frac{L_2}{d_2^5} + \frac{L_3}{d_3^5}\right]$$

Hence: $$\boxed{\frac{L}{d^5} = \frac{L_1}{d_1^5} + \frac{L_2}{d_2^5} + \frac{L_3}{d_3^5}}$$ Ans

b. $L = 300m$, $D = 0.1m$, $f = 0.009$.

$$d = \left(\frac{D^5}{8fL}\right)^{1/4} = \left(\frac{0.1^5}{8 \times 0.009 \times 300}\right)^{1/4} = 0.02608m. \text{ Ans}$$

2a. $D = 0.25m$.

$$h_f = h_{f_1} = h_{f_2}.$$

$$Q = Q_1 + Q_2, \text{ So } Q_1 = Q_2 = Q/2.$$

$$h_f = \frac{fLv^2}{D \times 2g} = \frac{f \times L \left(\frac{Q}{\frac{\pi}{4} \times 0.25^2}\right)^2}{0.5 \times 2 \times 9.81} = \frac{f \times L \times (4Q)}{0.25 \times 2 \times 9.81 \times (\pi \times 0.25^2)}$$

$$h_{f1} = \frac{f \times L \times (v_1)^2}{d \times 2g} = \frac{f \times L \times \left(\frac{Q}{2 \times \frac{\pi d^2}{4}}\right)^2}{d \times 2g} = \frac{f \times L \times (4Q)^2}{d \times 2 \times 9.81 \times (2\pi d^2)^2}$$

$h_f = h_{f1}$

So
$$\frac{f \times L \times (4Q)^2}{0.25 \times 2 \times 9.81 \times (\pi \times 0.25^2)^2} = \frac{f \times L \times (4Q)^2}{d \times 2 \times 9.81 \times (2 \times \pi \times d^2)^2}$$

$\boxed{d = 0.19\,m}$ Ans

b. $d = 0.2\,m$.
$H = 40\,m$.
$L = 8000\,m$.
$\frac{P_c}{\rho g} = 3\,m$.
$f = 0.006$.
$L_1 = 500\,m$.

Let the depth of the pipe below the summit of ridge $= x\,m$.
So ht of syphon from water surface in the upper reservoir $= (8 - x)\,m$.
$\frac{P_a}{\rho g} = 10.3\,m$

$$\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\rho g} + \frac{V_B^2}{2g} + Z_B + h_f$$ (Applying Bernoulli's eqn. to A & B).

$v = 0.904\,m/s$.

Again
$$\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + Z_A = \frac{P_c}{\rho g} + \frac{V_c^2}{2g} + Z_c + h_{f1}$$ (Applying Bernoulli's eqn to A & c)

So $x = 3.24\,m$.

$Q = \frac{\pi}{4} \times (0.2)^2 \times 0.904 = 0.0283\,m^3/s$ Ans

$D = 0.6\ m$

$L = 1500\ m$

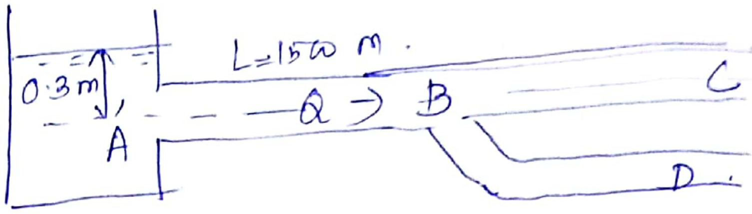
$4f = 0.04,\ f = 0.01$

$h = 0.3\ m$

Outlet head = 0

$L_1 = \frac{1500}{2} = 750\ m$

$d_1 = 0.6\ m$



Case - I

$h_f = \frac{4fLv^{*2}}{d \times 2g}$, $v^* = 0.2426\ m/s$, $Q^* = 0.2426 \times \frac{\pi}{4}(0.6)^2$

$= 0.0685\ m^3/s$

Case - II

$Q = Q_1 + Q_2$, $Q_1 = Q_2 = Q/2$

$h_f \text{ in } AB = \frac{4f \times 750 \times v^2}{0.6 \times 2 \times 9.81}$, $v = \frac{4Q}{\pi \times 0.36}$, $31.87Q^2 = h_{f_{AB}}$

$h_{f_{BC}} = \frac{4 \times f \times 750}{0.6 \times 2 \times 9.81} \times \left(\frac{Q}{2 \times \frac{\pi}{4}(0.6)^2}\right) = 7.969Q^2$

$0.3 = 31.87Q^2 + 7.969Q^2$

$Q = 0.0867\ m^3/s$

$Q - Q^* = 0.0182\ m^3/s$ Ans

3.b. $C = \sqrt{\frac{dp}{d\rho}}$

$\mu = 0.097\ Ns/m^2$ $\qquad P_1 - P_2 = \frac{32 \mu \bar{u} L}{D^2}$

$\rho_o = 900\ kg/m^3$

$D = 0.1m$ $\qquad \bar{u} = 0.471\ m/s$

$L = 10m$ $\qquad Re^* = \frac{\rho V D}{\mu} = 436.91$

$M = 100\ kg,\ t = 30 sec$ $\qquad$ Hence laminar flow.

$$P_1 - P_2 = \frac{32 \times 0.097 \times 0.471 \times 10}{(0.1)^2} = 0.1462\ N/cm^2 \ \underline{Ans}$$

6 b. $D = 0.1m$

$R = 0.05m$

$Q = \frac{2.27}{60} = 0.0378\ m^3/s$, $\nu = 0.0098 \times 10^{-4}\ m^2/s$

$\bar{U} = 4.817\ m/s$

$Re = 4.9154 \times 10^5 \left(\frac{\bar{u} \times D}{\nu}\right)$. $(Re < 10^5)$

So $\frac{1}{\sqrt{4f}} = 2 \log_{10}(Re\sqrt{4f}) - 0.8$

or $\frac{1}{\sqrt{4f}} - \log_{10}(4f) = 10.583$

friction factor $= 4f$ so $\frac{1}{\sqrt{f^*}} - \log_{10} f^* = 10.583$

(i) By hit & trial method, $f^* = 0.013$.

(ii) $\underline{u_{max}} = u_* \left[5.75 \log_{10} \frac{u_* \times R}{\nu} + 5.55\right]$

$= 0.194 \left[5.75 \log_{10} \frac{0.194 \times 0.05}{0.0098 \times 10^{-4}} + 5.55\right]$

$= 5.528\ m/s$

$\tau_o = 37.63\ N/m^2 \left[u_* = \sqrt{\frac{\tau_o}{\rho}}\right]$ $\underline{Ans}$ (5)