

hf

$$\therefore h_f = f \cdot \frac{L}{d} \cdot \frac{V^2}{2g}$$

$$f = \frac{64}{\text{Re}} \quad :$$

$$f = \frac{64}{\text{Re}} = \frac{64 \times \nu}{V \cdot d}$$

$$\therefore h_f = \frac{64 \times \nu}{V \cdot d} \cdot \frac{L}{d} \cdot \frac{V^2}{2g} = \frac{64 \times \nu \times L \times V}{d^2 \times 2g}$$

$$\therefore \frac{64 \times \nu \times L}{d^2 \times 2g} = \text{const.} = K$$

$$\therefore h_f = K \cdot V$$

$$\therefore h_{f1} = K \cdot V_1$$

$$\therefore h_{f2} = K \cdot V_2$$

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$$V_2 = \frac{1}{2} V_1$$

$$\therefore h_{f2} = K \cdot V_2 = \frac{1}{2} K V_1 = \frac{1}{2} h_{f1}$$

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h_f

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$$f \propto \frac{e}{d}$$

f

-

f

Re

f

-

. V

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f

$$\therefore h_f = f \cdot \frac{L}{d} \cdot \frac{V^2}{2g}$$

f

$$\therefore \frac{f \times L}{d \times 2g} = \text{const.} = K$$

$$\therefore h_f = K \cdot V^2$$

$$\therefore h_{f1} = K \cdot V_1^2$$

$$\therefore h_{f2} = K \cdot V_2^2$$

$$\text{at } V_2 = 2 V_1$$

$$\therefore h_{f2} = K \cdot V_2^2 = K \cdot (2V_1)^2 = 4KV_1^2 = 4h_{f1}$$

4

20

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$$\frac{.}{(\alpha)} \quad / \quad 55$$

200

$$. \quad / \quad 0.002$$

$$d = 20 \text{ cm} \quad , \quad T = 10 \text{ year} \quad , \quad hf = 4 \text{ m} \quad , \quad L = 200 \text{ m}$$

$$Q = 55 \text{ L/s} \quad , \quad e_o = ? \quad , \quad \alpha = 0.002 \text{ cm/year}$$

$$\therefore V = \frac{Q}{A} = \frac{0.055}{\frac{\pi}{4}(0.20)^2} = 1.75 \text{ m/s}$$

$$\therefore h_f = f \cdot \frac{L}{d} \cdot \frac{V^2}{2g} \quad \therefore 4 = f \times \frac{200}{0.20} \times \frac{(1.75)^2}{2 \times 9.81}$$

$$\therefore f = 0.0256$$

$$R_e = \frac{V \cdot d}{\nu} = \frac{1.75 \times 0.20}{1 \times 10^{-6}} = 3.5 \times 10^5$$

$$\therefore \frac{e}{d} = 0.0025$$

$$\therefore e = 0.0025 \times 20 = 0.050 \text{ cm}$$

$$\therefore e = e_o + \alpha T$$

$$0.050 = e_o + 0.002 \times 10$$

$$\therefore e_o = 0.03 \text{ cm}$$

$$\therefore \frac{e_o}{d} = \frac{0.03}{20} = 0.0015$$

$$\therefore R_e = 3.5 \times 10^5$$

$$f_o = 0.023$$

$$\therefore h_f = 0.023 \times \frac{200}{0.20} \times \frac{(1.75)^2}{2 \times 9.81} = 3.59 \text{ m}$$

$$\therefore \Delta h_f = \frac{4 - 3.59}{3.59} \times 100 = 11\%$$

/ 75 300 5.0 0.85 -
4.0

$S = 0.85$, $d = 5.0$ cm , $L = 300$ m , $Q = 75$ L/min

$hf = 9$ m , $\mu = ?$

$$\therefore Q = 75 \text{ L/min} = \frac{75}{1000 \times 60} = 1.25 \times 10^{-3} \text{ m}^3/\text{sec}$$

$$\therefore V = \frac{Q}{A} = \frac{1.25 \times 10^{-3}}{\frac{\pi}{4}(0.05)^2} = 0.637 \text{ m/s}$$

$$\therefore h_f = f \cdot \frac{L}{d} \cdot \frac{V^2}{2g}$$

$$\therefore 4 = f \times \frac{300}{0.05} \times \frac{(0.637)^2}{2 \times 9.81}$$

$$\therefore f = 0.073$$

$$\therefore R_e = \frac{64}{f} = \frac{64}{0.073} = 882.4$$

$$\therefore R_e = \frac{V \cdot d \cdot \rho}{\mu}$$

$$\therefore 882.4 = \frac{0.637 \times 0.05 \times (0.85 \times 1000)}{\mu}$$

$$\therefore \mu = 0.0307 \text{ pa.s}$$

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$^{\circ}4$	$^{\circ}20$	$^{\circ}20$	$^{\circ}15$	
				(e)
	25.0	20.0	12.5	(d)
3.5	1.60		2.0	/ (V)
				/ (Q)
1280				(Re)
				(e/d)
		0.065		(f)
	1.2			(hf)

a: \rightarrow $\rightarrow e = 0.25 \text{ mm}$

$$d = 12.5 \text{ cm} \quad V = 2 \text{ m/s}$$

$$\therefore \frac{e}{d} = \frac{0.25}{12.5} = 0.002$$

$$Q = A \cdot V = \frac{\pi}{4} (0.125)^2 \times 2 = 0.0245 \text{ m}^3/\text{s} = 24.5 \text{ L/s}$$

$$\text{at } T = 15^{\circ} \text{ C} \quad \rightarrow \quad \nu = 1.141 \times 10^{-6} \text{ m}^2/\text{s}$$

$$R_e = \frac{V \cdot d}{\nu} = \frac{2 \times 0.125}{1.141 \times 10^{-6}} = 2.19 \times 10^5$$

$$\therefore R_e > 4000$$

f

$$f = 0.0246$$

$$\therefore h_f = f \cdot \frac{L}{d} \cdot \frac{V^2}{2g}$$

$$\therefore h_f = 0.0246 \times \frac{100}{0.125} \times \frac{(2)^2}{2 \times 9.81} = 4.01 \text{ m}$$

b:

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$$\rightarrow e = 0.017 \text{ mm}$$

$$\rightarrow S = 1.262 \quad , \quad v = 661 \times 10^{-6} \text{ m}^2/\text{s}$$

$$d = 20 \text{ cm} \quad f = 0.065$$

$$\therefore \frac{e}{d} = \frac{0.017}{20 \times 10} = 0.000085$$

$$\therefore R_e = \frac{64}{f} = 984.6$$

$$\therefore R_e = \frac{V \cdot d}{v} \quad \therefore 984.6 = \frac{V \times 0.20}{661 \times 10^{-6}}$$

$$\therefore V = 3.25 \text{ m/s}$$

$$\therefore Q = A \cdot V = \frac{\pi}{4} (0.20)^2 \times 3.25 = 0.102 \text{ m}^3/\text{s} = 102 \text{ L/s}$$

$$\therefore h_f = f \cdot \frac{L}{d} \cdot \frac{V^2}{2g}$$

$$\therefore h_f = 0.065 \times \frac{100}{0.20} \times \frac{(3.25)^2}{2 \times 9.81} = 17.5 \text{ m}$$

c:

$$\text{Water at } T = 20^\circ \text{ C} \quad \rightarrow \quad v = 1.007 \times 10^{-6} \text{ m}^2/\text{s}$$

$$V = 1.6 \text{ m/s} \quad d = 25 \text{ cm} \quad h_f = 1.2 \text{ m}$$

$$Q = A \cdot V = \frac{\pi}{4} (0.25)^2 \times 1.6 = 0.0785 \text{ m}^3/\text{s} = 78.5 \text{ L/s}$$

$$\therefore h_f = f \cdot \frac{L}{d} \cdot \frac{V^2}{2g}$$

$$\therefore 1.2 = f \times \frac{100}{0.25} \times \frac{(1.6)^2}{2 \times 9.81}$$

$$\therefore f = 0.023$$

$$R_e = \frac{V \cdot d}{v} = \frac{1.6 \times 0.25}{1.007 \times 10^{-6}} = 3.97 \times 10^5$$

$$\therefore R_e > 4000$$

$$\therefore \frac{e}{d} = 0.00175$$

$$\therefore e = 0.00175 \times 25 = 0.04375 \text{ cm} = 0.43 \text{ mm}$$

d:

$$\rightarrow \quad \rightarrow e = 0.61 \text{ mm}$$

$$\rightarrow S = 0.918 \quad , \quad v = 412 \times 10^{-6} \text{ m}^2/\text{s}$$

$$V = 3.5 \text{ m/s} \quad \text{Re} = 1280$$

$$\therefore R_e < 2000$$

$$\therefore f = \frac{64}{R_e} = \frac{64}{1280} = 0.05$$

$$\therefore R_e = \frac{V \cdot d}{\nu} \quad \therefore 1280 = \frac{3.5 \times d}{412 \times 10^{-6}}$$

$$\therefore d = 0.15 \text{ m} = 15 \text{ cm}$$

$$\therefore \frac{e}{d} = \frac{0.61}{150} = 0.004066$$

$$\therefore Q = A \cdot V = \frac{\pi}{4} (0.15)^2 \times 3.5 = 0.0618 \text{ m}^3/\text{s} = 61.8 \text{ L/s}$$

$$\therefore h_f = f \cdot \frac{L}{d} \cdot \frac{V^2}{2g}$$

$$\therefore h_f = 0.05 \times \frac{100}{0.15} \times \frac{(3.5)^2}{2 \times 9.81} = 20.8 \text{ m}$$

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\circ_4	\circ_{20}	\circ_{20}	\circ_{15}	
0.61	0.43	0.017	0.25	(e)
15.0	25.0	20.0	12.5	(d)
3.5	1.60	3.25	2.0	/ (V)
61.85	78.5	10.2	24.5	/ (Q)
1280	3.97×10^5	984.6	2.19×10^5	(Re)
0.00407	0.00175	0.000085	0.0246	(e/d)
0.05	0.023	0.065	0.0246	(f)
20.8	1.2	17.5	4.01	(hf)