Voluntary homework - Dam

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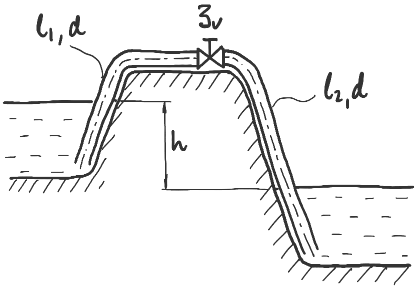

$l_1 = 8\,m$ $\quad \zeta_v = 3.5$ $\quad g = 10\,\frac{N}{kg}$

$l_2 = 6\,m$ $\quad \nu = 1.3 \cdot 10^{-6}\,\frac{m^2}{s}$ $\quad \varepsilon_{max} = 5\%$

$h = 3\,m$ $\quad \rho = 1000\,\frac{kg}{m^3}$

$k = 0\,mm$ $\quad q_{vmin} = 18\,\frac{m^3}{h} = 0.005\,\frac{m^3}{s}$

$d = ?$

BE 1-2

$$p_1 + \rho\frac{v_1^2}{2} + \rho U_1 = p_2 + \rho\frac{v_2^2}{2} + \rho U_2 + \Delta p'$$

$p_1 = p_0$, $v_1 \approx 0$, $U_1 = gh$, $p_2 = p_0$, $v_2 \approx 0$, $U_2 = 0$

$$\Delta p' = \Delta p'_{pf} + \Delta p'_v + \Delta p'_{out}$$

$$\Delta p'_{pf} = \lambda \frac{l_1}{d}\rho\frac{v^2}{2} + \lambda\frac{l_2}{d}\rho\frac{v^2}{2}$$

$$\Delta p'_v = \zeta_v \rho \frac{v^2}{2}$$

$$\Delta p'_{out} = \rho\frac{v^2}{2}$$

$$\rho g h = \lambda\frac{l_1+l_2}{d}\rho\frac{v^2}{2} + \zeta_v\rho\frac{v^2}{2} + \rho\frac{v^2}{2} = v^2\left(\frac{1}{2}\lambda\frac{l_1+l_2}{d} + \frac{1}{2}\zeta_v + \frac{1}{2}\right)$$

$$v = \sqrt{\frac{2gh}{\lambda\frac{l_1+l_2}{d} + \zeta_v + 1}} = \sqrt{\frac{60}{\frac{\lambda}{d}14 + 4.5}}$$

Iteration

Initial guess: $v^0 = 1\,\frac{m}{s}$ $\quad d^0 = 0.1\,m$

I. $Re = \frac{vd}{\nu} = 76925$ $\quad \lambda = \frac{0.314}{\sqrt[4]{Re}} = 0.0189$ $\quad v = \sqrt{\frac{60}{\frac{\lambda}{d}14 + 4.5}} = 2.899$

$d = \sqrt{\frac{4}{\pi}\frac{q_{vmin}}{v}} = 0.047\,m$ $\quad \varepsilon^{I} = \left|\frac{v^{I} - v^{0}}{v^{I}}\right| \cdot 100 = 65.5\,\%$

II. $Re = 104500$ $\quad \lambda = 0.0175$ $\quad v = 2.485\,\frac{m}{s}$ $\quad d = 0.051\,m$

↑ task says Blasius formula can be used

$\varepsilon^{II} = \left|\frac{v^{II} - v^{I}}{v^{II}}\right| \cdot 100 = 16.7\,\%$

III. $Re = 96749$ $\quad \lambda = 0.0178$ $\quad v = 2.523\,\frac{m}{s}$ $\quad \underline{d = 0.0502\,m}$

$\varepsilon^{III} = \left|\frac{v^{III} - v^{II}}{v^{III}}\right| \cdot 100 = 1.5\,\%$ $\rightarrow$ we accept this result