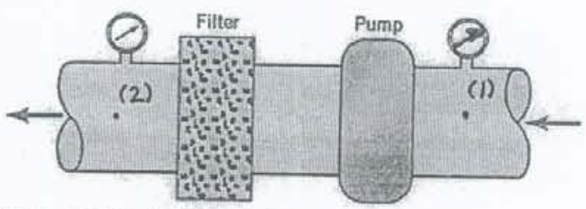
8.94

8.94 When the pump shown in Fig. P8.94 adds 0.2 horsepower to the flowing water, the pressures indicated by the two gages are equal. Determine the flowrate.

Length of pipe between gages = 60 ft
Pipe diameter = 0.1 ft
Pipe friction factor = 0.03
Filter loss coefficient = 12



■ FIGURE P8.94

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 + h_p = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$$

$p_1 = p_2$, $z_1 = z_2$, $V_1 = V_2$

So, $h_p = h_L$ (1)

The pump adds 0.2 hp of power.

$$\dot{W} = 0.2\ hp \times \frac{550\ \frac{ft\cdot lb}{s}}{1\ hp} = 110\ \frac{ft\cdot lb}{s}$$

Convert to head by:

$$h_p = \frac{\dot{W}}{\gamma Q} = \frac{110\ \frac{ft\cdot lb}{s}}{62.4\ \frac{lb}{ft^3}\ Q} = \frac{1.76}{Q}$$

Sub into (1)

$$\frac{1.76}{Q} = \left(f\frac{l}{D} + \Sigma K_L\right)\frac{V^2}{2g} = \left(f\frac{l}{D} + \Sigma K_L\right)\frac{(Q/A)^2}{2g}$$

or $$Q^3 = \frac{1.76(2)(g)A^2}{\left(f\frac{l}{D} + \Sigma K_L\right)}$$ where $A = \frac{\pi}{4}(0.1\ ft)^2 = 7.85\times10^{-3}\ ft^2$

$$= \frac{1.76(64.4)(7.85\times10^{-3})^2}{\left(0.03\frac{60}{0.1} + 12\right)}$$

$$Q^3 = 2.328\times10^{-4}$$

$$\underline{\underline{Q = 0.0615\ ft^3/s}}$$