6.110 In Fig. P6.110 the pipe entrance is sharp-edged. If the flow rate is 0.004 m^3/s, what power, in W, is extracted by the turbine?

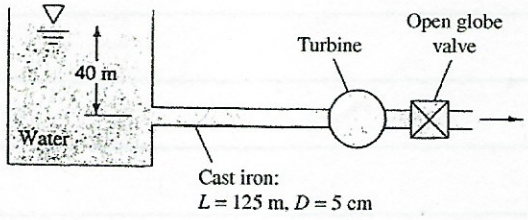

Fig. P6.110

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 + h_p = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_t + h_f + \sum h_m$$

$$h_m = \frac{V^2}{2g} K$$

$$h_t = z_1 - \frac{V_2^2}{2g} - f\frac{L}{D}\frac{V_2^2}{2g} - \sum \frac{V_2^2}{2g} K$$

$$= 40 - \frac{V_2^2}{2g}\left[1 + f\frac{L}{D} + .5 + 6.9\right]$$

↑ globe valve

$f = f(Re_D, \varepsilon/D)$ $\quad V = \frac{Q}{A} = 2.04 \frac{m}{s}$ $\quad K_{entrance}$

$Re = 102{,}000 \Rightarrow f = .0316$

$h_t = 21.5 m$

$P = \rho g Q h_t = 840 W$