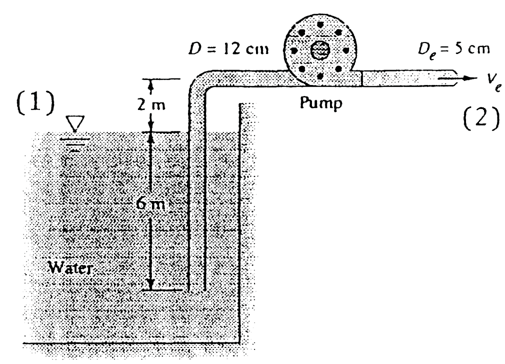

Fig. P3.130

3.130 When the pump in Fig. P3.130 draws 220 m^3/h of water at 20°C from the reservoir, the total friction head loss is 5 m. The flow discharges through a nozzle to the atmosphere Estimate the pump power in kW delivered to the water.

Solution: Let "1" be at the reservoir surface and "2" be at the nozzle exit, as shown. We need to know the exit velocity:

$$V_2 = Q/A_2 = \frac{220/3600}{\pi(0.025)^2} = 31.12\ \frac{m}{s},\quad \text{while } V_1 \approx 0 \text{ (reservoir surface)}$$

Now apply the steady flow energy equation from (1) to (2):

$$\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_f - h_p,$$

$$\text{or:}\quad 0+0+0 = 0 + (31.12)^2/[2(9.81)] + 2 + 5 - h_p,\quad \text{solve for } h_p \approx 56.4 \text{ m.}$$

The pump power $P = \rho g Q h_p = (998)(9.81)(220/3600)(56.4)$

$= 33700\ W =$ **33.7 kW** *Ans.*

3.131 When the pump in Fig. P3.130 delivers 25 kW of power to the water, the friction head loss is 4 m. Estimate (a) the exit velocity; and (b) the flow rate.

Solution: The energy equation just above must now be written with V_2 and Q unknown:

$$0+0+0 = 0 + \frac{V_2^2}{2g} + 2 + 4 - h_p,\quad \text{where } h_p = \frac{P}{\rho g Q} = \frac{25000}{(998)(9.81)Q}$$

and where $V_2 = \dfrac{Q}{\pi(0.025)^2}$. Solve numerically by iteration: $V_2 \approx$ **28.1 m/s** *Ans.* (a)

and $Q = (28.1)\pi(0.025)^2 \approx 0.0552\ m^3/s \approx$ **200 m^3/hr** *Ans.* (b)
