8.60

8.60 Water flows from the nozzle attached to the spray tank shown in Fig. P8.60. Determine the flowrate if the loss coefficient for the nozzle (based on upstream conditions) is 0.75 and the friction factor for the rough hose is 0.11.

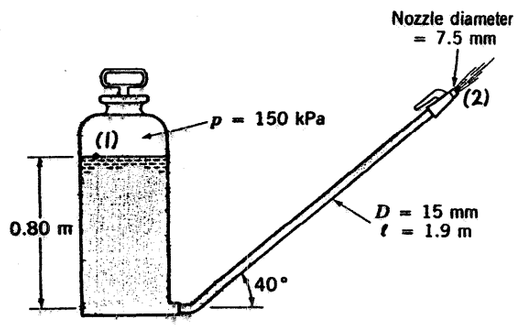

FIGURE P8.60

$\frac{p_1}{\gamma}+\frac{V_1^2}{2g}+z_1=\frac{p_2}{\gamma}+\frac{V_2^2}{2g}+z_2+\left(f\frac{\ell}{D}+K_L\right)\frac{V^2}{2g}$, where $p_1=150\,kPa$, $p_2=0$, (1)

$z_1=0.8m$, $z_2=\ell\sin 40^\circ=(1.9m)\sin 40^\circ=1.22\,m$, $V_1=0$,

$V=\frac{Q}{A}$, and $V_2=\frac{Q}{A_2}=\left(\frac{A}{A_2}\right)V=\left(\frac{D}{D_2}\right)^2V=\left(\frac{15\,mm}{7.5\,mm}\right)^2V=4V$

Thus, with $f=0.11$ and $K_L=0.75$ Eq. (1) gives

$$\frac{150\times10^3\frac{N}{m^2}}{9.80\times10^3\frac{N}{m^3}}+0.8m=1.22m+\left(4^2+0.11\left(\frac{1.9m}{0.015m}\right)+0.75\right)\frac{V^2}{2(9.81\frac{m}{s^2})}$$

or

$V=3.09\frac{m}{s}$

Thus, $Q=AV=\frac{\pi}{4}(0.015m)^2(3.09\frac{m}{s})=\underline{\underline{5.46\times10^{-4}\frac{m^3}{s}}}$