

3.123

3.123 Draw the energy line and the hydraulic grade line for the flow of Problem 3.83.

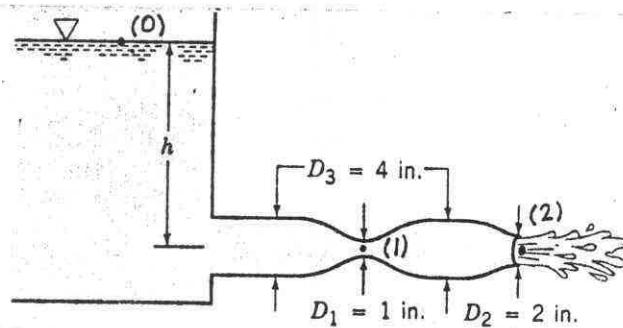


FIGURE P3.83

For inviscid flow with no pumps or turbines, the energy line is horizontal, a distance h above the outlet. From Problem 3.83 we obtain $h = 1.79$ ft.

The hydraulic grade line is $\frac{V^2}{2g}$ below the energy line, starting at the free surface where $V_0 = 0$ and ending at the pipe exit where $p_2 = 0$ and $\frac{V_2^2}{2g} = h$. At point (1) the pressure head is $p_1/\gamma = (2.88 - 14.5) \frac{\text{lb}}{\text{in}^2} \left(\frac{144 \text{ in}^2}{\text{ft}^2} \right) / 62.4 \frac{\text{lb}}{\text{ft}^3} = -26.8$ ft, and $z_1 = 0$.

In the 4 in. pipe $V_3 = A_2 V_2 / A_3 = \left(\frac{D_2}{D_3} \right)^2 V_2$ so that

$$\frac{V_3^2}{2g} = \left(\frac{D_2}{D_3} \right)^4 \frac{V_2^2}{2g} = \left(\frac{D_2}{D_3} \right)^4 h = \left(\frac{2}{4} \right)^4 (1.79 \text{ ft}) = 0.112 \text{ ft}$$

The corresponding EL and HGL are drawn to scale below.

