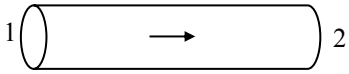
The average flow speed in a constant-diameter section of the Alaskan pipeline is 8.27 ft/s. At the inlet, the pressure is 1200 psig and the elevation is 150 ft; at the outlet, the pressure is 50 psig and the elevation is 375 ft. Calculate the head loss in this section of pipeline.

SOLUTION:



Apply the Extended Bernoulli's Equation from 1 to 2.

$$\left(\frac{p}{\rho g}+\alpha\frac{\bar{V}^2}{2g}+z\right)_2=\left(\frac{p}{\rho g}+\alpha\frac{\bar{V}^2}{2g}+z\right)_1-H_{L,1\to2}+H_{S,1\to2} \tag{1}$$

where

$$\frac{p_2-p_1}{\rho g}=\frac{\left(50-1200\right)\ {}^{\text{lb}_\text{f}}\!/_{\text{in}^2}\cdot 144\ {}^{\text{in}^2}\!/_{\text{ft}^2}}{\underbrace{\left(0.9\right)}_{=\text{SG}_{\substack{\text{crude}\\\text{oil}}}}\left(1.94\ {}^{\text{slug}}\!/_{\text{ft}^3}\right)\left(32.2\ {}^{\text{ft}}\!/_{\text{s}^2}\right)}=-2940\text{ ft} \tag{2}$$

$$\left(\alpha\frac{\bar{V}^2}{2g}\right)_2=\left(\alpha\frac{\bar{V}^2}{2g}\right)_1 \quad \text{(since the flow is fully developed and mass is conserved)} \tag{3}$$

$$z_2-z_1=\left(375-150\right)\text{ ft}=225\text{ ft} \tag{4}$$

$H_{L,1\to2}=?$ (This is what we're trying to find.) (5)

$H_{S,1\to2}=0$ (There is no shaft work between points 1 and 2.) (6)

Substitute and solve for H_L.

$$\boxed{H_{L,1\to2}=-\left(\frac{p_2-p_1}{\rho g}\right)-\left(z_2-z_1\right)} \tag{7}$$

$$\boxed{\therefore H_{L,1\to2}=2940-225\text{ ft}=2720\text{ ft}} \tag{8}$$