When fluid with a specific weight of 50 lb_f/ft^3 flows with a flow rate of 2.0 ft^3/s in a 6 in. pipeline, the frictional stress is 0.5 psf.

a. Calculate the head lost per foot of pipe (in ft/ft).
b. How much power is lost per foot of pipe (in hp/ft)?

SOLUTION:

The (major) head loss is,

$$H_L = f\left(\frac{L}{D}\right)\frac{\bar{V}^2}{2g} \Rightarrow \frac{H_L}{L} = f\left(\frac{1}{D}\right)\frac{\bar{V}^2}{2g}, \quad (1)$$

where,

$$f = \frac{4\tau_w}{\frac{1}{2}\rho\bar{V}^2}, \quad (2)$$

$$\bar{V} = \frac{Q}{\frac{\pi}{4}D^2}. \quad (3)$$

Using the given data,

Q = 2.0 ft^3/s,

D = 6 in. = 0.5 ft,

=> $\bar{V}$ = 10.19 ft/s,

ρg = 50 lb$_f$/ft^3 => ρ = 50 lb$_m$/ft^3 (Note: 1 lb$_f$ = 32.2 lb$_m$.ft/s^2.),

τ_w = 0.5 lb$_f$/ft^2,

=> f = 0.0248,

=> $\boxed{H_L/L = 0.08}$.

The power lost is,

$$H_L = \frac{\dot{W}_L}{\rho Q g} \Rightarrow \dot{W}_L/L = \rho Q g\, H_L/L\,. \quad (4)$$

Using the given data,

$\boxed{\dot{W}_L/L = 8.0 \text{ lb}_f\text{/s} = 0.0145 \text{ hp/ft}}$. (Note: 1 hp = 550 lb$_f$.ft/s.)