8.41

8.41 Oil ($SG = 0.9$), with a kinematic viscosity of 0.007 ft²/s, flows in a 3-in.-diameter pipe at 0.01 ft³/s. Determine the head loss per unit length of this flow.

$h_L = f \frac{\ell}{D} \frac{V^2}{2g}$ Where $\ell = 1$ ft for "per unit length of pipe".

Determine friction factor based on Re & ε/D

$Q = 0.01\ ft^3/s = VA$

$V = \frac{0.01}{\frac{\pi}{4}\left(\frac{3}{12}\right)^2} = 0.20\ ft/s$

$Re = \frac{VD}{\nu} = \frac{0.20(3/12)}{0.007} = 7.14$

Since Re is below 2100, the flow is laminar.

The friction factor can be determined from

$f = 64/Re = 64/7.14 = 8.96$

$h_L = (8.96)\frac{1}{(3/12)}\frac{(0.2)^2}{2(32.2)} = \underline{0.022\ ft}$ per ft of pipe