Question #81136

Oil, with 900 kg/m^3 and 0.00001 m^2/s, flows at 0.2 m^3/s through 500 m of 200-mm diameter cast iron pipe. Determine the head loss.

Answer:

We can determine the velocity of the oil from the known flow rate Q = 0.2 m^3/s and the pipe diameter d = 0.2 m as follow:

$$u = \frac{4Q}{\pi d^2} = \frac{4 \cdot 0.2}{\pi \cdot 0.2^2} = 6.366 \text{ m/s}.$$

Then the Reynolds number is (given dynamic viscosity v = 0.00001 m^2/s):

$$Re = \frac{ud}{v} = \frac{6.366 \cdot 0.2}{0.00001} = 127{,}324 = 1.27 \cdot 10^5.$$

The absolute roughness for the cast iron is k = 0.25 – 0.8 mm (see Engineering ToolBox at https://www.engineeringtoolbox.com/major-loss-ducts-tubes-d_459.html).

Assume k = 0.25 mm. Then

$$\frac{k}{d} = \frac{0.25}{200} = 0.00125.$$

From Moody chart (see Engineering ToolBox at https://www.engineeringtoolbox.com/moody-diagram-d_618.html) for the known values of k/d and Re, we can read the friction factor f = 0.025. Then the head loss is:

$$\Delta h = f \frac{L}{d} \frac{u^2}{2g} = 0.025 \cdot \frac{500 \cdot 6.366^2}{0.2 \cdot 2 \cdot 9.81} = 129 \text{ m}.$$