CE 3305 Fluid Mechanics
Quiz 20
Spring 2014

1. The pressure drop over 15 m of 2-cm-diameter galvanized iron pipe is measured to be 60 kPa. Roughness height is $k_s = 0.20$ millimeters. If the pipe is horizontal, estimate the flow rate of water. Express the result in Liters per second. ($\nu = 10^{-6} m^2/sec$)

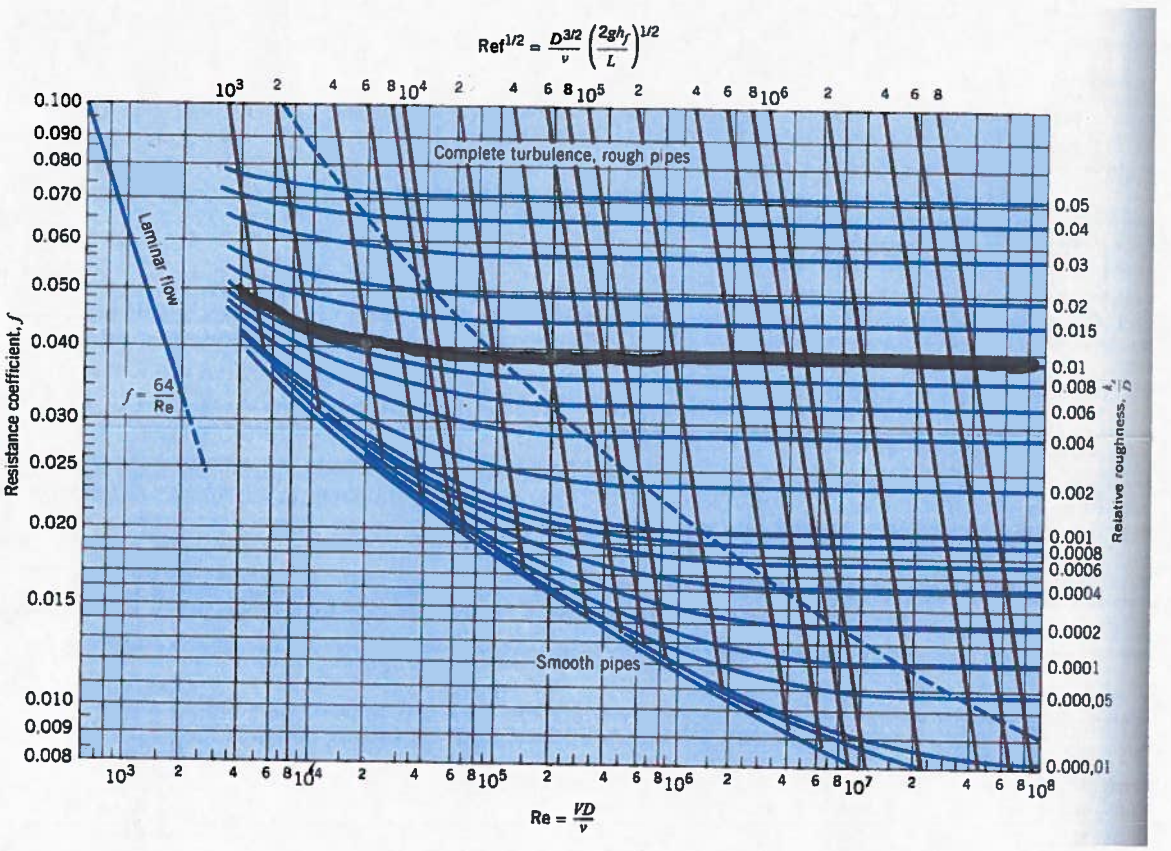
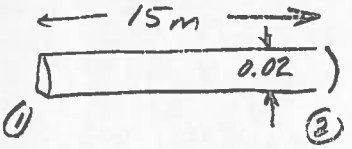


Figure 1: Moody Chart for Problem 1

SOLUTION



$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$$

$V_1 = V_2$

$z_1 = z_2$

$$\frac{p_1 - p_2}{\gamma} = \frac{\Delta p}{\gamma} = h_L$$

$\Delta p = 60\,kPa = 60{,}000\,N/m^2$

$$\frac{\Delta p}{\gamma} = \frac{60{,}000\,N/m^2}{9800\,N/m^3} = 6.12 \quad m$$

$$\frac{\Delta p}{\gamma} = f\frac{L}{D}\frac{V^2}{2g} = \frac{f(15m)V^2}{2(0.02m)(9.8m/s^2)}$$

$$Re = \frac{\rho V D}{\nu} = \frac{(1000\,kg/m^3)(0.02m)V}{10^{-6}\,m^2/s}$$

	A	B	C	D	E	F
1	V	Re	ks/D	V^2	f	Loss
2	0.001	2000	0.01	0.000001	0.032	1.2245E-06
3	0.01	20000	0.01	0.0001	0.04	0.00015306
4	0.1	200000	0.01	0.01	0.039	0.01492347
5	0.2	400000	0.01	0.04	0.039	0.05969388
6	0.3	600000	0.01	0.09	0.039	0.13431122
7	0.5	1000000	0.01	0.25	0.039	0.37308673
8	1	2000000	0.01	1	0.039	1.49234694
9	1.5	3000000	0.01	2.25	0.039	3.35778061
10	2	4000000	0.01	4	0.039	5.96938776
11	2.03	4060000	0.01	4.1209	0.039	6.1498125

← CLOSE ENOUGH!

$$Q = V \cdot A = \left(2.03\frac{m}{s}\right)\left(\frac{\pi(0.02)^2}{4}\right)$$

$$= 0.000637\,m^3/s$$