Calculation of Simple Pressure Drop Due to Fluid Flow Friction

The pressure drop in straight coiled tubing can be calculated as

$$\Delta\rho = f\left(\frac{1}{2}\rho U^2\right)\left(\frac{L}{D}\right)$$

f = Darcy friction factor (non-dimensional)
ρ = fluid density (lbm/ft^3)
U = average (bulk) fluid velocity (ft/s)
L = tube length (ft)
D = tube internal diameter (ft)

The average velocity is calculated from the volumetric flow rate

$$U = \frac{4Q}{\pi D^2}$$

Q = volumetric flow rate (ft^3/s)

To determine the Darcy friction factor, it is necessary to determine two non-dimensional parameters, the Reynolds Number

$$Re = \frac{\rho UD}{\mu}$$

Re = Reynolds number (non-dimensional)
μ = fluid dynamic viscosity (lbm/ft·s)

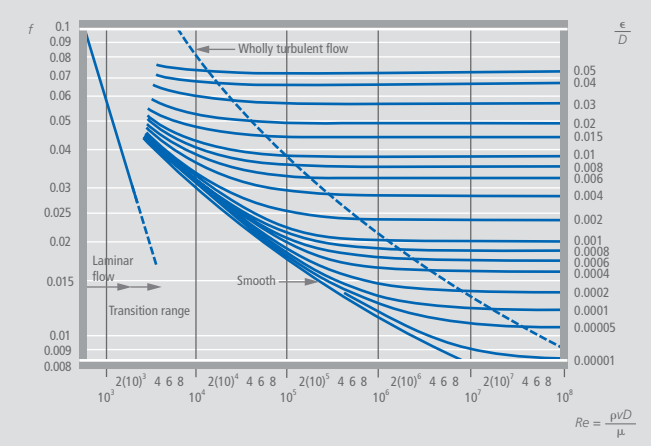
and the relative roughness

$$\epsilon/D$$

ϵ = tube internal roughness (ft)

A reasonable value for the internal roughness of new coiled tubing is 8.3 x 10^{-5} ft (0.001 in)

With these values known, the Darcy friction factor can be found graphically using the Moody chart



or calculated by an iterative process with Colebrook's equation

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{\epsilon/D}{3.7}\right) + \left(\frac{2.5}{Re\sqrt{f}}\right)$$

The following unit conversions are useful for these calculations
1 BPM = 9.36 x 10^{-2} ft^3/s
1 cP = 6.72 x 10^{-4} lbm/ft·s
1 ppg = 7.48 lbm/ft^3

The following table provides common fluid properties used in these calculations

FLUID (68°F)	DENSITY (lbm/ft^3)	VISCOSITY (cP)
Fresh water	62.310	0.9784
10 ppg brine	74.806	2.3000
15% HCl	66.967	1.9500
Diesel	51.724	1.6200

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