1. Compute the Reynolds number for a 50mm id pipe carrying water at a rate of 0.05 m^3 per second.

Re = m-dot / A * d/mu = 50/1.963(-3) * 0.050/9.07(-5) = 14,038,000

2. Compute the Reynolds number for a 500mm id duct carrying CO2 at a speed of 20 metres per second, at 900K and 4MPa.

Rho = 44.01*4e6/(8314*900) = 23.527 kg/m^3, mu = 38.6(-6),

so Re=23.527*20*0.5/38.6(-6) = 6.09e6

3. What is meant by 'friction factor'?

4. What is the pressure drop

(i) A 25mm id pipe, 100m long, carrying water at a rate of 3m^3 per hour?

Reynold's number

$$Re = \frac{\rho u d}{\mu} = \frac{\frac{\dot{m}}{A} d}{\mu} = \frac{\rho \dot{V} d}{A \mu}$$

$$Re = \frac{1000 \times 3 \times 0.025 \times 4}{3600 \times \left(\pi \times 0.025^2\right) \times 0.907 \times 10^{-4}} = 4.68 \times 10^5$$

So from the Moody chart (smooth pipe)

f=0.016

$$f \equiv \frac{2\left(\frac{\Delta p}{L}\right) d}{\rho u^2} = 0.016$$

$$\frac{\Delta p}{L} = \frac{0.016 \rho u^2}{2d} = \frac{0.016 \rho}{2d}\left(\frac{\dot{V}}{A}\right)^2 = \frac{0.016 \times 1000 \times (1.7)^2}{0.05} = 924.8$$

So pressure drop over 100m = 93kPa.

(ii) A smooth CO2 pipeline, 0.5m id, 2km long, carrying 20m^3 /s of CO2 at 900K, 40 bars.

Re = 6.09e6 from above, so from chart f = 0.009

$$\Delta p = f \frac{\rho u^2 L}{2d}$$

=0.009*23.527*400*2000/(2*0.5)=169e3Pa

5. Determine the hydraulic diameter of a typical flow passage in a PWR, with pin od 0.009500, and a square pitch of 0. 0126m

(0.011777m)

$$d_h = \frac{4\left(p^2 - \frac{\pi d^2}{4}\right)}{\pi d} = \frac{4\left(0.0126^2 - 7.088\times10^{-5}\right)}{2.98\times10^{-2}} = \frac{4\times8.788\times10^{-5}}{2.98\times10^{-2}}$$
$$= 0.01179$$

6. What is the pressure drop in passing up such a channel under the following conditions: channel mass flow 0.336 kg/s, (300K water props).

$$A_f = 8.788\times10^{-5}$$

$$Re = \frac{\frac{\dot{m}}{A}d_e}{\mu} = \frac{\frac{0.336}{8.788\times10^{-5}}\times0.0118}{0.907\times10^{-4}} = 0.497\times10^6$$

$$f \equiv \frac{2\left(\frac{\Delta p}{L}\right)d_e}{\rho u^2} = 0.013$$

$$\frac{\Delta p}{L} = \frac{\rho u^2 f}{2d_e} = \frac{\rho^2 u^2 f}{\rho 2 d_e} = \frac{\left(\frac{\dot{m}}{A}\right)^2 f}{2\rho d_e} = \frac{\left(\frac{0.336}{8.788\times10^{-5}}\right)^2\times0.013}{2\times1000\times0.0118} = 8.05\times10^3$$

7. Determine the hydraulic diameter of the AGR coolant passage defined below.
Channel id = 0.1900 m
Clad od = 0.01525 m
36 pins in cross section.
(0.03752m)

8. Compute the frictional pressure drop in the AGR passage above, under the following conditions:

Friction factor 4 times that for a smooth tube

Passage flow rate 13.36 kg/s

Mean temperature in channel 750K

(Re 8.0203e+05, friction factor 0.0121, frictional pressure drop 7.2918+04 Pa)