OLD EXAM QUESTIONS FROM CHAPTERS 2 & 3

Q. (**20 pts**)

(a) The Colburn equation for heat transfer is given by:

$$\left(\frac{h}{CG}\right)\left(\frac{C\mu}{k}\right)^{2/3} = \frac{a}{\left(\frac{DG}{\mu}\right)^{0.2}}$$

where C = heat capacity, $\left(\frac{\text{Btu}}{\text{lb}_\text{m}\ \text{F}^\circ}\right)$

μ = viscosity, $\left(\frac{\text{lb}_\text{m}}{\text{hr ft}}\right)$

k = thermal conductivity, $\left(\frac{\text{Btu}}{\text{hr ft F}^\circ}\right)$

D = pipe diameter, ft

G = mass velocity, $\left(\frac{\text{lb}_\text{m}}{\text{hr ft}^2}\right)$

a is a dimensionless number

What are the equivalent **SI** units of the heat transfer coefficient, h ?

(b) The equation of pressure drop due to friction for fluids flowing in a pipe is given by:

$$\Delta P = \frac{2\ f\ L\ \rho\ v^2}{D}$$

where ΔP = pressure drop, v =velocity, L = length of the pipe, D = diameter of the pipe, and ρ is the fluid density. What is the dimension of the friction factor, f ? (Hint: Use base dimensions in your solution.)

Q. (**25 pts**) Consider that some (x,y) data follow the equation $y = \sqrt{a\ e^{b/x} + 4}$

(a) How would you plot the data to get a straight line on a rectangular paper?

(b) Determine the slope and intercept (with their units) of the linear plot using the data points (x=1.25 s, y= 5.12°C) and (x=2.5 s, y= 3.74°C) by calculation (without plotting).

(c) Plot the linear equation on a rectangular graph paper (supplied) using the two data points in part (b) and showing the intercept on your plot.

(d) Determine the constants a and b with their units.

Q. (**10 pts**) A mixture of gases has the following composition by mole:

CH_4 40.0 %, C_2H_6 20.0 %, C_3H_8 30.0 %, C_4H_{10} 10.0 %

Calculate the mass composition and the average molecular weight of the gas.
(Atomic weigths of C and H are 12 and 1, respectively.)

Q. (**7 pts**) Air (79 mole% N_2, 21 mole% O_2) flows to a reactor at a rate of 1000 kg/h. Calculate the rate of flow of O_2 into the reactor in kg/h.