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NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
B.Tech Third Semester (Monsoon 2012) Chemical Engineering
Test 1
CH2002 PROCESS CALCULATIONS

Time: 1hour **Maximum marks: 20**

1. State Dalton's law. Show that pressure fraction and mole fraction of an ideal gas are identical. (2.5)
2. What is API scale and where is it used? A certain solution has a specific gravity of 0.95 at 288.8K referred to water at 288.8K. Express the specific gravity as °Be. (2.5)
3. An aqueous solution of NaCl contains 20% NaCl. The density of the solution is 1.16g/ml. One litre of water of density 1g/ml is added to 1 litre of the solution. What will be the molality and molarity of the resulting solution? (3.5)
4. The following empirical equation correlates the values of variables in a system in which solid particles are suspended in a flowing gas:

$$\frac{k_g d_p y}{D} = 2.00 + 0.600\left(\frac{\mu}{\rho D}\right)^{1/3}\left(\frac{d_p u \rho}{\mu}\right)^{1/2}$$

both $\left(\frac{\mu}{\rho D}\right)$ and $\left(\frac{d_p u \rho}{\mu}\right)$ are dimensionless groups; k_g is a coefficient that expresses the rate at which a particular species transfers from the gas to the solid particles; and the coefficients 2.00 and 0.600 are dimensionless constants obtained by fitting experimental data covering a wide range of values of the equation variables. The value of k_g is needed to design a catalytic reactor. Since this coefficient is difficult to determine directly, the values of other variables are measured or estimated and k_g is calculated from the given correlation. The variable values are as follows:

$d_p = 0.0164$ ft, $y = 0.10$ (dimensionless), $D = 556$ in^2/hr, $\mu = 2.419$ lb/(ft . hr), $\rho = 0.016$ lb/ft^3, $u =$ 118.11 ft/hr. What is the estimated value and unit of k_g in SI units? (4.5)

5. A cylinder 0.150 m^3 in volume containing 22.7 kg of propane C_3H_8 stands in hot sun. A pressure gauge shows that the pressure is 4790 kPa gauge. What is the temperature of propane in the cylinder? Use van der Waal's equation. Critical properties are $T_c = 369.8$ K, $P_c = 42.48$ bar (4)
6. An average person's lungs contain about 5 L of gas under normal conditions. If a diver makes a free dive (no breathing apparatus), the volume of the lungs compressed when the pressure equalizes throughout the body. If compression occurs below 1 L, irreversible lung damage will occur. Calculate the maximum safe depth for a free dive in sea water (assume the density is same as fresh water). Relevant data required may be assumed suitably. (3)