UNIVERSITY OF GHANA

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FACULTY OF ENGINEERING SCIENCES

BSc. SECOND SEMESTER EXAMINATIONS: 2013/2014
FPEN 312: MASS TRANSFER

TIME ALLOWED: 1½ HOURS
Instructions: Answer all Questions

1. A single-effect standard evaporator operating at 1 atmosphere and 40°C is used to concentrate orange juice with an initial concentration of 200 g of orange juice per dm^3 of water to give a concentrated orange juice (syrup) with concentration of 800 g per dm^3 of solution.
   (i) What is the quantity of water evaporated for every tonne of initial solution?
   (ii) What is the quantity of orange juice concentrate produced for every tonne of initial solution?
   (iii) The cost of evaporating one (1) kilogram per hour of water has been estimated by the process engineer as GH¢0.01, estimate the cost of producing one tonne/hour of orange juice concentrate and cost during an eight (8) hour shift.

2. A counter-current absorber is used to remove sulphur dioxide (SO_2) from a flue gas generated in a factory. Water (H_2O) is used as an absorbent. Gas analysis of the flue gas indicates that the initial concentration of SO_2 is 2.0×10^{-1} kg/kg while the final concentration is 5×10^{-3} kg/kg. The flue gas has a density of 1.30 kg/m^3 at normal operating conditions. The absorber (scrubber) has a capacity of 10,000 m^3/h of flue gas.
   (i) Sketch the counter-current absorber indicating all the streams of absorbent and flue gas.

   (ii) Determine flow rate of water if the initial and final concentrations

of the SO_2 in the water are 5×10^{-2} kg/kg and 1.5 kg/kg respectively.

Gas constant R = 8.314×10^3 Nm/kmol K.

3. Methane is diffusing through a stationary hydrogen medium which has an estimated diffusivity of 5.0×10^{-5} m^2/s. Assume the partial pressure of Methane at two planes, 30×10^{-3} m apart are 30 kN/m^2 and 10 kN/m^2 respectively calculate the rate of diffusion of methane through the hydrogen medium at 1 atmosphere and 27°C
Gas constant R = 8.314×10^3 Nm/kmol K.