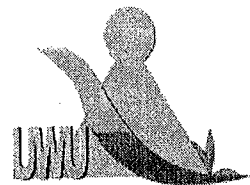


Uva Wellassa University, Sri Lanka
End Semester Examination – Sept. 2011
SCT 314-2 Chemical Engineering Science

-Repeat-

Time: Two (02) hours



Total 04 questions

Answer **all** questions

Clearly state any assumptions made

You can assume any missing data

Tables of properties are provided

- 01) I. Briefly discuss the importance of doing material and energy balance calculations for a processing industry. (40 marks)

- II. A wet scrubbing system has three separate inlet streams. The mass flow rates in these inlet streams are 35 kg/min, 20 kg/min, and 25 kg/min. The water spray rate into the scrubber is 20 kg/min and some of this spray evaporates and leaves with the gas stream. The water stream leaving the scrubber is 16 kg/min. What is the mass of the gas stream leaving the scrubber?

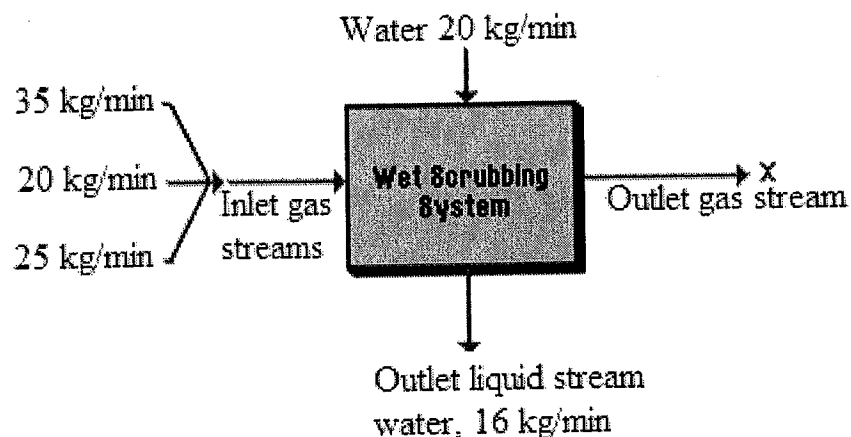


Fig Q1

(60 marks)

- 02) I. Briefly explain the three modes of heat transfer. (30 marks)

- II. A furnace wall is made of three layers. The first layer of insulation is made of brick of 12 cm thickness having conductivity of 0.6 W/mK. The face is exposed to gases at 870°C

with a convection coefficient of $110 \text{ W/m}^2\text{K}$. This layer is backed by a 10 cm thick layer of firebricks having conductivity of 0.8 W/mK . There is a contact resistance between the layers of $2.6 \times 10^{-4} \text{ m}^2\text{°C/W}$. The third layer is the plate backing of 10 mm thickness with conductivity of 49 W/mK . The contact resistance between the second and third layers is $1.5 \times 10^{-4} \text{ m}^2 \text{°C/W}$. The plate is exposed to air at 30°C with a convection coefficient of $15 \text{ W/m}^2\text{K}$. Determine the heat flow, the surface temperatures and the overall heat transfer coefficient.

(70 marks)

- 03) A methanol-water mixture is separated using continuous distillation column operating at 1 atm. The feed which is at its boiling point enters the column at a rate of 400 kmol/hr. A reflux ratio of 2.5R_{min} is used. Compositions of 0.9 and 0.1 (both in mole fractions) are desired for the top and bottom streams, respectively, when the feed composition is 0.4 (mole fraction). Equilibrium curve for methanol-water system at 1 atm is given in Fig Q3. Determine:

- The amounts of distillate and bottoms produced by the column. (20 marks)
- The minimum reflux ratio for the column. (10 marks)
- The operating line equation for the rectifying section at the given reflux ratio. (15 marks)
- The equation of the q-line. (10 marks)
- Locate the top and bottom operating lines on the x-y plot. (30 marks)
- The number of theoretical plates required for the column. (15 marks)

- 04) I. Briefly discuss the mechanical separation methods used in chemical industry. (40 marks)

II. Filtration is a very useful method of separation that is widely used in the industry.

- State the fundamental equation for filtration, explaining all the notations. (20 marks)
- Starting with the fundamental equation, derive the equation for constant pressure filtration. (20 marks)
- What are the uses of the equation that you derived, in the industrial level? (20 marks)

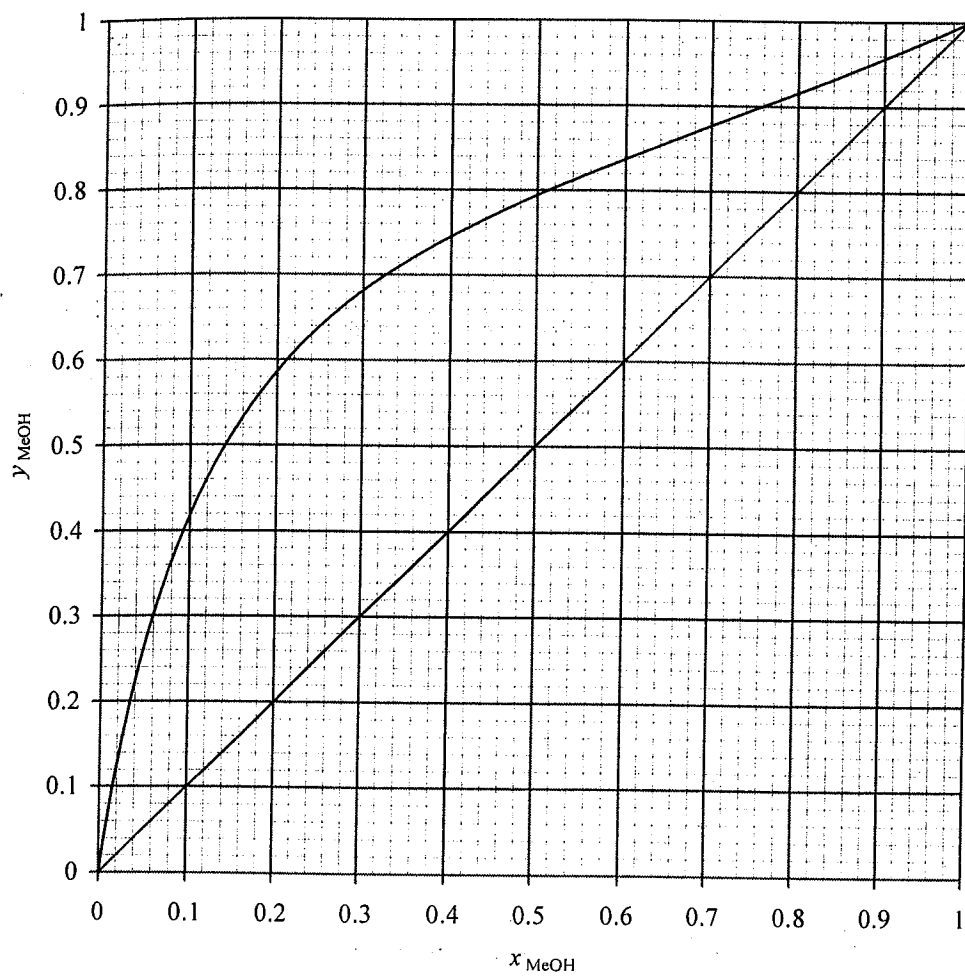


Fig Q3 Liquid-vapor systems for methanol- H_2O mixtures at 1 atm