NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part One Examination December 2006

TCE1101 Chemical Engineering Calculations

Duration of Examination 3 Hours

Instructions to Candidates:

1. Answer ALL FIVE questions.
2. Each question carries equal marks.
3. Show all your steps clearly in your calculation.
4. Start the answers for each question on a new page.

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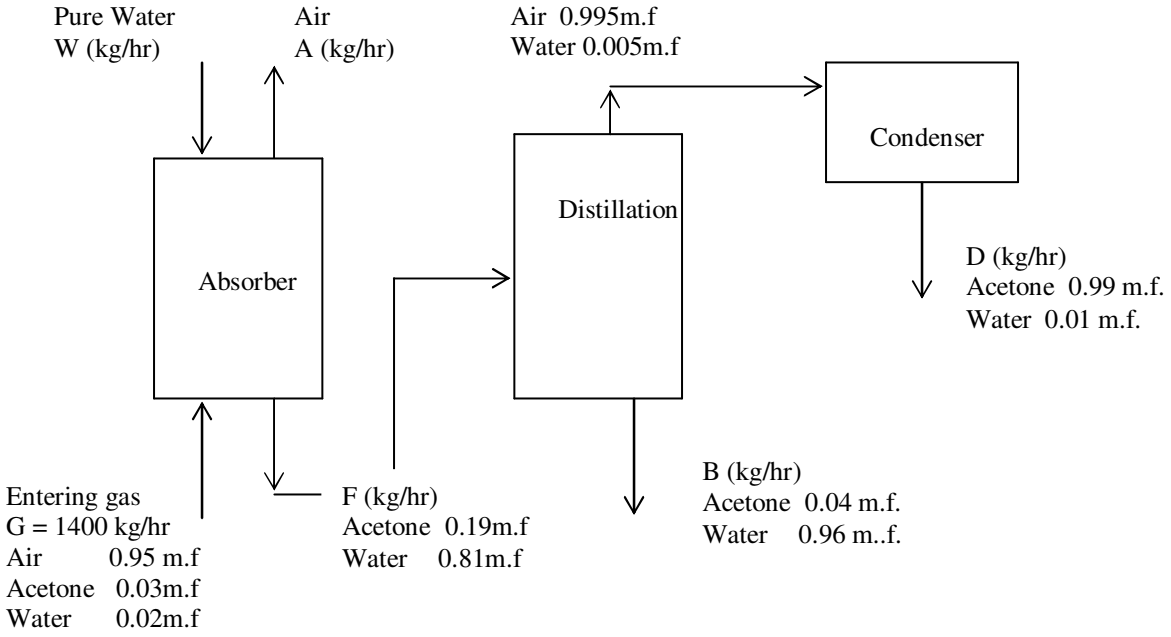
1. Acetone is used in the manufacture of many chemicals and also as a solvent. In its latter role, many restrictions are placed on the release of acetone vapors to the environment. You are asked to design an acetone recovery system having the flowsheet illustrated below. All the concentrations of gases and liquids are specified in weight % (mass %). Calculate A, F, W, B and D per hour given G = 1400 kg/hr. (25 marks)



2. a) Define the dimensions of force, energy and pressure (5 marks)

b) Consider the equation D = At + B, where D [=] ft and t [=] s. What are the dimensions of D and t? What are the dimensions and units of A and B? (5 marks)

c) You are traveling at 50 km/hr and you increase your speed by 1 ft/s. What is your final velocity? (5 marks)

d) A solution contains 15% A by mass and 20% B by mole. Calculate the following:

i. mass of A in 175kg solution (5 marks)

ii. the molar flow rate of B in a stream flowing at 1000 mol/min (5 marks)

3. a) Water flows into a process unit through a 2cm inner diameter (ID) pipe at a rate of 2 m^3/hr. Calculate the kinetic energy for this stream in units of J/s (7 marks)

b) Crude oil is pumped at a rate of 15.0 kg/s from a well 220m deep to a storage tank 20m above the ground level. Calculate the rate at which potential energy increases (J/s) (8 marks)

c) What is the change in internal energy when 10 kgmol of air is cooled from 60 to 30˚C in a constant volume process?

You are given that $C_{V, air} = 2.1 \times 10^4$ J/ (kgmol.˚C) (10 marks)

4. a) Calculate the volume occupied by 88 lb_m CO_2 at 15 ˚C and at 32 ft H_2O. (7 marks)

(6 marks)

c) What is the specific gravity of N_2 at 80 ˚F and 745 mm Hg compared to air at 80˚F and 745 mm Hg? (8 marks)

d) What is 4 kg.m/s^2 equivalent to in N? (4 marks)

5. a) A mixture of gases has the following composition by mass:

O_2	20%
CO	4.0%
CO_2	13%
N_2	63%

What is the molar composition? (10 marks)

b) A 0.6 molar aqueous solution of sulphuric acid flows into a process unit at a rate of 1.5 m^3/min. The specific gravity of the solution is 1.03

i. Calculate the mass concentration of H_2SO_4 in kg/m^3.

ii. The mass flow rate of solution in kg/s

iii. The mass flow rate of H_2SO_4 in kg/s

iv. The mass fraction of H_2SO_4

v. The molar flow rate of H_2SO_4 in kgmoles/s (15 marks)