
MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL

III SEMESTER B.TECH. (CHEMICAL ENGINEERING)

MAKEUP EXAMINATIONS, DECEMBER 2017

SUBJECT: CHEMICAL PROCESS CALCULATIONS [CHE 2101]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** questions.
- Missing data, if any, may be suitably assumed.
- Atomic Mass- Mg:24.3, O:16, N:14, S: 32, Na: 23, H:1, C:12, Ca:40, Cl: 35.5, Cu: 63.5, P:31, Cr:52, Fe:59
- Use of humidity chart is permitted

(28th December, 2017, FN)

1A. Convert :
i. Density of 10gm/cc to kg/m^3
ii. Viscosity of 10 cp to lbm/ft.hr.
iii. Mass flow rate of 50 lb/hr.ft^2 to kg/sec.m^2 **1+2 +2**

1B. How many of each of the following are contained in 200.0 g of CO_2 (M = 44.01)? **5**
(1) mol CO_2 ; (2) lb-moles CO_2; (3) mol of Carbon (C); (4) mol of O; (5) mol of O_2; (6) gram of O; (7) molecules of CO_2 .

2A. A juice contains 12% solids and balance water, the concentrated juice contains 42% solids. In the present process the evaporator is bypassed with a fraction of fruit juice. The juice that exits out of the evaporator is concentrated to 58% solids and the product is mixed with fresh juice to achieve the final concentration. Calculate **5**
i) Amount of concentrated fruit juice produce per 2500 kg of fresh juice.
ii) Fraction of feed that bypasses the evaporator.

2B. Ethylene oxide is produced by the oxidation of ethylene with oxygen-enriched air: **5**

$$C_2H_4 + ½\ O_2 \rightarrow C_2H_4O$$

An undesired side reaction is the oxidation of ethylene to carbon dioxide:

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

The feed stream to the ethylene oxide reactor consists of 45% (by mole) C_2H_4, 30% O_2, and 25% N_2. The amounts of ethylene oxide and carbon dioxide in the product stream are 20 gmol and 10 gmol per 100 gmol of feed stream, respectively. Determine the composition of the exiting gas stream.

3A. N_2 and H_2 mixed in a mole ratio of 1:3 is used for manufacturing NH_3. The conversion per pass is 16%. Ammonia is separated and the unconverted gases are recycled. The feed contains 0.2 moles of Argon per 100 moles of N_2 and H_2 mix by volume. The tolerance limit of Argon entering the reactor is 6 parts per 100 parts of N_2 and H_2 mix by volume. Calculate: **5**

i. The fraction of the recycle that must be continuously purged.
ii. Recycle ratio

3B. A distillation column separates feed mix containing 30 mole % Benzene , 50 mole% Toluene and 20 mole % xylene into an over-head containing 95 mole% Benzene, 4 mole % Toluene and 1 mole % Xylene and bottom product containing 2 mole % Benzene. The reflux ratio is 2.5. On the basis of 1000 moles of feed/ hr. calculate **5**

i) Mass of top and bottom product
ii) Recovery of Benzene in top product and recovery of Xylene in bottom product
iii) Recycle Ratio

4A. Slabs of building boards containing 15% moisture by weight are dried to a moisture content of 1% by circulating hot air over them. The fresh air contains 0.02 kg water vapour/ kg dry air and the exhaust gas contains 0.08 kg water vapour per kg dry air. Calculate the quantity of fresh air in m^3/h required per 2000kg/h of net dry board if the fresh air is supplied at 30 ^oC and 1 atm pressure abs. **5**

4B. A gas analyzing CO=27%, CO_2=3.5%, H_2=14%, CH_4=0.5%, O_2=3%, N_2=52% is burnt with 10% excess air. Calculate the Orsat analysis of the flue gas. **5**

5A. Urea is produced as per the following reaction **5**

$2\ NH_3+CO_2 \rightarrow NH_2COONH_4$

$NH_2COONH_4 \rightarrow NH_2CONH_2+H_2O$

If only 60% of NH_3 takes part in the reaction and 1000 kg of urea is to be produced, Find

i. Volume of NH_3 to be fed at STP
ii. The amount of H_2O produced

5B. The standard heats of the following combustion have been determined experimentally **5**

$C_2\ H_6+7/2\ O_2 \rightarrow 2CO_2+3H_2O \quad \Delta H = -1559$ kJ/mole

$C+O_2 \rightarrow CO_2 \quad \Delta H = -393.5$ kJ/mole

$H_2+ 1/2O_2 \rightarrow H_2O \quad \Delta H = -285.8$ kJ/mole

Using Hess's law, determine the standard heat of reaction for

$2C+ 3H_2 \rightarrow C_2H_6$