

Total No. of Question : [4]

Registration No. :

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Programme Name : Bachelor of Chemical Engineering

Regular S.Y.B.Tech.Sem.IV ESE May / June 2023

IV SEMESTER (2021 BATCH)

201CHL 213-Chemical Process Calculations

Duration : 2 Hours

Marks : 50

Instructions :

1.Read questions carefully.

(Q1) All questions are compulsory [20.0]

(1.1) 20 g of caustic soda are dissolved in water to prepare 500 ml of solution. Find the normality and molarity of solution. [6.0]

CO :- CO1

Blooms Taxonomy :- Remember

(1.2) By electrolyzing a mixed brine a gaseous mixture is obtained at the cathode having the following composition by weight [7.0]

$\text{Cl}_2 = 67\%$, $\text{Br}_2 = 28\%$, and $\text{O}_2 = 5\%$

Calculate:

- Composition of gas by volume
- Average molecular weight and
- Density gas mixture at 298 K and 101.325 kPa

CO :- CO2

Blooms Taxonomy :- Understand

(1.3) An evaporator is fed with 15000 kg/h of a solution containing 10% NaCl, 15% NaOH and rest water. In the operation water is evaporated and NaCl is precipitated as crystals. The thick liquor leaving the evaporator contains 45% NaOH, 2% NaCl and rest water. [7.0]

Calculate:

- Kg/h water evaporated
- Kg/h precipitated
- Kg/h thick liquor

CO :- CO3

Blooms Taxonomy :- Apply

(Q2) All questions are compulsory [10.0]

(2.1) In production of SO_3 , 100 kmol of SO_2 and 200 kmol of O_2 are fed to a reactor. The product stream is found to contain 80 kmol SO_3 . Find the percent conversion of SO_2 [4.0]

CO :- CO4

Blooms Taxonomy :- Understand

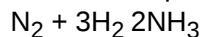
OR [2.1 / 2.2]

- (2.2) A combustion reactor is fed with 50 kmol/h of butane and 2100 kmol/h of air. Calculate [4.0]
the % excess air used.

CO :- CO4

Blooms Taxonomy :- Understand

- (2.3) Ammonia is produced by the following reaction [6.0]



Calculate:

- The molal flow rate of hydrogen corresponding to nitrogen feed rate of 25 kmol/h if they are fed in the stoichiometric proportion
- The kg of ammonia produced per hour if % conversion is 25 and nitrogen feed rate is 25 kmol/h

CO :- CO4

Blooms Taxonomy :- Understand

- (Q3) All Questions are compulsory [10.0]

- (3.1) 100 kg/h of methanol liquid at a temperature of 303 K is to be obtained by removing [3.0]
heat from saturated methanol vapor. Find out the amount of heat to be removed in this case.

CO :- CO5

Blooms Taxonomy :- Apply

- (3.2) A stream of CO₂ flowing at a rate of 100 kmol/min is heated from 298 K to 383 K. [7.0]
Calculate the heat that must be transferred using Cp data:

$$C_p = a + bT + cT^2 + dT^3$$

Gas	a	b $\times 10^3$	c $\times 10^6$	d $\times 10^9$
CO ₂	21.3655	64.2841	-41.0506	9.7999

CO :- CO5

Blooms Taxonomy :- Apply

- (3.3) A stream of nitrogen flowing at a rate of 100 kmol/h is heated from 303 K to 373 K. [7.0]
Calculate the heat that must be transferred.

$$C_p \text{ for nitrogen} = 29.5909 + 5.141 \times 10^{-3}T + 11.1829 \times 10^{-6}T^2 + 4.968 \times 10^{-9}T^3$$

CO :- CO5

Blooms Taxonomy :- Apply

- (Q4) Solve any two from three questions [10.0]

- (4.1) Calculate the heat of formation of phenol crystals at 298.15 K from its elements using [5.0]
the following data:

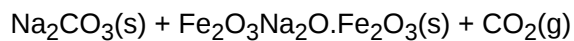
- $\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) \quad \Delta H_1 = -393.51 \text{ kJ/mol}$
- $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O(l)} \quad \Delta H_2 = -285.83 \text{ kJ/mol}$
- $\text{C}_6\text{H}_5\text{OH(c)} + 7.5 \text{ O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 3\text{H}_2\text{O(l)} \quad \Delta H_c = -3053.25 \text{ kJ/mol}$
- $6\text{C(s)} + 3\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{C}_6\text{H}_5\text{OH(c)}$

CO :- CO6

Blooms Taxonomy :- Apply

(4.2) Calculate the standard heat of reaction of the following reaction

[5.0]



Data:

Component	ΔH°_f , kJ/mol at 298.15 K
$\text{Na}_2\text{CO}_3(\text{s})$	-1130.68
Fe_2O_3	-817.3
$\text{Na}_2\text{O} \cdot \text{Fe}_2\text{O}_3(\text{s})$	-1412.2
$\text{CO}_2(\text{g})$	-393.51

CO :- CO6

Blooms Taxonomy :- Apply

(4.3) Calculate the standard heat of reaction of the following reaction:

[5.0]



Data:

Component	ΔH°_c , kJ/mol at 298.15 K
$(\text{COOH})_2$	-244.76
$\text{HCOOH}(\text{l})$	-254.64

CO :- CO6

Blooms Taxonomy :- Apply
