Exam Date & Time: 30-Apr-2019 (02:00 PM - 05:00 PM)



MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES II SEMESTER B. Sc. (APPLIED SCIENCES) END SEMESTER THEORY EXAMINATIONS -APRIL / MAY 2019

Chemical Process Calculations [ICHM 121]

Marks: 100

Duration: 180 mins.

Answer 5 out of 8 questions. Missing data, if any, may be suitably assumed. Use of humidity chart is permitted

(10)

1) Solve:

A)

- i) The viscosity of water at 60°F is given as 7.8 x $10^4\,\rm lb~ft^{-1}~s^{-1}.Calculate this$
 - viscosity in N s m^2 .
 - ii) The thermal conductivity of aluminium is given as 120 Btu ft¹ h⁻¹ °F⁻¹. Calculate this thermal conductivity in W m¹ °C⁻¹.
 - iii) Convert 1.5 cal/(g^oC) to Btu/(lb ^oF).

B) Hemlock bark contains 6% mixture, 10.8% tannin and 8.2% soluble nontannin. The balance is insoluble lignin. After extraction the waste bark on dry basis contains 0.95% tannin and 0.22% soluble non tannin. If raw tannin brings Rs. 100 per kg, how much money is lost per 1000 kg of original bark because of imperfect extraction of tannin? Also find % recovery of tannin?

2)

- A limestone analyses CaCO₃=92.89%; insolubles 1.7%; MgCO₃=5.41%. ⁽¹⁰⁾
 a) How many kg of CaO can be made from 5 tonnes of this limestone?
 b) How many kg of CO₂ are obtained per kg of limestone?(Ca:40; Mg:24)
- A treating plant operating under steady state conditions processes raw (10) waste liquor containing 0.5% noxious hazardous impurities. A treatment plant reduces the level of impurities to 0.01%. By local law a maximum of 0.1% of impurity may be discharged to the local river. What fraction of raw waste liquor stream the plant must bypass?

³⁾ In the Decon process of manufacturing Chlorine gas, HCl gas is oxidized (10) with air. The reaction is given as $^{(A)}$ $^$

^{B)} It is desired to have 100 kg of a mixed acid containing 40% HNQ₃, 42% ⁽¹⁰⁾

 H_2SO_4 and 18% H_2O by weight. Sulfuric acid of an unknown composition and nitric acid of 69.5% are mixed to obtain the required composition given above. Calculate a) the strength of sulfuric acid b) mass of HNO₃ and H_2SO_4 require^{d.}

- ⁴⁾ Determine the flue gas analysis and air-fuel ratio by wt. when a fuel oil with ⁽¹²⁾ ^{A)} B4.5% C, 11.8% H₂, 3.2 % S, 0.4% Q₂, 0.1% ash is burned with 25% excess air.
 - ^{B)} 1000 kg / hr. of a mixture of 40 mole % Ethylene Di-Chloride (EDC) and 60 ⁽⁸⁾ mole % Phenol is to be separated in a distillation column. The distillate stream consists of 95 mole % EDC and bottom stream contains 10 mole % EDC.

Determine

5)

i) The flow rate of the distillate and residue product streams

ii) The Phenol recovered in the bottom product as a percentage of that present in feed.

 N_2 and H_2 mixed in a mole ratio of 1:3 is used for manufacturing NH_3 . The ⁽²⁰⁾ conversion per pass is 18%. 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:

i) The fraction of the recycle that must be continuously purged.

ii) Recycle ratio

- ⁶⁾ Acetone nitrile is produced by the reaction of propylene, ammonia and Q. ⁽¹⁰⁾ _{A)} $C_3H_6 + NH_3 + 3/2 O_2 \rightarrow C_3H_3N + 3 H_2O$
 - The feed contains 10 % propylene, 12 % ammonia and 78 % air (in mole %)

i) Determine the limiting reactant

- ii) % by which the other reactants are in excess.
- ^{B)} Calculate the volume occupied by 1 mole of water vapour at 900^oC and ⁽¹⁰⁾ 100 atm by

i) Perfect gas law

ii) Vander Waal's equation

The Vander-Waal's constants are a= $(5.404 L^2.atm)/(mole^2)$; b= 0.03049 L/mole

- Air at a pressure of 1atm is at 40°C and has a humidity of 70%. Find using (12) humidity chart:
 - i) Absolute Humidity
 - ii) Molal Humidity
 - iii) Dew Point Temperature

- iv) Adiabatic Saturation Temperaturev) Humid Heatvi) Humid Volume
- ^{B)} Two engineers are calculating the average molecular wt. of gas mixture (8) containg O₂ and other gases. One uses the correct mol.wt. of 32 and finds the avg. mol. wt. as 37.6. The other uses an incorrect value of 16 and determines the avg. mol. wt. as 32.8. What is the % of O₂ in the mixture.
- 8)

A)

Calculate the standard heat of reaction Δ HoR for the reaction 2FeS₂ + 11/2O₂ \rightarrow Fe₂O₃ + 4SO₂

(8)

The standard heat of formation of the compounds are

Components	ΔHº _F kJ/mole
FeS₂	-178.03
O ₂	0
Fe ₂ O ₃	-822.75
SO ₂	-297.11

B) It is desired to make a 24 % by wt. of caustic soda solution. It is done in 2 (12) steps.

i. The caustic soda is dissolved in a dissolution tank in a correct quantity of water to produce 50% solution.

ii. After complete dissolution, the solution is taken to a dilution tank, where some water is added to produce 24% by wt. of solution. Calculate the wt. ratios of water added to both the tanks.

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