

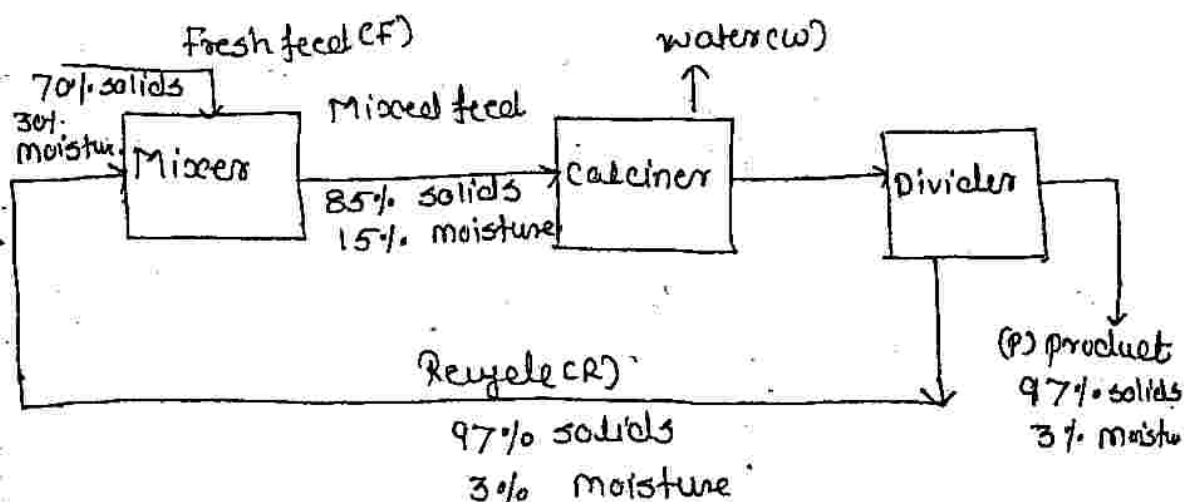
Attempt any four questions from the remaining six questions.

Assume suitable data if necessary.

Figures to the right indicate full marks.

- A sample of limestone is found to contain 54.5% CaO (by mass). If this CaO is present as CaCO_3 in the limestone, find the content of CaCO_3 in the limestone. 4
- A sample of solution contains 20% alcohol (ethanol) on volume basis. Find the mass % of a alcohol in the solution. Assume the densities of alcohol and alcohol free liquid (essentially water) to be 0.79 kg/L and 1.0 kg/L respectively. 4
- A mixture of CH_4 and C_2H_6 has density 1.0 kg/m³ at 273 K, and 101.325 KPa pressure. Calculate the mol% and weight% of CH_4 and C_2H_6 in the mixture. 6
- A mixture of vapour of 'A' and 'B' at 20 °C and 760 mm Hg contains 0.35 kg of 'A' per kg of 'B'. Calculate the partial pressure of 'A' in the mixture. 6
- M.W of 'A' = 58
M.W of 'B' = 28

- Soyabean seeds are extracted with n-hexane in batch extractors. The Flaked seeds contain 18.6% oil, 69% solids and 12.4% moisture. At the end of extraction process, de-oiled cake (DOC) is separated from the n-hexane oil mixture. DOC analysis yields 0.8 oil, 87.7% solids and 11.5% moisture. Find the percentage recovery of oil. All percentage are by mass. 8
- In particular drying operation, it is necessary to hold the moisture content of feed to a calciner to 15% (mass) to prevent lumping and sticking. This is accomplished by mixing of feed having 30% moisture (mass) with a recycle stream of dried material having 3% moisture (mass). The drying operation is shown in figure. What fraction of the dried product must be recycled ? 12



Also calculate amount of product formed.

- A sample of fuel oil has $\frac{C}{H}$ ratio 9.33 (by mass) and contains sulphur to the extent of 0.3% (mass). The GCV of the fuel is measured to be 41785 kJ/kg at 25 °C. Calculate its NCV at 25 °C. 10
- = 2256 kJ/kg.
- Write note on Proximate analysis and Ultimate analysis of coal. 10

[TURN OVER]

4. (a) A pilot plant reactor was charged with 50 kg naphthalene and 200 kg (98% by mass) H_2SO_4 . The reaction goes to near completion. The product distribution was found to be 18.6% monosulphonate naphthalene and 81.4% disulphonate (DSN) products and (b) complete analysis of product.
- (b) A combustion chamber is fed with butane and excess air combustion of butene is complete. The composition of combustion gases on volume basis is given below:
- $CO_2 = 9.39\%$, $H_2O = 11.73\%$, $O_2 = 4.70\%$ and $N_2 = 74.18\%$
- Find % excess air used and mole ratio of air to butane used.

5. Methyl alcohol is produced by the reaction of carbon monoxide with hydrogen.
- $CO + 2H_2 \rightarrow CH_3OH$ — (1)
- $CO + 3H_2 \rightarrow CH_4 + H_2O$ — (2)
- The conversion per pass is 12.5%, of this 87.5% CO reacts by reaction (1) and 12.5% CO reacts by reaction (2). The stream leaving the reactor passes through condenser and separator. The carbon monoxide and hydrogen leaving these units are recycled. The methanol leaves as a gas and liquid mixture of methanol and water passes to a distillation column. Fresh feed contains 32 mol% CO and 68 mol% H_2 .
- Calculate:
- The analysis of hot gaseous stream leaving the reactor
 - The recycle ratio
 - The volumetric flow rate of gaseous combined feed to reactor at 338.5 K and 7 MPa
 - yield 1 kg/sec of methanol.

6. (a) Calculate the change in enthalpy of reaction if both reactants and products are at 25 °C and if 5 mol formaldehyde is produced according to following reaction.
- $CH_4(g) + O_2(g) \rightarrow HCHO(g) + H_2O(g)$
- Data: Component $\Delta H^\circ C$ (kJ/mol)
- $CH_4(g)$ - 890.65
- $HCHO(g)$ - 563.46

- (b) A natural gas has the following composition on mole basis. $CH_4 = 84\%$, $C_2H_6 = 13\%$ and $N_2 = 3\%$.
- Calculate the heat to be added to heat 20 mol of natural gas from 25 °C to 250 °C. Use heat capacity data given below:
- $(C_p^\circ = a + bT + cT^2)$ (kJ/kmol.K)

Gas	a	b $\times 10^3$	c $\times 10^6$
CH_4	19.2494	52.1135	11.973
C_2H_6	5.4129	178.0872	- 67.3749
N_2	29.5909	- 5.141	13.1829

7. (a) Calculate heat of formation of gaseous ethyl alcohol at 25 °C using the following data:
- Standard Heat of formation of $CO_2(g) = - 393.51$ kJ/mol
- Standard Heat of formation of $H_2O(l) = - 285.83$ kJ/mol
- Standard Heat of combustion of gaseous ethyl alcohol = - 1410.09 kJ/mol at 25 °C
- (b) Dry methane and dry air at 298 K and 1 bar pressure are burnt with 100% excess Standard Heat of reaction is - 802 kJ/mol of methane. Determine the final temperature attained by the gaseous products if combustion is adiabatic.
- Data - Cpm (J/mol.K)
- $O_2 - 31.9$, $N_2 - 32.15$, $H_2O \rightarrow 40.19$, $CO_2 \rightarrow 51.79$.