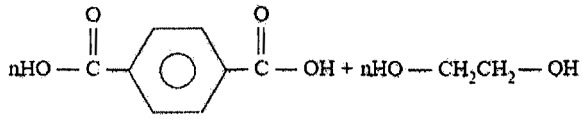
Ref. No.: Ex/PG/ChE/T/129C/2024

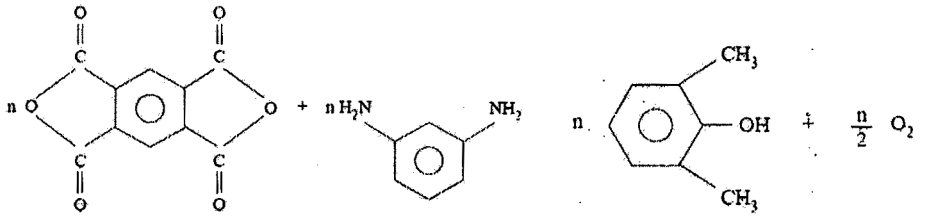
M.E. CHEMICAL ENGINEERING FIRST YEAR SECOND SEMESTER - 2024

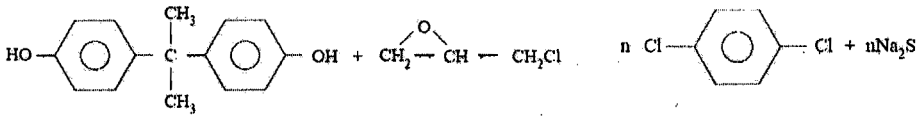
Subject: HIGH POLYMER ENGINEERING

Time :3hrs Full Marks: 100

1. (a) Write down the repeat unit structure (10)







(b) A polymer chemist prepared nylon from the following amino acid (ω-amino caproic acid): [NH_2 – $(CH2)_5$ – COOH]. Due to improper purification of the reactant, side reactions occurred leading to a 2% stoichiometric imbalance (i.e., 2% excess of one of the functional groups). Calculate:

i. The number-average molecular weight if conversion was 95%.

ii. The number-average molecular weight for the maximum degree of polymerization. (10)

Or

The preparation of poly(ethylene terephthalate) from terephthalic acid and ethylene glycol is stopped at 99% conversion. Calculate:

i. The number-average degree of polymerization.

ii. The weight-average degree of polymerization.

2. (a) Discuss glass-rubber transition behaviour of polymer. (5)

(b) 0.20 gm of polystyrene (PS) sample is dissolved in 200ml of butanone. Flow time of are measured employing ubbelhode capillary viscometer. Determine the molecular weight of PS. (5)

Given: Flow time of butanone = 140 sec and that of PS solution is 160 sec. $K = 40*10^{-3}$ and $a = 0.6$

(c) Show the steps of chain polymerization of vinyl chloride using benzoyl peroxide as initiator considering all possible intermediate formation. (10)

3. (a) Write short note on (any two): Blow Molding, Retardation effect, Chain Transfer Reaction, Metathesis Polymerization (10)

(b) Discuss the different steps associated with injection molding process? (10)

4. (a) The data for the bulk polymerization of styrene at 60°C with benzoyl peroxide as initiator are as follows:

$[M] = 8.5 \times 10^3$ mol/m^3; $[I] = 4.0$ mol/m^3; $k_p^2/k_d = 1.2 \times 10^{-6}$ m^3/mol-s

If the initial rate of polymerization of styrene is 0.025 mol/m^3-s and the spontaneous decomposition of benzoyl peroxide in styrene is 3.0×10^{-6} s^{-1}, what is the efficiency of the initiator? (6)

Or

Estimate the feed and copolymer compositions for the azeotropic copolymerization of Methyl methacrylate and styrene at 60°C.

Monomer 1	Monomer 2	r_1	r_2	T (°C)
Acrylonitrile	1,3-Butadiene	0.02	0.30	40
	Methyl methacrylate	0.15	1.22	80
	Styrene	0.04	0.40	60
	Vinyl acetate	4.2	0.05	50
	Vinyl chloride	2.7	0.04	60
1,3-Butadiene	Methyl methacrylate	0.75	0.25	90
	Styrene	1.35	0.58	50
	Vinyl chloride	8.8	0.035	50
Methyl methacrylate	Styrene	0.46	0.52	60
	Vinyl acetate	20	0.015	60
	Vinyl chloride	10	0.1	68
Styrene	Vinyl acetate	55	0.01	60
	Vinyl chloride	17	0.02	60
Vinyl acetate	Vinyl chloride	0.23	1.68	60

(b) Write down the mechanism of stereo regular polymerization. Write down the typical recipe of Emulsion Polymerization. State the differences between (any one): (i) addition vs Condensation polymerization (ii) Bulk vs Solution Polymerization; (6+4+4)

5. (a) Discuss the steps of manufacturing of Nylon 6,6 (show the PFD). (15)

(c) Discuss the roles of expander and coating head in foaming operation. (5)