REF. NO.: Ex/PG/ChE/T/129C/2019

M.E. CHEMICAL ENGGINEERING 1st YEAR 2ND SEMESTER EXAMINATION-2019

SUBJECT: HIGH POLYMER ENGINEERING

TIME-3HRS FM-100

Answer all the questions. (Assume any missing data)

1. (a) Nylon 6,6 is made on every 8 hour shift. In each batch, equimolar reactants are used and conversion is 92%. In final stage, the bulk product is extruded and chopped into pellets. (Given: M_o=113)

i. Calculate the number average molecular weight.
ii. In afternoon shift, the operator added 2.0 moles of excess adipic acid. If the batch went to the usual conversion, what will be the number average molecular weight?
iii. The night shift operator went for a long walk and in the meantime the reaction went too long. What will be the number average molecular weight of this batch?

How should the engineer mix these batches to obtain the number average molecular weight of the usual product? Calculate the weight average molecular weight? (15)

Or

It is desired to prepare a polymer with M_n of 20000 via unimolar reaction between a diol and diacid. (Given: M_o = 100)

i. Calculate the extent of reaction.
ii. Assume 2 mol% diol is lost during the course of reaction. What would be the value of M_n in that scenario?
iii. suppose 3 mol of adipic acid contains 2% of monoacid as impurity. What would be the value of extent of reaction to achieve the desired product?

(b) M_n of polyester is 6200 having a polydispersity index of 3.0. The system is fractioned into two samples with M_n of 2300 and 9200, respectively. What would bethe M_n and M_w of the new system. (7)

(c) 0.25 gm of a polymer sample has been dissolved in 120 ml of solvent. The respective flow time at RT is mentioned below:

Flow time $_{solvent}$ = 130 sec; Flow time $_{Polymer\ solution}$ = 170 sec

Given: K= $3*10^{-3}$ and a = 0.5

Determine the molecular weight of a Polymer sample. (8)

(d) A steady state free radical polymerization is being controlled such that the rate of polymerization is constant at $2*10^{-3}$ gm of monomer/ml-min. Let the initiator concentration be $6*10^{-6}$ mol/l. (i) What would be the value of free radical generation and value of X_n? (ii) What % of initiator concentration remains after 3 hrs? (10)

Or

Consider the isothermal solution polymerization of styrene at 60°C in the following formulation:

100 g styrene; 400 g benzene; 0.5 g benzoyl peroxide

Assume that the initiator is 100% efficient and has a half-life of 44 h. At 60°C, k_p = 145 l/mol-s, k_t = 0.130 l/mol-s. All ingredients have unit density.

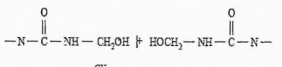
(i). Derive the rate expression for this polymerization reaction.

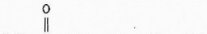
(ii). Calculate the rate of propagation at 50% conversion.

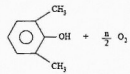
2. (a) Draw the schematic of a Plastic Extruder and henceforth describe the working principle of the extrusion process. How do you control the heat build up inside the barrel? Write down the mechanism of "Track Etching" towards polymer membrane fabrication. (5+5+2+8)

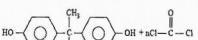
3. Write short notes on (any four): i) Aezotropic copolymerization, (ii) Inhibition; (iii) Kinetic Chain Length; (iv) Stoitiometric imbalance; (v) Polydispersity index (vi) Gel point (20)

4. (a) Distinguish the repeat Units from the following.









(b) Write down the mechanism (show all steps and consider head to head configuration) of addition polymerization considering styrene as monomer.

(c) Write down the typical recipe of Emulsion polymerization. Differentiate Bulk polymerization from Suspension Polymerization (8+8+2+2)