

CHEM 342 – Polymers and Petrochemicals

Homework – Chapter 2: Step-Growth Polymerization

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Question 1

Compare step-growth and chain-growth polymerization in terms of:

- (a) the need for an initiator,
- (b) how the molar mass changes with reaction time / monomer conversion,
- (c) the stability of the intermediate species.

Question 2

Poly(ethylene terephthalate) (PET) can be made by a two-stage ester-interchange process from dimethyl terephthalate (DMT) and ethylene glycol.

- (a) Write the reaction for each stage, stating the temperature range and the by-product removed in each.
- (b) Why is ester interchange often preferred over direct esterification of the dicarboxylic acid?
- (c) What side reaction must be minimized by temperature control, and how does it affect the T_m of the polymer?

Question 3

Nylon-6,6 is prepared from hexamethylenediamine ($M = 116.21$ g/mol) and adipic acid ($M = 146.14$ g/mol).

- (a) Write the polymerization equation.
- (b) Why is the "nylon salt" prepared first?
- (c) How can the molecular weight be controlled?
- (d) Calculate the molar mass of the repeating unit and the degree of polymerization (n) of a nylon-6,6 sample with $M = 33,950$ g/mol. ($H_2O = 18.02$ g/mol)

Question 4

Polyurethanes:

- (a) How does step-addition polymerization (polyaddition) differ from, and resemble, condensation polymerization?
- (b) Write the general reaction of a diisocyanate with a diol to form a polyurethane, and name two commonly used diisocyanates.
- (c) Explain, with a reaction, how water produces polyurethane foam.

Question 5

Phenol-formaldehyde and melamine resins:

- (a) Compare Novolac and Resole resins with respect to: reaction medium (pH), phenol : formaldehyde ratio, method of crosslinking, solubility, and thermoplastic vs. thermoset behavior.
- (b) Why are melamine-formaldehyde resins preferred over phenolic resins for light-colored products?