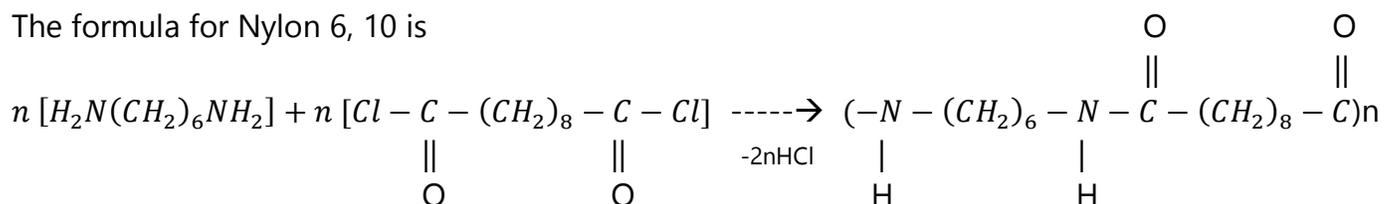


Experiment 4: Synthesis and Analysis of Polymers

POST- LAB QUESTIONS I

1. Write the formula for the repeat unit of Nylon 6.10.

The formula for Nylon 6, 10 is



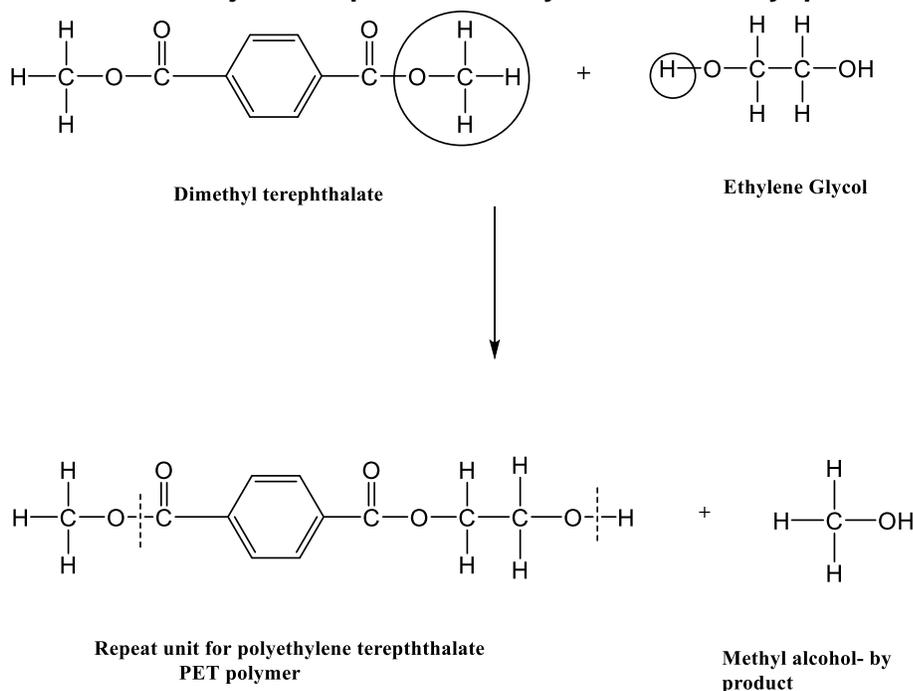
2. Briefly explain the meaning of thermosetting and thermoplastic.

What kind of a polymer is Nylon 6.10?

Thermosetting polymer is one in which the chains are cross-linked due to over-heating. Therefore, they can't be recycled or reprocessed for further applications. For instance. Bakelite.

Thermoplastic polymer is one that has straight chains of polymers with no cross linking structure. Therefore, these polymers can easily be processed and recycled from heating process. For instance, PVC and Nylon.

5. Consider a similar condensation reaction of polyethylene terephthalate (PET), a common polyester, as shown below, where the OCH_3 and a hydrogen atom are removed from the monomers permitting the two monomers to join and produce methyl alcohol as a by-product:



If 100g each of the two reactants (dimethyl terephthalate and ethylene glycol) above were combined and reaction went to 100% completion how much methanol would be generated?

Hint: Recognize that Dimethyl terephthalate has “2” reaction sites, one at each end.

Ans. According to the balanced reaction, the single mole of dimethyl terephthalate reacts with two moles of ethylene glycol and methanol. The total number of moles of dimethyl terephthalate is equals to:

$$\text{moles} = \frac{\text{mass}}{\text{molar mass}}$$

$$\text{moles} = \frac{100\text{g}}{194.2 \frac{\text{g}}{\text{mol}}} = 0.5150 \text{ mol}$$

The total number of moles of ethylene glycol is equivalent to:

$$\text{moles} = \frac{100g}{62 \frac{g}{mol}} = 1.6129 \text{ mol}$$

Therefore, the ethylene glycol is in excessive amount, so the number of moles produced

$$= 0.5150 \times 2$$

$$= 1.03 \text{ moles}$$

Mass of Methanol

$$= 1.03 \text{ mol} \times 32 \text{ gm/mol} = 32.96 \text{ g}$$

Volume of this methanol

$$= \frac{32.96 \text{ gm}}{0.792 \frac{\text{gm}}{\text{mL}}} = 41.6 \text{ mL}$$

Therefore, the density of methanol at 20°C is 0.792 g/mL

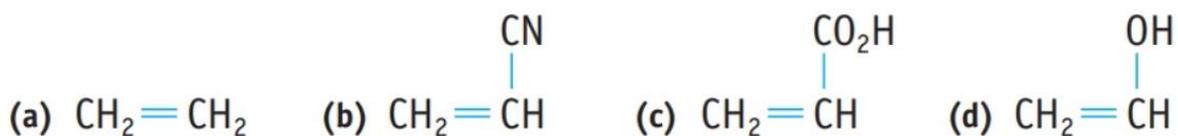
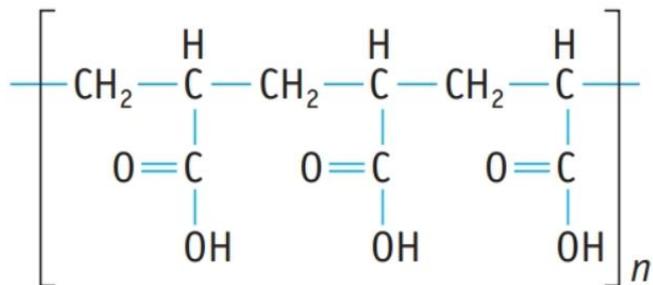
- 6. In the room temperature bench top preparation of nylon, it is preferable to dissolve the acid derivative in an organic solvent. What are the advantages of having the acid derivative be soluble in an organic solvent?**

In order to produce polyamide or Nylon, the molecule of amine should have -NH_2 group attached at the end and the acidic group must have -COOH group at the end. If the derivative of carboxylic acid is like the acyl chloride, then the rate of reaction will be increased due to carboxylic acid derivatives will make it more reactive. The main advantage of having acidic group in the derivative is the solubility in organic solvent compound, which is more reactive. If the acid derivative is dissolved into water, it reacts with it and show hydrolysis process that can reduce the activity of water. This is the reason why the dissociation of the organic solvent is better.

- 7. Which elements or groups are necessary for hydrogen bonding? Does nylon contain these elements or groups?**

If the hydrogen atom is related with the electronegative atom (e.g. N, O). It can form the bond with electronegative atoms (N, O, Cl, F, etc.). Yes, the Nylon comprises of these groups, as we know it is polyamide therefore, the N-atom can make hydrogen bond with the other chain of polyamide chain. Also, the Nylon chain polymer has terminal of the acyl group due to hydrogen bonding.

- 8. Polyacrylic acid , shown below is made from which of the following monomers? (The sodium salt of this polymer and cellulose are important ingredients in disposable baby diapers)**



Ans. In order to determine the monomer, the first step is to identify the repetitive structure of the polymer, as indicated in the figure above. The next step is to disconnect the repeating units to the double bond so that two bonds are broken. Therefore, the compounds obtained from redrawing the monomer corresponds to the option (c).

9. Based on what you have learned on polymers in class. What important properties do the following characteristics impart to a polymer?

a) Crosslinking in polyethylene

Ans. It allows the effective recycling of the polymer. Besides, it induces good impact resistance, high chemical resistivity, reduce the flexure modulus, and increases crack resistance in the polymer.

b) The OH groups in polyvinyl alcohol

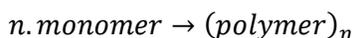
Ans. The polyvinyl alcohol is the water-soluble polymer that is formed by electro spinning process. The presence of the hydroxyl group makes the overall structure cross-linked by interacting with the hydrogen bond.

c) Hydrogen bonding in a polyamide like nylon.

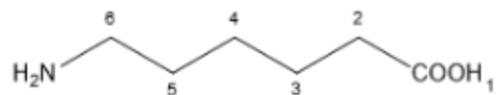
Ans. The role induced by the hydrogen bonds in polyamide like nylon is subjected to mechanical properties and heat resistance properties.

10. Nylon-6 is a polyamide formed by polymerizing $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$. Write an equation for this reaction.

Ans. The combination of monomers is known as polymer, and this process is known as polymerization. The general equation is known as:



The monomer is p-Nylon-6 is 6-aminohexanoic acid and the characteristic structure of 6-aminohexanoic acid is given as:



6-aminohexanoic acid

Polymerization of 6-aminohexanoic acid to Nylon-6 is given as:

