CHAPTER 5

SUMMARY AND CONCLUSION

Plastic has become a widely used commodity because of its inherent characteristics of being light, durable, strong and versatile. As a result plastic products are energy efficient when compared to alternative materials such as glass and paper. However, the plastic is a very complex and difficult material to recycle and reuse. It is widely recognized that plastic recycling can make a valuable contribution to sustainable waste management. Today PET is being used as major commodity for packaging. The rapidly growing large scale use of PET beverage containers and the generation of waste during the production of PET fibres, film and textiles have increased the necessity of waste management. PET is the most common consumer plastic and it has become a material of choice for a variety of applications. With growing demand of PET products being disposed of soon after their purchase, the landfill space required by PET waste is also a growing concern.

The best alternative to overcome this environmental hazard is through its recycling. Recycling recovers the raw materials, which can then be used to make new plastic products. This is important from the environmental point of view (less landfill space is needed) as well as from the economic point of view because recycling allows energy and materials to be reused. The objective of the present work is to develop a value added and cost-effective method of recycling of polyethylene terephthalate waste.

Polyethylene terephthalate is recycled by different alkalies, glycols, alcohols and amines through the processes hydrolysis, glycolysis, methanolysis and aminolysis respectively. These methods, though effective are not economical from industrial point of view in the sense that these processes need very high temperature and pressure for long duration and consumes lot of energy. Therefore, it was felt that an ecological and economical methodology should be developed for the recycling of PET waste to minimize these problems. Ultimate goal of the
present work is to establish a technology enabling the complete recycling of post-consumer PET waste along with saving time and materials.

In the present study we have focused on the chemical recycling of PET waste by aminolysis and alcoholysis through hydrazine monohydrate and different alcohols such as 2-ethyl hexanol, polyethylene glycol, glycerol, and succinic and hydride and then use of there products as plasticizer in PVC and nitrile rubber. The brief summary of synthesis, characterization, plasticizer properties and application of these products is presented below.

1) Post consumer polyethylene terephthalate waste used in the present study was obtained from different sources such as film grade, coloured bottles and x-ray films. PET waste has been recycled to obtain Terephthalic dihydrazide through aminolysis with aqueous hydrazine monohydrate. The aminolysis of PET waste as were investigated at room temperature avoiding tedious condition of high temperature and high pressure. The PET waste was recycled completely only 24 hours as compared with other amines. The ultimate end product was characterized with the help of chemical tests such as amine value, CHN %, spectroscopic techniques namely infrared spectroscopy, nuclear magnetic resonance spectroscopy, UV-visible spectroscopy and differential scanning calorimeter. The end product was characterized as terephthalic dihydrazide & further used in PVC compounding as secondary plasticizer. The hardness, tensile strength, elongation at break, thermal stability and compatibility of the PVC sheet was studied and concluded that the aminolysed product may find potential application as secondary plasticizer in PVC formulations and the mechanical properties and thermal stability of PVC sheets were also improved by the use of terephthalic dihydrazide

2) The PET waste has also been degraded in order to produce polymeric plasticizers through alcoholysis. Plasticizer was synthesized successfully by the alcoholysis of PET waste with 2-ethyl hexanol and Zinc Chloride was used as catalyst. The polymeric plasticizer was characterized for various properties
such as hydroxyl value, acid value, density, and volatile loss, kinematic viscosity, dynamic viscosity, and spectroscopic techniques namely infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectroscopy and differential thermal analysis. The end product was characterized as mixture of oligomers & further used in PVC compounding as plasticizer. The specific gravity, hardness, tensile strength, tensile modulus, elongation at break, thermal stability, volume resistivity, abrasion, volatility by weight loss, liquid extraction, thermal stability, aging properties and compatibility of the PVC sheet was studied and compared with DOP plasticized sheets and concluded that the alcoholysed end product may find potential application as plasticizer in PVC formulations and the all properties of PVC sheets were also improved. The nitrile rubber sheets thus obtained were tested and compared for various properties such as hardness, tensile properties, aging properties, compatibility and volatile loss. The polymeric plasticizer synthesized in this work is low in cost as it is produced from PET waste and can be used in manufacturing of nitrile rubber products. This polymeric plasticizer has also been used in nitrile- PVC blend.

3) The PET waste degraded in order to produce polymeric plasticizer having the number average molecular weight in the range 300-1000. Plasticizer was synthesized successfully by the alcoholysis of PET waste with polyethylene glycol (600m.w.) and 2 ethyl 1-hexanol. Zinc Chloride is also used which act as a catalyst. The polymeric plasticizer was characterized for various properties such as hydroxyl value, acid value, density, volatile loss spectroscopic techniques namely infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectroscopy and thermal gravimetric analysis. The end product was characterized as mixture of oligomers & further used in PVC compounding as plasticizer. The specific gravity, hardness, tensile strength, tensile modulus, elongation at break, thermal stability, volume resistivity, abrasion, volatility by weight loss, liquid extraction, thermal stability, aging properties and compatibility of the PVC sheet was studied and compared with
DOP plasticized sheets and concluded that the alcoholysed end product may find potential application as plasticizer in PVC formulations and the all properties of PVC sheets were also improved.

The nitrile rubber sheets thus obtained were tested and compared for various properties such as hardness, tensile properties, aging properties, compatibility and volatile loss. The polymeric plasticizer synthesized in this work is economically and ecofriendly as it is produced from PET waste and can be used in manufacturing of Nitrile rubber products. This polymeric plasticizer has been used in nitrile- PVC blend rubber and compared DOP plasticized sheets.

4) The PET waste degraded in order to produce polymeric plasticizer having the number average molecular weight in the range 752-1094. Plasticizer was synthesized successfully by the alcoholysis of PET waste with polyethylene glycol (300 m.w.) and 2-ethyl 1-hexanol. In this reaction Zinc Chloride was used as a catalyst. The polymeric plasticizer was characterized for various properties such as hydroxyl value, acid value, density, volatile loss all formulation was found in range 1-1.08 and spectroscopic techniques namely infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectroscopy and thermal gravimetric analysis. The end product was characterized as mixture of oligomers & further used in PVC compounding as plasticizer. The specific gravity, hardness, tensile strength, tensile modulus, elongation at break, thermal stability, volume resistivity, abrasion, volatility by weight loss, liquid extraction, thermal stability, aging properties and compatibility of the PVC sheet was studied and compared with DOP plasticized sheets and concluded that the alcoholysed end product may find potential application as plasticizer in PVC formulations and the all properties of PVC sheets were also improved.

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compatibility and volatile loss. The polymeric plasticizer synthesized in this work is low in cost as it is produced from PET waste and can be used in manufacturing of Nitrile rubber products. This polymeric plasticizer has been used in nitrile- PVC blend rubber synthesized in this work is low in cost as it is produced from PET waste and can be used in manufacturing of NBR product.

5) The PET waste degraded in order to produce polymeric plasticizer having the number average molecular weight in the range 752 to 855. Plasticizer was synthesized successfully by the alcoholysis of PET waste with 2-ethyl hexanol and Succinic anhydride. The polymeric plasticizer was characterized for various properties such as hydroxyl value, acid value, density, volatile loss and spectroscopic techniques namely infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectroscopy and thermal gravimetric analysis. The end product was characterized as mixture of oligomers & further used in PVC compounding as plasticizer. The specific gravity, hardness, tensile strength, tensile modulus, elongation at break, thermal stability, volume resistivity, abrasion, volatility by weight loss, liquid extraction, thermal stability, aging properties and compatibility of the PVC sheet was studied and compared with DOP plasticized sheets and concluded that the alcoholysed end product may find potential application as plasticizer in PVC formulations and the all properties of PVC sheets were also improved.

The nitrile rubber sheets thus obtained were tested and compared for various properties such as hardness, tensile properties, aging properties, compatibility and volatile loss. The polymeric plasticizer synthesized in this work is low in cost as it is produced from PET waste and can be used in manufacturing of Nitrile rubber products. This polymeric plasticizer has been used in nitrile- PVC blend rubber synthesized in this work is low in cost as it is produced from PET waste and can be used in manufacturing of NBR product.

The present work focus on the utilization of PET waste is to produce useful products, which can be used for various applications. An attempt has
been made to depolymerizing PET waste to produce polymeric plasticizers, which can be used in PVC, Nitrile and Nitrile-PVC rubber.

Therefore, this work is highly beneficial from economic as well as environmental point of view as it provides a better solution to the solid waste problem and also contributes to the conservation of raw chemicals and energy.
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