CHAPTER I

INTRODUCTION

1.1 Background

The majority of products used in daily life today is made from materials which have been manufacturing by a chemical process, including ***plastics***. The significant growth rate in plastic consumption raises concerns about plastic waste disposal. Discarded plastics are a rapidly increasing percentage of the solid waste in landfills. These problems have made plastic waste a major focus in the management of solid waste. ***Recycling*** is a preferred option for the environmentally safe disposal of plastics [Ehrig,1992].

In the durable goods industry such as ***engineering plastics***, the recycling process is motivated by the high cost of raw materials and the increasing the value added on the manufacturing waste. This results in high economical incentives for reprocessing engineering plastics.

1.2 Engineering Thermoplastics

In recent years, there has been a significant increase in the consumption of plastic materials in engineering applications, namely ***engineering plastics***. The development of engineering thermoplastic resins began with the pioneering work of Carothers on the nylons at DuPont in 1930s [McCrum et al., 1994].

Engineering thermoplastics are defined as:

- a group of polymers which offer a combination of some of the following; high strength, stiffness, resistance to wear, chemical attack and heat [Whelan, 1994].

- the plastics which lend themselves to use for engineering design, which can substitute for traditional materials of construction, particularly metals [Herman, 1986].

- the plastics which combine lightness and corrosion resistance with a good balance of stiffness and toughness maintained over a wide temperature range [McCrum et al., 1994].

- polymers that may be used in engineering applications and have a combination of stiffness, toughness and low creep [Alger, 1989].

Ideal thermoplastics [Dyson, 1990] for engineering applications will have the following attributes:- strength; high modulus; resistance to impact, fatigue, creep, chemicals and heat; and dimensional stability. In addition, they should be easy to process and have low mold shrinkage. But it is difficult to produce a polymer which meets all of these requirements because the factors which enhance some properties will diminish others. Engineering thermoplastics include polyamides, polyimides, polyacetals, polyphenylene sulfides and polyether ether ketone.

1.3 Literature Review

Nightingale [1976] worked on the re-use of nylons. After a number of passages through an injection machine, the relative molecular weights were slightly lower after each pass. The degradation was negligible.

Khanna et al. [1988] studied on the effects of processing history on nylon 6. The extruded resin produced a smaller size spherulite structure reflecting a higher overall crystallization rate than the virgin material. However, the mechanical properties were not different.

Photodegradation of polyimides based on hexafluorinated dianhydride was studied by Hoyle and Anzures [1991] indicated a significant decrease in T_g and thermo-oxidative stability upon photolysis. The photodegradation was characterized by chain cleavage.

Wyzgoski and Novak [1992] studied on the influence of processing history on the nylon 66. Thermal analysis did not reveal any change in the degree of crystallinity. Smaller spherulites were observed after reprocessing.

Eriksson et al. [1994] studied the mechanical properties of the in-plant recycled glass fiber reinforced polyamide 66. The thermal and thero-oxidative stability decreased in reprocessed samples as evidenced by lower oxidation induction time and onset temperature of oxidation.

Shriver et al. [1994] worked on the characterization of recycled polycarbonate, an amorphous engineering thermoplastic. Reprocessing led to a decrease in molecular weight as regrind-generation increase. An increase in melt index also indicated material degradation. However, reprocessing did not significantly affect mechanical properties.

Stivala and Patel [1994] studied the mechano-chemical degradation of polyacetal (POM). In comparison with virgin POM, the degraded POM showed higher heat of fusion which indicated a higher in crystallinity. The initial decomposition temperature values were lower, indicating a reduction in the molecular weight of degraded POM.

1.4 Objective

To study the effects of reprocessing on the thermo-physical properties of engineering thermoplastics.

1.5 Scope of Research Work

Three types of engineering thermoplastics were selected to be studied, nylon 6,6 (Zytel 101 from Dupont), polyacetal (Delrin 500 from Dupont) and polyetherimide (Ultem 1000 from GE).

The effects of reprocessing on the selected polymers were studied by following instruments :

- *Thermogravimetric Analyzer (TGA)* was used to measure the degradation temperature profile (onset and half life temperature and reaction interval).
- *Differential Scanning Calorimetry (DSC)* was used to measure the glass transition temperature, melting transition, heat of fusion and degree of crystallinity.

- *Density kit* was used to measure density and corresponding degree of crystallinity.