CHAPTER I

INTRODUCTION

Nowadays, waste tire rubber is large scale discarding of rubber products. It has caused a severe environmental problem. Recycle of waste tire rubber represents a great challenge in both environmental and economic reasons. The oldest method of recycling used, i.e., reclaiming and retreating, has been employed for many years although it has recently become less common for passenger tires in developed countries. Another strategy is to use as energy source by heating. Both incineration and pyrolysis methods are possible for large volumes of recycling. Major problems exist, however, with the avoidance of air pollution and expensive initial investment cost being major factors. A further, potentially attractive method is the utilization of powdered rubber. Rubber powder obtained from grinding tires can be classified as "crumb rubber". It can be applied to sport surfaces as a rubber mat when bonded with a polymer binder. It is commercially used in golf ranges, industrial floorings and pathways. Crumb rubber can be used for roofing material because conventional bitumen roofing material tends to crack. Carpet underly is another attractive applied field which is produced by mixing crumb rubber with latex. The crumb rubber mixed with bitumen could provide insulation for large cables and tar mixed with crumb rubber might well offer good protective products. Another application is for friction linings, where a proportion of crumb rubber can be incorporated. A potentially large volume application of recycling is for pavements. Two processes, dry and wet, have been developed for incorporating crumb rubber into paving mixtures. Rubber modified asphalt has also been used, the advantages being improved road life, significantly less road maintenance, increased crack resistance and improved anti-skid properties. However, the additional costs are a barrier in this field. The advantage of powder utilization is that it is easy to apply with simple equipment. However, difficulties arise in processing and mechanical performance because the bonding force between crumb rubber and matrix are often low. Therefore, numerous efforts have been made to improve mechanical performance. Good results were obtained from the reduction of particle size by cryogenic processes that produce a fine mesh rubber powder.

The productions of finely ground rubber tires include cryogenic grinding, ambient grinding and wet-ambient grinding. The ambient grinding process involves a tire splitter to cut the tire, followed by grinding it on a two roll grooved rubber mill or hammer mill. The bead wire is removed by hand or with a magnet and the fiber is removed at intermediate operations with the hammer mills, reel beaters and an air table that maintain a steady flow of air across the rubber. In the cryogenic grinding process, after initial subdivision the worn tire pieces are cooled with liquid nitrogen below the glass transition temperature of the rubber constituents and are then crushed to a powder in a hammer mill. The particles of fiber and rubber are separated magnetically. The elastic recovery (the percent deformation recovery after the removal of an external force) of ambient-ground GRT is 35%, whereas that of cryogenic ground GRT is 6%. Other processes have been developed by wet-grinding the rubber tires in water with high shear force. The ground rubber tire material prepared by different methods is believed to differ in particle shape, surface area, modulus and elastic recovery. Generally the cryogenic grinding process, compared to ambient grinding, allows a smaller particle size powder and a higher level of seperation. The viscosity of cryogenic powdered composites was lower than that of ambient powdered composites because the shape of the ambient grinding powder was sponge-like and cryogenically ground powder was dense [1].

1.1 Thermoplastic Elastomer from Ground Rubber Tire and Polyolefin

The disposal of worn tire and their economic recycling represent a great challenge for both academic and industry. One particular concern is the recycling of worn rubber tires, not only because of the valuable hydrocarbon resource they represent, but also because of the potential environmental hazard, should a tire stockpile catch on fire. One established method of utilizing worn rubber tires is to burn them for their calorific value. Research on pyrolyze tires to recover hydrocarbon liquid and carbon is also progress. Within the framework of direct recycling options a number of applications for ground rubber tire (GRT) outside the rubber industry have been proposed. Such applications include use as a filler in asphalt for the surface treatment of roads and as a rubberized surface for sport facilities. GRT alone or in combination with other fillers such as leather waste, cellulose fiber, synthetic fiber, chalk, carbon black and silica have been reported to make composites with different thermoplastic polymers. Among the various polymers used as the matrix in GRT composites, polyethylene is the most common due to low polarity and low crystallinity of the matrix appeared to favor compatibility. Rajalingam et al. [2] investigated the role of functional polymers in ground rubber tire polyethylene composite. It was found that the addition of GRT to either HDPE and LLDPE matrix results in a large drop in the impact energy. The maximum force, which has been shown to correspond to the yield point in the failure process, decrease for LLDPE and decreases even more for HDPE. This is due to the fact that, in LLDPE, the impact failure is a ductile yielding process in which the dart actually draws the materials out as it passes through. In contrast, the failure of pure HDPE, though involving some plastic deformation, is observed to occur through catastrophic propagation of a crack through the impact zone. This may be explained by the smaller fraction of amorphous component in the matrix phase of the HDPE system. This difference in the mode of failure is believed to be responsible for the poorer impact energy of the HDPE-GRT composite. For LLDPE, in which the failure is more ductile because of a high fraction of amorphous phase, large particles with moderate adhesion are more easily tolerate.

The GRT usually works as a cheap filler in the relevant recipes. The ineffective use of GRT is mainly due to poor interaction between the GRT particles and the matrix polymer. This may be due to the fact that the molecules of the crosslinked GRT cannot entangle with those of thermoplastic and rubbers as a consequence the interfacial adhesion between the GRT particles and the matrix forming polymer is very low. The necessity is to decrease the degree of crosslinking (reclaimation) of GRT. Reclaimation may also be achieved by thermomechanical or thermochemical processes.

1.2 Properties of Blends Prepared by Dynamic Vulcanization

Dynamic vulcanization is the process of vulcanizing elastomer during its intimate melt mixing with a nonvulcanizing thermoplastic polymer. Small elastomer droplets are vulcanized to give a particulate vulcanized elastomer phase of stable domain morphology during melt processing and subsequently. The effect of the dynamic vulcanization of elastomer-plastic blends is to produce compositions that have improvements in permanent set, ultimate mechanical properties, fatigue resistance, hot oil resistence, high temperature utility, melt strength and thermoplastic fabricability. Permanent set of these compositions can be improved by only slight or partial vulcanization of the elastomer before mixing with plastic or by dynamic vulcanization (during mixing with plastic). However, the other improvements can be obtained only by dynamic vulcanization in which the elastomer is technologically fully vulcanized. The term fully vulcanized refers to a state of cure such that the crosslink density is at least $7x10^{-5}$ mol per milliliter of elastomer (determined by swelling) or that the elastomer is less than about 3% extractable by cyclohexane at 23°C [3,4].

1.3 Objective

The principle objective of this thesis is to improve impact and tensile strength of RTR and polyolefin blends by using different type of vulcanizing agents.

1.4 Scope of the Research

The scope of this research work involves the preparation of thermoplastic i.e., polypropylene (PP), high density polyethylene (HDPE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE) and reclaimed tired rubber (RTR) blends at various ratios using a two-roll mill for mixing. The compatibilizer and dynamic vulcanizing agents using sulphur, maleic anhydride (MA)/ dicumyl peroxide (DCP) and mixed system (sulphur/MA/DCP) were used to improve physical properties of the blends.

Investigation of the impact and tensile strength of the blends was performed, according to ASTM D256 and D412 respectively. Differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) were employed to investigate the thermal properties. Their morphology, using scanning electron microscopy (SEM) and the rheological properties were also observed by parallel plate and plate rheometer. Finally, the result was analyzed and summarized.