Chapter I

Introduction

Plastic industry has become one of the favorable industries since plastics were originated and their demanding has been increasing to the essential for daily life. Till today, plastics have been needed to be used as constituents in anything or anywhere. Due to a lot of advantages of plastics, such as light weight, tough, strength, and so on, plastics have been brought to replace some natural and synthetic materials. Furthermore, one of the main advantages of plastics is that they can be easily molded by several standard processes such as injection molding, extrusion molding, blow molding, compression molding and others [1]. The selection of suitable process depends greatly on several factors including each plastic properties. One of the uncomplicated plastic manufacturing processes is the so called rotational molding. This is a shear and pressure free process, hence giving no residual stress in the products. In addition, the product properties are nearly the same as those of raw material properties. Also, their mechanical properties are better than those produced from other processes of the same material [2].

The rotational molding process is suitable for manufacturing hollow plastic products, especially for large and uncomplicated articles, for instance, chemical and water containers, dustbins, traffic cones, canoes, kayaks, backyard play equipments, toys, and so on. The concept of rotational molding originated from liquid poly(vinyl chloride) (PVC) plastisols in a process called slush molding [3-5]. However, the process developed slowly because of the lack of other suitable materials. It was not until the early 1960s that a suitable grade of thermoplastic [4, 6], polyethylene (PE) powder, was introduced. After that time the process developed steadily, and today it has an annual growth rate of 10 to 15% [3]. Polyethylene accounts for more than 85% of the volume in rotational molding because of its acceptable processabilities [7, 8]. Moreover, PE is a material well suited to the rotational molding and usually has a high MFI which makes it

flux and flow easily [5]. When processing, PE is placed in the mold which is then placed in an oven and rotated in two planes to give a tumbling action. After that, PE is sintered at the walls.

For variety of color products, the coloring is necessary. Colorants can be classified in two basic types, pigments and dyes. Since dyes in plastics are limited by their properties as the solubility in water, pigments are more commonly used to produce color in plastics. However, pigments are not soluble in the plastics, they are usually dispersed. Therefore, in order to increase the quality of the products, all manufacturers must pay attention on how to make pigments disperse uniformly in the plastics [9]. In plastic industry, pigments are usually used in two forms as pigment powder and color concentrated plastic pellets in the names of "pigment" and "masterbatch", respectively. Moreover, pigments can be divided into two groups, organic and inorganic, by their chemical structure. Compared to the inorganics, organic pigments generally have much superior brilliance and tinctorial strength, smaller particle size, poorer dispersibility, and lower resistance to chemical, heat and light. They may bleed or migrate to plasticizers or mark off or plate out on equipment. Nevertheless, many organic pigments are superior to inorganics on balance, and the trend in the plastics industry is definitely toward them [10-12].

Ordinarily, the manufacturer using the rotational molding process has brought plastic powder from plastic factory and pigment powder from pigment factory to mix by dry blending technique in a dry blender prior to the actual rotational molding process. This dry blending can be called as the raw material preparation procedure of the rotational molding process. One disadvantage of this process is long cycle times which can be varied from 5-10 minutes, yet can be as long as one hour for larger parts [7, 13], depending on the material used, the wall thickness and the machinery involved [14]. Hence, the total cycle time of the rotational molding process must be longer than other processes.

Consequently, this work proposes to reduce the raw material preparation procedure of the plastic manufacturer using the rotational molding process and to improve the dispersibility of organic pigments in polyethylene. In doing so, the PE powder and organic pigment powder were mixed via the melt blending technique using a twin screw extruder before sending to the plastic manufacturer. Plastic manufacturers can then promptly use the compounded plastics in their process. Besides, the other objective of this study is to compare the effects of blending techniques, dry and melt blending, and manufacturing conditions on the mechanical properties and dispersibility of organic pigments in polyethylene.

In this research, medium density polyethylene (MDPE) powder, the most suitable and favorable plastic for rotational molding process [14] was mixed with the organic pigments via dry and melt blending techniques. Three organic pigments, namely phthalocyanine, diarylide, and quinacridone pigment, were used in this work. After mixing, the mixtures from each technique were molded or pressed by the compression molding. The compression molding is nearly comparable to the rotational molding than any other processing techniques due to its, low shear forces, variable of stress or pressure to the suitable level, and low residual stresses in product [5]. The effects of pigment types, pigment content, blending techniques, and manufacturing processes on the mechanical, physical, and thermal properties of colored MDPE were investigated.