CHAPTER I

INTRODUCTION

Processing frequently demands that solid materials be mixed together. The need arises in making chemicals, blending polymers, preparing food and in the manufacture of new materials, to name but a few. A simple intermingling of particles may be sufficient to achieve a satisfactory operation but there is often a great deal more taking place during the mixing operation. For example, heat generation could be significant and degrade a product. Thus whilst heat generation will often prove to be undesirable, breaking of agglomerates will often need to be promoted actively through increased energy input. Processing may demand the presence of a liquid, or a liquid may be added to promote the process of homogenisation. Processing of pastes and doughs is becoming increasingly important to modern technology. It is a diverse and complicated area.

In the plastics industry, compounding of additives into a polymer matrix is an important process. Additives have been used extensively for improving plastic product properties, such as optical appearance, electrical conductivity, thermal stability and so on. Since only a small limited amount of each additive is used, its uniform distribution in the polymer matrix is crucial. And it is well recognized that the dispersion state of the additive has an important bearing on the plastic properties, so additives should be mixed with base polymer using a suitable type of compounding equipment. Good dispersion of additives can be accomplished by using multi-screw compounders or kneaders, which can provide comparatively high shear stress and uniform thermal history without serious degradation of the resin and additives. Because of increasing cost competitiveness, the level of attention to the specific types of compounding equipment chosen has increased. This has actually allowed a reduction in the amount of additives required, thus decreasing additive costs and resulting in improved physical and processing properties of polymers.

Pigments are widely used as colorant additive to produce an aesthetic quality, such as beauty or artistry for commercial and for functional purposes. Most plastic consumer goods are colored, rather than natural. Colorant is also used as a symbol for a sensation of mood and to sell a product. In today's market, the color of a car could be as important for clinching a sale as its technical features. Often the commercial failure of a plastic product could be traced to the failure of the producer to satisfy the color demand of the consumer. In other words, color could make the difference between selling and not selling a product. Although the aesthetic and commercial values of color are the most important reasons for its use as decoration, its functional value is becoming increasingly important. Color has found functional use in industrial applications for identification, such as the coloring of wire and cables. Safety coding, such as yellow hoses for transferring hazardous liquids, is another example of color's functional value.

In decorating plastics, generally, dispersing a pigment in a polymer is difficult and expensive, requiring specialized equipment and techniques. So, in this work, the author is interested in studying the effects of dispersion state of additives in a plastic. Pigments and polystyrene are used as representatives of the additive and the polymer, respectively, and a continuous twin-screw kneader is used to find suitable kneading conditions on the dispersion of pigments. A novel method for evaluating the dispersion state of pigments in the plastic, which is based on fractal geometry, is adopted.

The fractal analysis method is a novel quantitative analytical method that uses the concept of fractal geometry to describe structures too complex to describe clearly with the aid of Euclidean geometry. Conventional methods to evaluate the degree of dispersion of an additive of interest either rely on experience or employ statistical methods (for example, the sample variance of the composition of the additive of interest obtained from random sampling). The obtained information is only at the mesoscale (semi-macroscale) level. However, since fractal analysis yields information down to the microscale level, it should provide a quantitative index that can differentiate whether the resulting mixture is simply a perfect random mixture or an ordered mixture, and distinguish between the intensity levels of kneading by indicating the presence or absence of as well as the degree of breaking up of clusters or secondary particles during the operation.

The present study demonstrates how the concept of fractal may be applied to study the degree of dispersion of pigments in plastics. The obtained information can also be applied to evaluate the dispersion state of other additives in plastics and other main materials, which is essential to the production of functional materials and novel materials with unconventional properties.

1.1 Objectives of Present Study

In the present study, the effects of kneading conditions on the dispersion of pigments in polystyrene using a continuous kneader are to be investigated. The main objectives of this work are as follows :

1.1 To study the factors that affect the dispersion of organic pigment and inorganic pigment in polystyrene using a continuous kneader with the aid of the fractal dimension.

1.2 To determine the suitable kneading conditions on the dispersion of pigments in polystyrene using a continuous kneader.

1.2 Scope of This Study

1.2.1 Studying the influence of major factors on the dispersion of pigments in polystyrene.

1) Type of pigment : organic pigment, inorganic pigment.
2) Feed rate of polystyrene - pigment mixture.
3) Kneading temperature : 170 - 210 °C.
4) Rotational speed of screw : 100 - 300 rpm.

1.2.2 Analyzing the dispersion of pigment in polystyrene by applying the concept of fractal geometry analysis.

1.2.3 Discussion, comparison and conclusion on the experimental results.