CHAPTER I
INTRODUCTION

Poly (methyl methacrylate) (PMMA) is usually manufactured in sheet form in a wide variety of types, such as clear, colored, translucent, and semi-opaque sheets. These products are used in a variety of applications, ranging from toys to safety glasses. In order to obtain products of specific needs, various additives are used. The roles of additives are not only limited to imparting the physical appearance of the products to meet the customers' requirements, but they also help in cost reduction and ease of processing.

Depending on the applications, various polymerization methods, i.e., bulk polymerization, suspension polymerization, solution polymerization, and emulsion polymerization, are used to prepare PMMA. Commercially, cell-casting process, a batch bulk polymerization process, is widely used. In this process, methyl methacrylate (MMA), containing 10 ppm of inhibitor, and 2,2'-azobisisobutylonitrile (AIBN) are used as monomer and initiator, respectively. The MMA and AIBN are mixed and pre-polymerized in a reactor, of which temperature can be controlled during the pre-polymerization step. The product obtained from this step is called syrup, basically oligomeric polymers in liquid form.

The syrup is further mixed with 2,2'-Azobis-(2,4-dimethyl valeronitrile) (ADVN), another initiator, and other additives (e.g., pigment, UV stabilizer, plasticizer, etc.) in a mixing tank. The syrup is then filtered and degassed to rid of contaminations and bubbles, respectively, before being poured into a glass mold, consisting of two matched glass sealed with a PVC gasket. The polymerization reaction step is then carried out by heating the molding in a temperature-controlled water bath at 58°C for 3 hours, and is followed by annealing in a hot-air oven at 120°C for another 3 hours in order to maximize the conversion and improve the mechanical properties of the product. The resulting PMMA sheet is inspected for its appearance, thickness, before being cut into the desired dimensions.

The cell-casting process described above is the actual operational process utilized by the Pan Asia Industrial, Co., Ltd. (hereafter called Pan Asia), one of the

PMMA sheet manufacturers in Thailand which is located in the Ladkrabang Industrial Estate. Since the economic downturn and the inception of the WTO's free trade policy, competitions imposed by manufacturers in neighboring countries have been increasing. Pan Asia realized this treat, and is trying to improve its competitiveness by reducing the production time per sheet while maintaining the good quality of the product. Two strategies, among others, the management has come up with are to establish a detailed study of its current PMMA sheet-casting process and to explore an alternative process to be used in the future.

At present, the sheet-casting or cell-casting process at Pan Asia can be separated into three main steps: pre-polymerization, polymerization reaction, and annealing steps, respectively. Even though the source of heat used in all of the three steps is from steam, generated by a boiler, the heat transferring medium used in each step is totally different. In the pre-polymerization step, it is monomer and reacted monomer; in the polymerization reaction step, it is water; and, in the annealing step, it is air. Since the heat transferring media used in the polymerization reaction and annealing steps are water and air, respectively, it is logical to call them water and hot-air processes, respectively.

In actual process, both water and hot-air processes are required to obtain products with acceptable properties. Intuitively, if we are to reduce the total production time, the water process is the process where the reaction time, hence the total production time, can be reduced significantly. It is therefore very important to study the effects of initiator concentration and water or reaction temperature on the monomer conversion, ultimate average molecular weights, reaction time and the properties of the product in detail. Once the optimal condition has been found for the water process, the effects of annealing temperature and annealing time on the monomer conversion, ultimate average molecular weights, reaction time and the ultimate properties of the product will be investigated in detail. Due to the nature of the water and both the water and hot-air processes, we can call them as one-step (water) and two-step (water-hot air) isothermal processes, respectively.

An alternative way to the use of water as the heat transferring medium in both the one-step and two-step isothermal processes (during the polymerization reaction step) is to use hot air instead. In order to compare with the use of water as the heat

transferring medium, a special hot-air oven was constructed at Pan Asia. This allowed for similar experiments as described in the previous paragraph so that the one-step (hot air) and two-step (hot air-hot air) isothermal processes can be compared with the one-step (water) and two-step (water-hot air) isothermal processes, based on the total reaction time and the quality of the PMMA sheet products obtained.