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Product Performance

# Effect of enhancing fins on the heating/cooling efficiency of rotational molding and the molded product qualities

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**Abstract**

Rotational molding has become one of the most important polymer processing methods for producing hollow plastic articles. However, the long cycle time required by the rotational molding process has confounded the overall success of this technology. Molds with extended surfaces (fins) have the potential to enhance heat transfer by increasing surface area. This report aims to examine the effects of enhanced fins on the heating/cooling efficiency of rotational molding and on molded product qualities. Rotational molding experiments were carried out in a laboratory-scale uniaxial machine, which is capable of measuring internal air temperature in the cycle. Three types of fins, including pin, rectangular and triangular fins, were used to mold the parts. Cycle-time reductions by the fins were measured. Characterization of molded part properties was also performed after molding. It was found that the mold surfaces with pin fins exhibited the highest heating and cooling efficiency. The use of fins in rotational molding can be better justified under conditions for which the convective heat transfer is small. In addition, molds with extended surfaces produce parts with less shrinkage but with greater warpage. The internal surface quality and tensile strengths of molded parts were not affected by these fins. It was shown that the heating/cooling efficiency can be increased by the fins, and this increase provides significant advantages in terms of reduced cycle time.


*Keywords:* Rotational molding; Fins; Heating/cooling efficiency; Product quality

## 1. Introduction

Rotational molding [1] is one of the most important polymer processing methods for producing hollow plastic articles. In this process, plastic powder is placed in one half of a mold. The mold is then closed and subjected to biaxial rotation in an oven at a temperature of 200–400 °C. The plastic powder inside the mold is melted [2–4] by heat transferred through the mold wall. When all the powder has melted, the mold is moved out of the oven while maintaining the biaxial rotation. Still air, a fan or a water shower is usually used to cool the mold. Once the product inside the mold is cooled to a state of sufficient rigidity, which in most cases occurs when all regions of the part have cooled to below the melting temperatures of the polymers, the mold opens and the product is removed [5–7]. Fig. 1

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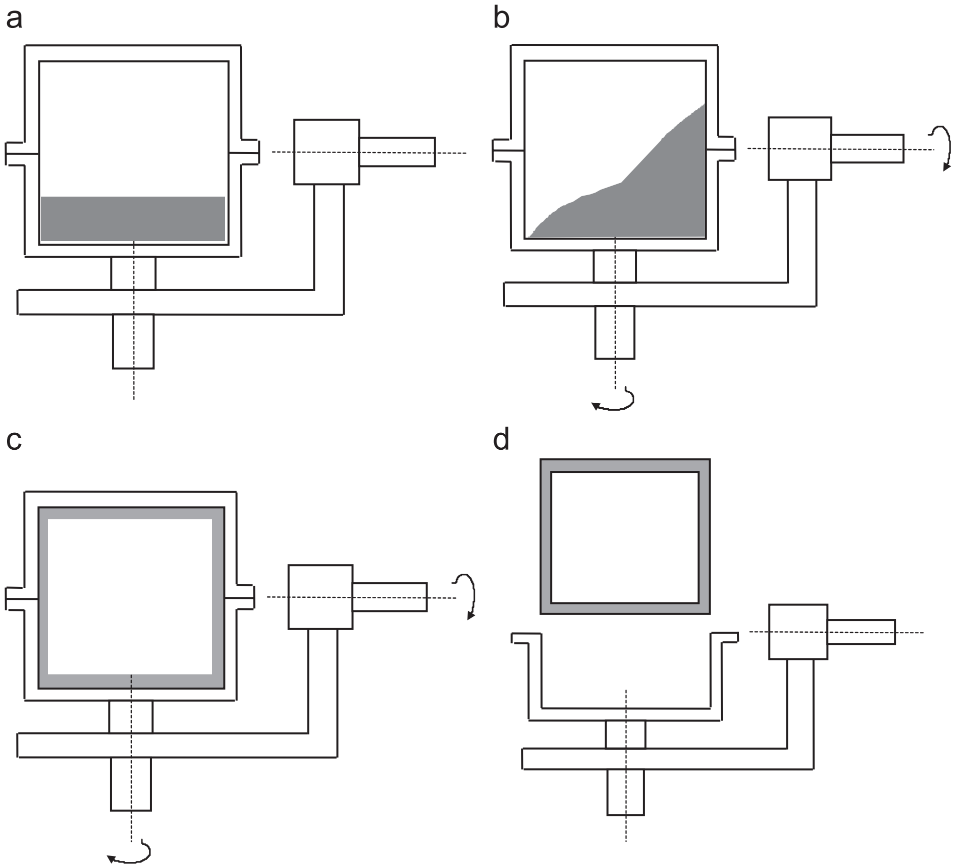


Fig. 1. Schematically, the rotational molding process, (a) mold charging, (b) heating and rotation, (c) cooling and rotation, (d) de-molding.

shows schematically the rotational molding process. Rotational molding is an attractive alternative to injection and blow molding because the molds are inexpensive and the process can handle complex shapes, a wide range of part sizes and variable thicknesses. Typical applications of rotational molding include chemical tanks, automotive and commercial aircraft parts, backyard play equipment, toys and many other items.

Despite the advantages associated with the processing method, the long cycle time required by the rotational molding process has confounded the overall success of this technology. Due to the complex rotation of the mold, heating and cooling are most commonly achieved by convection to the external surfaces of the mold using air as the transfer medium. The product cycle times are restricted by the time required to heat up and cool down the mold and the product by the slow heat convection process. Molds with extended surfaces or fins have the potential to enhance the heat transfer and reduce the cycle time by increasing the surface area. Despite the fact that this rotational molding technique has been developed for over three decades, research efforts on rotational molds with extended surfaces [8] have been limited. The only work done was carried out by Abdullah et al. [9], who studied the effects of a square pin and a pyramid roughness element on the convective heat transfer of a flat plate.

This report aims to examine the effects of various fins on the heating/cooling efficiency of the rotational molding process and on molded product qualities. Rotational molding experiments were carried out in a laboratory-scale uniaxial machine, which is capable of measuring the internal air temperature in the cycle. Molds with three types of extended fins, pin, rectangular and triangular, were used to manufacture the parts. Cycle time reductions by these fins were determined, and characterization of molded part properties was performed after molding.