GAS-ASSISTED MOLD SURFACE HEATING FOR IMPROVING THE QUALITIES OF INJECTION MOLDED PARTS

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Abstract

In this study, hot gas is utilized to achieve rapid mold surface heating. Different inlet sizes (4mm, 6mm, 8mm) at the mold entrance was designed. Mold surface temperature was raised to above glass transition temperature within few seconds’ heating prior to injection then mold is closed for melt injection. Heating speed can be as high as 40 °C/s. Hot gas heating was does eliminate the fiber floating marks of molded parts and achieving high surface quality. It was found that the gas inlet size can affect the heating speed and heating uniformity.

Introduction

Injection molding is one of the most important processing technologies used in the manufacturing of plastic products. In an injection molding cycle, the cooling process occupies about two-thirds of the cycle time. Therefore, efficient cooling can significantly reduce cycle time and operating costs. However, lower mold temperatures causing the development of a skin on the exterior of the part and a propagation of frozen layers towards the core of the part. These frozen layers increase the flow resistance, making the mold cavity difficult to fill. Meanwhile, many molding problems, including weld lines, part surface gloss, residual stress, and warpage, may become severe when the mold temperature is low and heat distribution is not uniform. High mold temperature may thus reduce or eliminate many molding problems.

In recent years, a number of innovative approaches for rapidly heating only the surface portion of the mold have been presented. The most inexpensive way to achieve high mold temperature is to use cooling water at temperatures as high as 90 °C or 100 °C. When mold temperature exceeding 100 °C is required, either a high pressure water supply system (to prevent the water from steaming) or heating oil [1] may be used. The former may lead to channel connection damage and safety issues after long-term use.

Local mold heating using electric heating elements [2] is sometimes used to assist high mold temperature control. However, this requires additional design and tool costs. Further, electrical heating is usually used as an auxiliary heating and is limited to increases in mold temperature of roughly several tens of degrees centigrade.

In fact, economics dictates higher mold temperatures during injection (to minimize part wall thickness and injection pressure) but lower mold temperatures during cooling (to allow rapid solidification). However, to maintain high mold temperature during the filling process, while lowering the mold temperature to below the deflection temperature during the post-filling process, without great increases in cycle time and energy consumption, is not easy. To address this problem, a variety of dynamic mold temperature controls (DMTC) have been explored in recent years [3-14]. Their purpose is to eliminate the frozen layer ideally producing a hot mold during the filling stage and a cold mold for cooling.

The most popular approach to DMTC is used to heat fluid and coolants alternatively, either by switch pumping in the same cooling circuits [9] or circulating in separate cooling channels. Either way, the massive mold base is either heating or cooling at the same time, resulting in great power consumption and lengthened operating times. Meanwhile, the exterior mold surface heating, such as induction heating [7-9], high-frequency proximity heating [10], Gas-assisted mold temperature control (GMTC) [11-14] can provide sufficient heating rates without significant increases in cycle time. In reason years, we provide a systematic study on mold surface heating and mold surface localization heating of the processing characteristics.

In this study, a gas-assisted heating system combined with water cooling, with different designs of inlet sizes