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Effects of cavity surface temperature on reinforced plastic part surface appearance in rapid heat cycle moulding

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ABSTRACT

The influences of the cavity surface temperature just before filling on surface appearance and texture of the moulded reinforced plastic parts in rapid heat cycle moulding (RHCM) are investigated. Two typical reinforced plastics including ABS/PMMA/nano-C_aCO_3 and 20% fibre reinforced polypropylene (FRPP) are tested in experiments. The roughness, gloss and morphology of the part surface are characterized with white light interferometer, gloss meter, and optical microscope, respectively. It is observed that the cavity surface temperature just before filling has a significant influence on part surface appearance. With the increase of the cavity surface temperature just before filling, aesthetic quality of the moulded part can be greatly improved. There is a critical value of the cavity surface temperature just before filling for each plastic. As the cavity surface temperature reaches the critical value, part surface appearance will reach the optimal level with low roughness and high gloss. The weld mark for ABS/PMMA/nano-C_aCO_3 has a V-shaped structure while that for FRPP has a hump-shaped structure. With the increase of the cavity surface temperature just before filling, the width of the V-shaped weld mark reduces gradually until it disappears completely while the height of the hump-shaped weld mark decreases firstly and then increases. The mechanisms for the improvement of surface appearance by increasing cavity surface temperature just before filling and the generation of the V-shaped and hump-shaped weld mark are disclosed.

1. Introduction

Rapid heat cycle moulding (RHCM) process has received extensive attention in recent years because it can significantly enhance the quality of the moulded part, especially in the aspects of part surface aesthetics. It has been gradually used to produce aesthetic plastic parts used in consumer electronics, automotive, etc., which have high surface-quality requirements. In fact, the surface quality of RHCM products is so perfect that secondary procedures such as sanding and painting usually necessary for the plastic parts produced by convention injection moulding (CIM) process are not needed any more [1–4]. Therefore, RCHM process can shorten the whole production process and reduce the environmental pollution and production cost. Additionally, RHCM process has also shown a rising application in microinjection moulding (MIM) field because it can significantly improve replication accuracy of the micro-featured plastic parts [5–8].

The main difference between RHCM and CIM process is the mould temperature control strategy and method [9,10]. In CIM process, the mould temperature is usually controlled by cycling the coolant with constant temperature in the cooling channels of the injection mould. Since the objective of mould temperature control in CIM is to keep the mould temperature at the constant desired level during the whole moulding cycle, such method can be called as a type of constant mould temperature control (CMTC) method. However, in RHCM process, the cavity surface temperature should be firstly heated to a preset high level, usually higher than the glass transition temperature or melt temperature of the plastic resin, before melt injection. During the following filling process, the cavity surface temperature is maintained at the high level to facilitate polymer melt filling the cavity. After the filling process is finished, the mould will be cooled as rapidly as possible to lower cavity surface temperature and solidify the shaped polymer melt in mould cavity until the plastic part is rigid enough for ejection. Since the cavity surface temperature in RHCM will fluctuate in a very large temperature range by rapid heating and rapid cooling, such mould temperature control method can be called as a type of dynamic mould temperature control (DMTC) method. A schematic diagram of RHCM process is illustrated in Fig. 1. For CMTC of CIM, the cavity surface temperature during filling process should be much lower than the glass transition temperature or melt temperature of the plastic resin to ensure a short moulding cycle and competitive production efficiency. The low cavity surface

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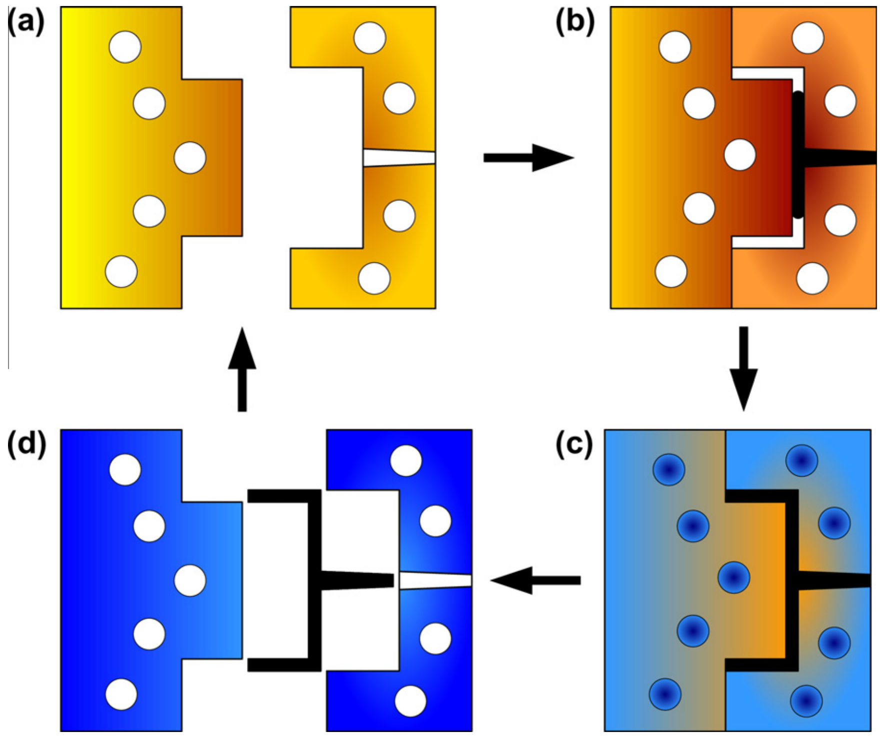

Fig. 1. The schematic diagram of RHCM process: (a) rapid heating of the injection mould; (b) injecting the polymer melt with high cavity surface temperature; (c) rapid cooling of the injection mould and the polymer melt and (d) ejecting out the part.

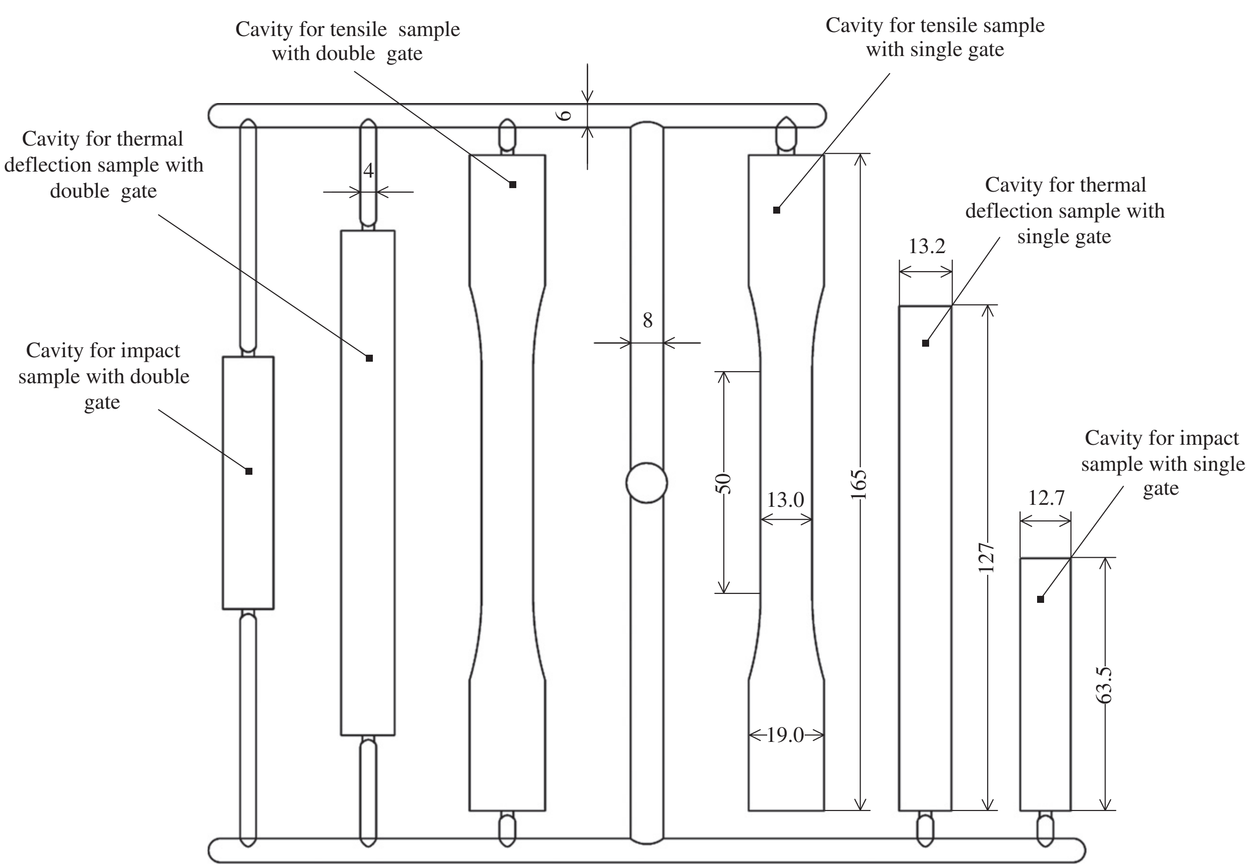

Fig. 2. Layout and dimensions of the electric heating RHCM mould cavities.