A Study on the Selection of Injection Time by the Formation of the Skin-layer in Microcellular Injection Molding Process

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1. Introduction

Microcellular injection molding process has the advantage that it can easily achieve lightweight by create cells inside plastic products.[1] However, microcellular injection molding is more difficult to optimize process conditions than normal injection molding process. In particular, if the injection time is increased for the purpose of reducing the pressure to suppress stress, it is likely that the formation of skin layer[2] because cooling will prevent the product from foaming properly.[3] In this study, injection analysis and experiments was conducted to optimize process conditions to reduce pressure and maximize foaming performance during the microcellular injection molding process.

2. Body of abstract

In this study, the effects of injection time on skin layer formation in microcellular injection molding process were investigated by experiments. Was injected a mixture of fillets in the form of chemical blowing agent[4] which generates carbon dioxide gas to a foam of a polymeric material in the thermoplastic polypropylene, it was applied to the core back process[5] in order to improve foaming performance. Injection molding analysis was performed to observe the effect of injection time on the skin layer and foaming cell formation. In case of applying the lowest pressure point in the method of selecting the injection time, the thickness of the skin layer and the weight of the product were increased. As a result also the injection time was analyzed by observing the cross section of the sample by scanning electron microscope (SEM) increase was confirmed that the increase in the diameter of the foam sell, which was in good agreement with the analysis result. From these results, it was found that when injection time is selected in the microcellular injection molding process, resin should be injected into the mold as soon as possible so that foaming does not occur during resin injection.

3. Analysis for microcellular injection molding

Microcellular injection molding analysis was performed using Moldflow by Autodesk Inc.

Equations (1) to (3) show continuity equations, momentum equations and energy equations respectively. And equations (4), (5) respectively show on hydrodynamic growth due to surrounding fluid and diffusion of gas from envelope into bubbles.

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \boldsymbol{v}) = 0 \tag{1}$$

$$\rho \frac{D\boldsymbol{v}}{Dt} = -\nabla p + \nabla \cdot \tau + \rho g \tag{2}$$

$$\rho C_p \frac{DT}{Dt} = \nabla \cdot (k \nabla T) + \eta \dot{\gamma}^2 + \beta T \frac{Dp}{Dt} \tag{3}$$

$$\frac{4\eta \dot{R}}{R} = \left(P_g - P\right) - \frac{2\sigma}{R} \tag{4}$$

$$\frac{d}{dt}\left(\frac{P_g R^3}{R_g T}\right) = \frac{6\rho^2 D k_h R_g T \left(P_{g0} - P_g\right)^2 R^4}{P_g R^3 - P_0 R_0^3} \tag{5}$$

The process conditions applied in the analysis are shown in Table 1 below.

Table 1 Process conditions for analysis

Index	Unit	Value
Injection time	Seconds	0.3 ~ 3.0
Injection temp.	℃	210
Mold temp.	℃	40
Contents of CBA	Weight percent	5

The result of injection time versus injection pressure is shown Fig. 1, the injection pressure decreased as the injection time increased. The reason of the injection pressure increased after 2.4 seconds is because the resin is hardened and is no longer injected into the mold. And the figure shows the lowest pressure when the injection time is between 1.5 and 2.4 seconds.

However, the results in Fig. 2 and 3 show that the thickness of the skin layer and the weight of the product increase as the injection time. Thus, in microcellular injection molding, resin injection into the mold must be completed as soon as possible. Otherwise, the skin layer can grow and interfere with cell production.

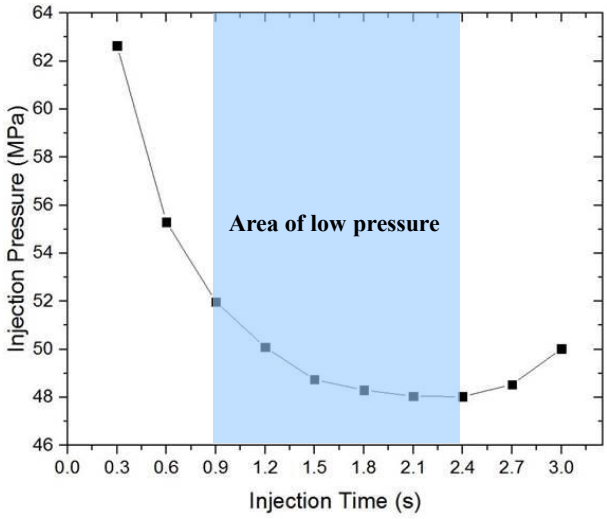

Fig.1 Injection time vs. injection pressure

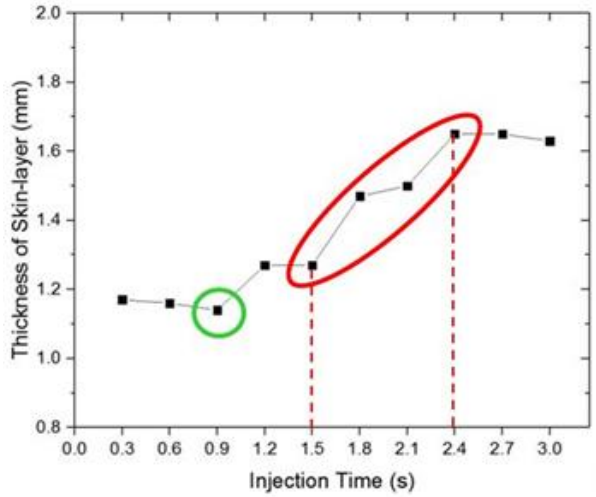

Fig.2 Injection time vs. thickness of skin layer

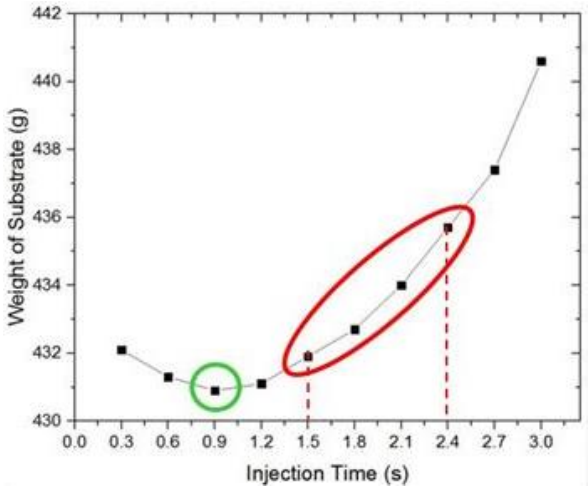

Fig.3 Injection time vs. weight of product

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