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Study of the Effects of Injection Molding Parameter on Weld Line Formation

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Abstract

Micro weld lines are the common problem that occurs for plastic molded parts through injection molding process. This study focus on the formation of weld lines of molten polypropylene and polypropylene-glass-fiber reinforced composite under different parameters (melt temperature, material & mold design). Three different mold with different design were fabricated and injected with molten polypropylene and polypropylene-glass-fiber reinforced. The experimental result of the length, angle and location of the weld line were compared to the result from Autodesk Simulation Moldflow Adviser software. The result show a good resemblance with polypropylene with melt temperature 240^{o}C and polypropylene-glass-fiber reinforced (10, 20, 25%) but not with polypropylene with melt temperature 250^{o}C and 260^{o}C. It is also concluded that the melt temperature, type of material and mold design affects the formation of weld lines.

Peer-review under responsibility of the organizing committee of the Urban Transitions Conference

Keywords: Injection molding parameter; Micro Weld line; Polypropylene; Polypropylene-Glass Fiber Reinforced; Simulation

1. Introduction

In plastics injection molding, an important criterion on the quality of the molded part is the appearance. The weld lines are formed when there is an obstacle in the cavity of the injection mold. Weld lines are formed during cavity filling whenever two separated melt flow font recombine. Weld lines are usually pointed out as the weak region in molded parts. There are two types of weld lines, cold and hot weld line. Cold weld line or known as “knit line” is formed when separate melt flow fronts converge at opposite. Hot weld lines also known as “meld lines” occurs when two melt flow fronts emerged parallel to each other and form a bond between them.

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Nomenclature

F_{WL}	weld line index
P_Y	mechanical properties with weld lines
P_N	mechanical properties without weld lines
P_i	proportion of the i_{th} components
r_i	short-long-diameter-ratio of the i_{th} components
n	total number of components
t_{vit}	time of melt cooled and arriving to glass-transition temperature
t_{fill}	time of glass-transition temperature
P	melt pressure
η_m	mean viscosity at the interface
b	half thickness of the cavity
z	coordinate in the gap-wise direction

Weld lines generally result in the reduction of mechanical properties and aesthetical appearance of the molded parts. There are great numbers of investigations about processing condition effect on the weld lines. An analysis on the strength and modulus of weld line was carried out and it shows less effect on the tensile modulus [1]. Based on several researchers, they used the "strength of specimens with weld line/strength of specimens without weld line" which is known as the WL-factor. Highest WL-factor is resulted from using high holding pressure, high melt temperature and low mold temperature was used as processing parameters during molding [1, 2, 3].

The research in weld line of injection molded parts has increased greatly nowadays, mainly because of the increasing requirements for the performance and appearances. The weld lines surface marks can be eliminated by applying induction heating on surface temperature, which have been investigated on ABS tensile specimen by Chen et al [4]. Weld lines elimination is not 100% guaranty without modifying the part geometry. But, the drawback on part performance and appearance can be reduced. This can be fulfilled by experimental based trial and error or by simulation model prediction. Due to the limitation on mathematical model for weld line, Zhou [5] found that computer injection molding simulation packages are only capable of predicting the weld line location accurately, but unable to predict the weld lines properties accurately.

Based on Mezghani [6], a comparison of the weld line location was made between the simulated results and the real position. A weld detector algorithm is introduced in Zhou [7] work, which formulated on the characteristics of the initial meeting point. On another note, the application of fuzzy theory was done in order to control the position of weld line by modifying the gate location and the wall thickness in simulations [8]. Nowadays, the prediction of weld line location and weld line strengths are the main focus of the weld line modelling. Chun [9] showed a simulation effect of thickness and gate location on the weld lines position and formation. This study will focus on the effects of injection molding parameter on weld line formation by using Polypropylene (PP) and Polypropylene-Glass-Fiber reinforced composite materials.