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Optimization of Packing Pressure Profile for Minimization of Multiple Injection Molding Defects

Yi-min Deng and Guo-fu Li

Ningbo University, Ningbo, China, dengyimin@nbu.edu.cn

Abstract

Injection moulding is a widely-used method for production of thin-walled plastic parts. Injection molding related design optimization has been researched extensively over the past years to address molding defects such as warpage, sink marks, weldlines, and so on. However, there still lacks a comprehensive study on the *packing pressure profile* related injection molding optimization. Packing pressure profile is commonly represented by a curve of pressure over a period of injection molding cycle called *packing stage*. This is one of the critical injection molding process conditions that may cause majority of the defects if not set properly. Most of the existing researches, including our own work, only regard packing pressure as a constant [1, 2]. There appears only one literature that takes packing pressure as a variable profile; yet it has unfortunately only addressed warpage problem, hence is still of limitation [3].

To tackle this problem, this paper proposes to use Design of Experiment (DOE) method, together with injection molding simulation (via Moldflow®), to study the implication of packing pressure profile on multiple molding defects, and to obtain an optimal set of molding process parameters, including packing pressure profile. The optimization process takes as objectives not only the molding defects, but also manufacturability such as short shot, and efficiency such as cycle time. The packing pressure curve is segmented into 3 sections, hence it is characterized as 7 variables, including 4 pressures and 3 time durations. In addition, 3 other process parameters, including injection time, mold temperature, melt temperature are also taken as design variables.

After that, DOE method is employed and an orthogonal array is selected to design and conduct simulation experiments. The simulation results are then investigated, with all necessary data retrieved, whereby a sensitivity analysis is carried out to study the relevance of packing pressure profile as well as other processing settings with the optimization objectives. Based on the results, the most prominent design variables are identified and the optimal values for these variables are further derived. A case study is finally presented, demonstrating the applicability and the strength of the proposed methodology.

References

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