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A Review on Effects of Variable Profile on Plastic injection Molding products Quality and Productivity

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Abstract - *Plastic injection molding is widely used for Manufacturing a variety of products.Molding conditions or process parameters play an important role that effects the product quality and the productivity of any plastic product.The objective of this paper reviews the Effects on the variable process parameters optimization for decrease the plastic injection molding defects and get short cycle time for high productivity and part quality.Generally,This review work proposed a method to determine the optimal process parameters in the plastic injection molding for high productivity and good product quality.A constant parameters during the plastic injection molding is conventionally used, but the variable process parameters profile that the parameters varies in the different phases is adopted as the advanced plastic injection molding.In this Radial basis function network adopted to determine the variable injection velocity and variable packing pressure profile.It is found through the result that variable parameters profile can improve product quality and high productivity.This work objective is intend as a contribute to awareness the optimization of plastic injection molding variable process parameters profile.*

Key Words: Plastic injection molding, variable parameters profile, Radial basis function network, Cycle time, Quality

1.INTRODUCTION

The injection molding process is fast,consisting of an autonomous operation and consistent duplication quality, it is widely used in recent modern molding industry.Injection molding is ideal for manufacture mass production of complex shapes and sizes of plastic products. It comprises four main phases:Filling,Packing,Cooling and ejection.Now a days it has become more difficult for the molding industry to produce high quality molded parts While at the same time enhancing the productivity rate.Plastic injection molding defects such as weld line and warpage results in uneven clearance or malfunction during the assembly process.Weldline that is formed when two or more melt fronts meet is one of the major defect.Which has influence on not only the loss apperance but also the straight of product,then it is important to reduce it for the high product quality. However,many of researches adopting conventionally settings the process parameters to reduce molding defects and enhancing product quality.So far,most plastic injection molding companies have relied on the best and guess approach to seek for an ideal settings of process parameters in reducing defects and minimized cycle time.Warpage is the deformation that occurs when there is uneven shrinkage in the different parts of the molded component.Warpage occurs when there are variations of internal stresses in the material. Warped part may not be functional or visually acceptable. Warping deformation of injection products which is one of the common defects in the plastic products.Controlling the process parameters is the most effective way to gurantee the quality of product in molding process.Many Scholars researching to reduce warpage defect in different ways like improving mold structure, process parameters,Micro cellular foaming process so on.Most of companies relay conventionally Controlling process parameters to reduce warpage defect. High product quality is always required in the plastic products. In the case of thin plastic product, the warpage that is one of the major defects should be minimized.In addition to the warpage minimization, the cycle time is one of the crucial factors for the high productivity. In other words, the cycle time should also be minimized for the high productivity.

The aim of this papr to understand proposed injection molding variable parameter profile which has influnce to minimize the surface defects like weld line,short shot and warpage of plastic products and at the same time get the short cycle time for high productivity. This work reviews the characteristics,advantages and scope of using variable parameters profile in plastic injection molding for high productivity, high product quality and reduction of different plastic injection molding defects and cycle time.Generally,there is too many researchers doing work conventionally on plastic injection

molding process parameters for reduces different defects and minimized cycle to get high product quality and high productivity.

1.1 packing Pressure profile

The proposed approach is more effective for the warpage reduction in comparison with the traditional one. The pressure profile of the traditional approach is so flat,constant and a high pressure is applied during the injection and packing phase. In contrast, in the proposed approach, the injection pressure gradually decreases. The high packing pressure is then applied at the beginning of the packing phase. After the packing pressure gradually decreases. The high pressure at the beginning of the filling phase gives the high velocity of the melt plastic, and the high pressure in the packing phase helps keep the high temperature of the melt plastic for avoiding the solidification of the plastic. These high pressures result in minimize injection molding defects.

We can understand about the variable packing pressure profile using Fig. 1, wheraes the horizontal axis represents the time, and the vertical axis represents the pressure, respectively. Figure 1a shows the conventional packing pressure profile during the Plastic injection molding process,from which it is found that a constant packing pressure is used.In the conventional approach, the packing pressure (P_p) and the packing time (t_p) are constant.lets understand about the proposed packing pressure profile shown in Fig. 1b, from which it is clear that the pressure profile varies according to the time unlike the conventional one.The proposed packing pressure profile consists of six parameters (the packing pressure P_{pi} and the packing time t_{pi} (i = 1,2,3) at points A, B, and C in Fig. 1b.

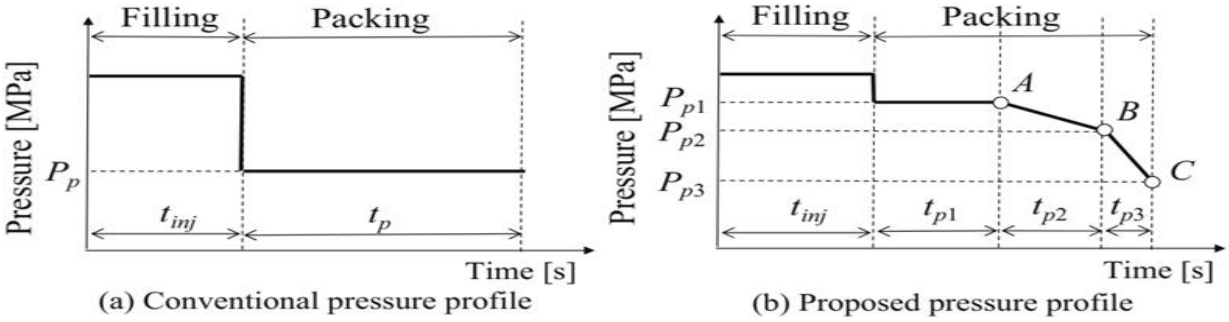

Fig -1: conventional and variable packing pressure profile

1.2 Injection Velocity profile

A constant injection velocity is conventionally used but an innovative approach using variable injection velocity is purposed in order to reduce the weldline without the short shot. Figure 2 shows the example of variable injection velocity profile. At the begining of injection process high injection velocity used for the weld line reduction. After that,to avoid the short shot,the injection velocity gradually decreases.The design variables in the variable injection velocity profile are the injection velocity (v_1^{inj} [mm/s] and v_2^{inj} [mm/s]) and the plunger position (L [mm]). L_{max} [mm] in Fig. 2 denotes the maximum distance of plunger.

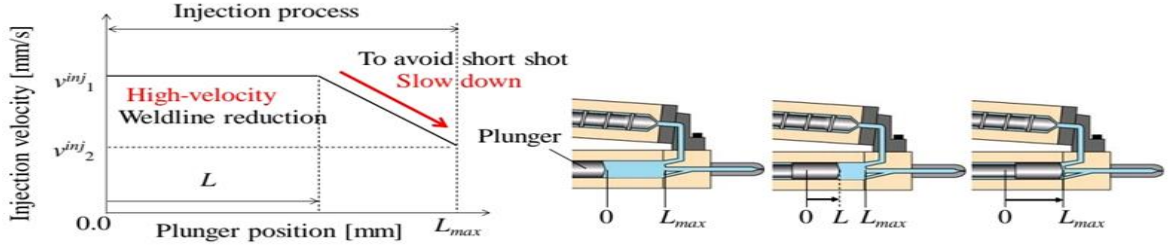

Fig -2: Example of Variable injection velocity profile

2. Literature review

This section investigated the conventional and porposed variable parameters profile to understand the effect of using conventionally and porposed profile plastic injection molding process parameters on quality of the product.There is lot of optimization techniques were used to control plastic injection process parameters which effects the molding process.

Satoshi kitayama et. al. [1], In this paper author presented the effect of variable injection velocity profile and variable pressure profile for minimizing weld line and cycle time by using radial basis network function.The larger the ratio of weldline temperature to injection time was, the shorter the weldline became.Weldline has an influence on not only the strength but also the surface appearance of a product, and the reduction is a crucial issue in the PIM. It is clear that the process parameter optimization plays an important role in the weldline reduction. According to the literature, several process parameters are optimized for weldline reduction.It has been reported in literature that injection velocity or injection time is one of the important factors for weldline reduction.However, a constant injection velocity was adopted in the literature.Unlike the conventional PIM process, variable injection velocity that the injection velocity varies during the injection phase is adopted for the further weldline reduction.variable pressure profile is effective to not only product quality but also productivity. High productivity (short cycle time) is always taken into account in the PIM. Therefore, the variable pressure profile approach is adopted and optimized for the weldline reduction and the short cycle time.Consequently, the multi-objective design optimization of process parameters minimizing weldline and cycle time is performed, in which variable injection velocity and variable pressure profile are adopted.Through the neumerical and experimental results the proposed approach is effective to the drastically weldline reduction and the short cycle time compared with the constant injection velocity and packing pressure.The selected process parameters in this study were variable injection velocity,variable pressure profile,Melt temprature,Mold temprature,Packing pressure and Cooling time.

Sara Hashimoto et. al. [2], The aim of author of this article is investigated the unconventionally control the process parameters to reduce weldline without short shot, in this author porposed the newly developed variable injection velocity profile which is effected to enhance product quality and observed the short cycle time.Variable injection velocity that the injection velocity varied during Injection molding is adopted for the weldline reduction without the short shot.A novel weldline evaluation considering the weldline temperature and the injection time is proposed, which is maximized for weldline reduction. On the other hand, the cycle time is minimized for high productivity.A multi-objective optimization is performed, in which the variable injection velocity profile as well as several process parameters are optimized. The SAO using radial basis function (RBF) network is adopted for the design optimization tool.It has been found that the variable injection velocity was effective to the weldline reduction without the short shot.High injection velocity is used at the beginning for weld line reduction, and the injection velocity gradually decreases for avoiding the short shot.the process parameters which studied in this paper are variable injection velocity, melt temprature,packing pressure, packing time,cooling temprature and cooling time.

Satoshi kitayama et. al. [3], In this paper author prsented the multi objective optimizatiojhn of variable packing pressure profile and process parameters in plastic injection molding for minimizing warpage and cycle time, in this purpose for sequential approximate optimization adopting radial basis function to optimize process parameters.The variable packing pressure profile clearly affects the warpage and the cycle time.In addition to the variable packing pressure profile, several process parameters such as the melt temperature and the cooling temperature of coolant should be optimized.The porposed aproach clearly affects the warpasge and cycle.The process parameters selected in this paper were melt temprature,injection time,cooling temprature and cooling time.Fig. 1 shows the porposed packing pressure profile which author used to confirm the neumerically and experimental results and clarified the variable pressure profile more effective then the traditionally used constant pressure.

Gyung-ju kang et. al. [4], In this article author aim were mathematical formulation of the design problem which can minimize the amount of warpage occurrence, satisfying the design requirements related with clamp force, weldline length, and fill and pack conditions was conducted.The effects of design variables using parametric study were analyzed. And the main design variables were selected to be used in the optimal design. The process parameters selected in this paper were melt temprature,injection time, mold temprature and cooling time.The optimal design using the metamodel and the optimizing methodology were performed. Maximum warpage reduction of 18.32% was obtained, satisfying all constraint

conditions such as clamp force, weldline length, and fill and pack condition. Through this, the effectiveness of the design methodology proposed in this study was verified.

Satoshi kitayama et. al. [5],The process parameters are optimized for warpage reduction with variable pressure profile. In other words, the pressure profile is taken as the design variables. In this paper, the filling and packing pressure profile is considered. Besides the variable pressure profile, the melt temperature, and the mold temperature are also taken as the design variables.Short shot is rarely discussed in the literature. In this paper, the short shot is evaluated quantitatively and is taken as the design constraint.The SAO procedure is used to optimize the process parameters. In particular, the SAO system with the RBF network is employed.Moldex3D, which is one of the commercial software for the plastic injection molding, is used in the simulation. It is expected that an optimal solution could be found with a small number of simulation runs compared with the trial and error method. the process parameters which studied in this paper are variable pressure preofile,variable packing time, melt temprature, mold temprature and injection time.It has been found that the variable pressure profile was more effective then conventionally control process parameters to the warpage reduction and short shot.

Table -1: Summary of Proposed plastic injection molding optimization techniques.

S.No.	Authors	Ref.	Year	Process parameters	Variable profile	Outcome
1.	Satoshi	3	2020	Melt temprature Mold temprature Packing pressure Cooling time	Variable injection velocity Variable pressure profile	Weld line reduction Short cycle time
2.	Sara	4	2019	Melt temprature Packing pressure Packing time Cooling temprature Cooling time	Variable injection velocity profile	Weld line reduction Short shot
3.	Satoshi	5	2017	Melt temprature Injection time Cooling temprature Cooling time	Variable packing pressure Variable packing time	Warpage Cycle time
4.	Gyung-ju kang	6	2016	Mold temprature Melt temprature Injection time Cooling time	Variable ram speed Variable packing pressure Variable packing time	Warpage Weldline
5.	Satoshi	7	2014	Mold temprature Melt temprature Injection time	Variable pressure profile Variable packing time	Warpage

3. CONCLUSIONS

In this paper, the multi-objective optimization for minimizing injection moding defects and cycle time using variable injection velocity and variable pressure profile was studied.As we notice that using porposed profiles injection moding defects were more minimize then conventionally controlling process parameters.The cycle time was also taken as the other objective function. Plastic injection molding is widely used process in manufacturing of products. There are lot of plastic products that manufactured by injection molding. So the settings of various processing parameters of the injection molding process to minimize defects is challenging issue that costs time, effort and money. This paper evaluate a review of research article in the optimization of variable profiles and processing parameters for injection molding. Here some of work had done by authors in this era. From the study we found that using variable profiles during molding process is more effectively decrease the defects and cycle time then used the constant parameters in injection molding.

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