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A REVIEW OF SHRINKAGE BEHAVIOUR AND OPTIMIZATION OF INJECTION MOLDING PROCESS

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Abstract

Previous works include the application of the Taguchi method [17] and RSM for modeling (present) injection molding parameters when slice work is presented. The effects of melt temperature, mold temperature, packing pressure, packing time, and cooling time on volumetric shrinkage have been considered in this work using a central compound design (CCD) according to the RSM method. Taguchi's technique, as well as the 3D surface graph of RSM, showed that temperature, mold temperature, packing pressure, packing time, and cooling time are the most important factors in reducing shrinkage. Volumetric after injection molding. A predictive mathematical model was then developed using regression analysis in analytical tools to analyze the response. Although the Taguchi's technique predicted values close to the mean error, the RSM technique appears to be more promising for predicting the response using mathematical models than the Taguchi's technique.

Keywords: *Optimization, Injection Molding, Process Parameter, Volumetric Shrinkage.*

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1. Introduction

Injection molding is ideal for manufacturing mass-produced plastic parts of complex shapes and sizes, with more than 30% of all plastic parts manufactured using the injection molding process [1]. It is capable of producing infinite types of part designs with uniformly different types of details such as rings, springs, and hinges in a single molding operation. The injection molding process begins with feeding the polymer through a hopper, which is then heated to a sufficient temperature for flow, the molten plastic that is melted is injected into the mold under high pressure, as shown in figure, an injection is applied to both plates of the injection molding machine (movable and fixed plates) to hold the figure tool together. The product is then cooled, which helps it in the freezing process. Once the product takes its shape, the two plates will move away from each other to separate the mold tool known as the mold opening. Finally, the molded product is removed or removed from the mold [2].

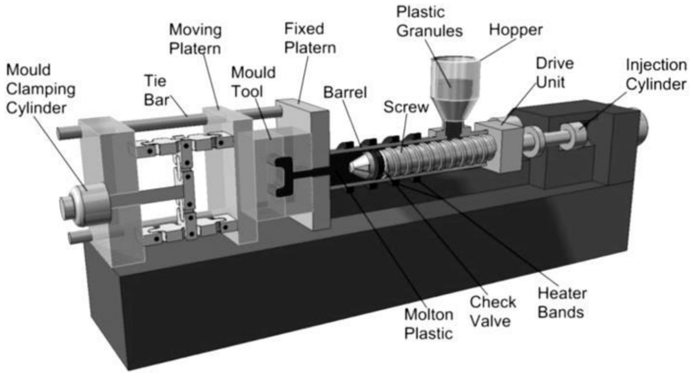

Figure 1.1 The injection molding process.

2. Literature Review

Iyer and Ramani [1] (2002), in an attempt to study the use of materials with high thermal conductivity, the sinking defect was taken as a quality parameter. It was observed that the thermal conductivity of the mold material affects the sink traces.

Erzurumlu and Ozcelik [2] (2006), implemented the Taguchi's technique to reduce deformation and sinking indices. In their study, they considered mold temperature, melt temperature, packing pressure, rib cross section and rib arrangement angle, and PC / ABS, POM, PA66 materials. In their research, they find that the packing pressure impact factor for PC / ABS plastic products, the rib cross section affects the plastic product of the POM material, and the rib arrangement angle significantly affects the plastic product material PA66.

Shen et. al. [3] (2007), investigate the numerical simulations are combined with Taguchi's Design of Experiment (DOE) technique to the effects of process conditions and cavity geometry to mark the injection molding and optimize the results. Could. Process conditions and cavity geometry. An orthogonal matrix L18 (37) based on the Taguchi method was constructed to minimize the loose traces of the injected parts, and the significance of each factor in the sag mark was investigated. For the factors chosen in the main experiments, part thickness, pressure, melting temperature, and mold temperature were found to be the main factors affecting the sink traces of the injection molded parts.

Tang et. al. [5] (2007), investigated of the production of thin sheets that it is going to make a mold that produces a thin sheet with dimensions of 120 mm × 50 mm × 1 mm. The thin plate will be used for deformation tests. In mold making, the mold base that is purchased will be machined and assembled. After that, the mold is fixed on an injection molding machine. The machine must be setup to produce the product. The product will then be used to test the effective factors in the deformation problem by applying the experimental design of the Taguchi method. The results show that the most effective factor in the deformation is the melting temperature.

Zhao et. al. [6] (2009), studied that with the application of computer aided engineering, integration with statistical techniques to reduce the deformation variation dependent on the parameters of the injection molding process during the production of plastic components. thin crust. For this purpose, various mold flow analyzes are performed using a combination of process parameters based on three levels of the L18 orthogonal matrix table. Meanwhile, apply the design of experiments (DOE) approach to determine an optimal parameter fit.

Mathivanan et. al. [7] (2010), presented a simple and efficient way to study the effect of injection molding variables on loose traces using the Taguchi approach. Applying the Taguchi approach also helps in arriving at optimal parameter settings. Depth through verification tests based on optimal parameters and predicted lump depth using the Taguchi approach for the same configuration were found to be in agreement. The results show the ability of this approach to estimate sink depth for various combinations of processing variables within the design space. It has been observed that greater distance of the rib from the feeding point produces deeper sink.

Chen et. al. [9] (2012), optimization of process parameters was proposed through the design of experiments (DOE), reaction surface methodology (RSM) and genetic algorithm (GA) to generate the optimal configuration of process parameters was done. In the first step, the important parameters of the PIM process can be determined by DOE detection experiments. The optimal settings of the process parameters are then obtained by a computer-aided engineering (CAE) simulation integrated with RSM and GA, which are taken near the initial settings of the process-related parameters.

Kusic et. al. [10] (2013), examined the effect of six parameters of the injection molding process on the post-molding contraction and deformation of parts made of large quantities of calcium carbonate-filled polypropylene used in the automotive industry. For experimental purposes, standard samples were used for the determination of post-molding shrinkage and stress. Each experiment was accurately observed through acoustic emission (AE) signals and measurement in cavity pressure.

Alam and Kumar [11], (2013), determinated of the optimal setting of process parameters that severely affect productivity, quality, and cost of production in the plastic injection molding (PIM) industry. In this paragraph, the optimal injection molding conditions for minimal shrinkage were determined using the DOE technique of Taguchi methods. Various observations have been made for polypropylene (PP) namely materials. The determination of the optimal parameters of the process was based on the S / N ratio.

Prateek and Bhamniya [12] (2013), investigated the polycarbonate injection molding process, which determined the melting temperature of the tensile strength and found that it is the most important factor contributing to it with 4.55%. Cooling time with 08.54% and injection pressure with 07.19%. The results suggest that the best combination of processing parameters in terms of tensile strength for polycarbonate is a melting temperature of 260 ° C, an injection pressure of 150 bar and a cooling time of 7.5 seconds. The effects of all factors have been identified and are believed to be an important factor in helping mold designers determine optimal process conditions, injection molding parameters.

Mehat et. al. [13] (2013), volumetric shrinkage and deflection of molded gear under various process conditions were studied using MPI software. The integration of the gray-based Taguchi optimization method and numerical simulation provides designers and engineers a systematic and efficient approach, with which to identify the most important processing parameters in the final molded gear quality characteristics from multiple processing variables. Minimum simulation tests required. In their study, only two parameters, including molten temperature and pack time, are considered important in the quality characteristics investigated of molded gears.

3. Conclusion

The data from the experiment [17] suggest a high degree of interest in comparing Taguchi and RSM to predict the reaction in the injection molding process. Generally, comparative studies on the performance of optimization techniques are lacking; In other words, which method would be best for a given optimization problem. However, RSM is more promising because it gives a much lower average error towards modeling and validation. The desirability criteria available in RSM will easily help users determine the optimal condition. In RSM the importance of interactions and the class words of the parameters are more clearly estimated. RSM illustrates the importance of all possible combinations of interactions.

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