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A REVIEW ON PLASTIC MOULD MANUFACTURING PROCESS AND PARAMETERS

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Abstract:

Injection Mold Design is the process of designing and developing the tools, methods and techniques needed to improve efficiency and productivity. The basic management conditions are learned from conceptual development to product production. The impact of varied factors studied supported processing parameters. Since quality and productivity are two important conflicting goals in any machining process. Quality has got to be somewhat compromised, ensuring high productivity. Similarly, productivity is reduced, but efforts to enhance quality are channelized. to make sure top quality and productivity, it's necessary to optimize the machining parameters. Various reactions of injection molding process quality supported performance parameters and methods are studied. the purpose of this paper is to illustrate the state of the plastic injection molding process. The working conditions are satisfied by the production of a product based on high quality.

Keywords: Injection Moulding, Parameters, Machining, Quality, Maintenance

INTRODUCTION

Modern-day injection molding tools are often a complex arrangement of mechanical, electrical, pneumatic, and hydraulic components that are expected to fulfill many demanding tasks. Whatever the complexity, mold design must specify a device that will work satisfactorily in production. Injection molding is the most commonly used manufacturing process for making plastic parts. A wide variety of products can be made using injection molding, which can vary greatly in their size, complexity, and application. The injection molding machine, raw plastic material, and mold are required for the injection molding process. The plastic is dissolved in the injection molding machine and then injected into the mold, where it cools and freezes at the end. This is one of the process that are greatly preferred in manufacturing industry because it can produce complex-shape plastic products and having good dimensional accuracy with short cycle times typical examples are automobile industry, casings and housings of products such as computer monitor, mobile phone and which has a thin shell feature.

LITERATURE REVIEW

Much research is being done to understand the important factors and design the molding processes. Much of the work over the past decade has been based on: theoretical, computer-based simulation models and practical experimental tests. (Erzurumlu & Ozcelik, 2006)used the Taguchi method to reduce the variance and sink index. In his study he considered mold temperature, melt temperature, packing pressure, rib cross section and rib layout angle and material PC / ABS, POM, PA66. They found in their research that PC / ABS plastic products, rib cross-sectional pom material plastic production and rib layout angle effect PA66 materials significantly affect plastic production. (Ozcelik et al., 2010)attempted to study the mechanical properties of materials using the Taguchi method. They are considered the melting temperature, packing time, cooling time, injection pressure. (L. Zhao et al., 2010)study the sink marks error with simulation with the help of software mold flow and experiment with the Taguchi method. In their research they study the process parameters on polypropylene content and solubility, mold temperature. Injection Time, Pressure Holding, Cooling Time. (Stanek et al., 2011)A mold design study with the help of cadmol software. They claim that Cadmold software can calculate curing time based on molding time, speed and vulcanization time, and material and technical parameters. (Saman et al., 2009) Study the mold condition of the injection mold to create the proper molding system through CAD / CAE devices. They represent the right gating systems with the help of CATIA and MOLDFLOW software. (Gruber et al., 2011)A study on visual perceptual measurement of sink markings on injection molding components. They study the sink marks of plastic parts that are stable by increasing the holding pressure and other parameters. (X. Wang et al., 2013) studied warpage and sink defects with the help of rapid heat cycle molding technology. They study the effect of melting temperature, injection time, packing pressure, packing time and cooling time on the warpage with the help of Teguchi and ANOVA. (Gruber et al., 2014)Study visual acuity on the sink markings of injection molded parts and develop CCD images. (Rathi, Salunke, 2012)consider the parameters of injection pressure, mold closure speed, mold pressure, rear pressure and short shot defect in the study of the injection molding process. (Raos & Stojsic, 2014)studied the effect of injection speed and injection pressure of two processing parameters on the tensile strength of the plastic molded component. He did his analysis on the polyethylene content in plastics. They showed that

injection pressure was an important factor influencing tensile content and that injection speed did not affect tensile strength. (Islam et al., 2013)studied the effect of pressure factors on the tensile strength of metal injection molding material. They found that as the pressure increases, the tensile strength of the molded part of the metal increases. (Li et al., 2007) studied the effects of processing parameters on the presence of weldline by the Taguchi experimental design method. Welders are obtained from the right door of the copy machine built with three gates. Images of mold products are taken with digital cameras. They are considered to be the major factors influencing the strength of the material polypropylene, such as the melting temperature, injection pressure, and injection speed. They showed that injection speed is a major factor in the visibility of weld lines. (P. Zhao et al., 2020) .This review introduces methods and strategies on the sensing, optimization, and control of intelligent injection molding and summarizes recent studies in these three areas. (Q. Wang et al., 2019). An experimental work is carried out to study the effect of the micro injection molding parameters on the product weight in this paper. (Park & Dang, 2017)This work introduces a conformal cooling channels applied in a medium-size injection mold that makes an automotive part. We improved an existent mold in order to reduce the cycle time and improve the quality of molded part. (Chen et al., 2018)This article presents a method of efficiently designing a manufacturing process for injection molding by determining the optimal Pareto Set of control factor settings; here the seare the value soft helmet temperature, packing time, packing pressure, and cooling time of the molding machine. (Elduque et al., 2018)The importance of deeply analyzing the energy efficiency of the manufacturing process has been discussed in this study. (Yu et al., 2020)The numerical calculation is carried out by combining the viscoelastic constitutive equation White-Metzner and the fiber orientation model iARD-RPR and then verified by experiment. (Siregar et al., 2017)This paper present the design and development of an injection moulding machine for manufacturing lab that have features of low cost, bench top size, and have similar proses as in commercial injection moulding machine. (Wibowo et al., 2019)The results of the study of pure ABS recycling with recycle stated that the parameters of the melting temperature, injection pressure and holding pressure affect the optimal value of a result. (Lou & Xiong, 2020)The MU viscosity model was established based on the ultrasonic energy, the characteristic micro dimension, and the molecular chain length. Ultrasonic microinjection molding experiments were performed using microgrooves with different flow length ratios.

1. RESULT AND DISCUSSION:

Most researchers have studied the injection molding process with different process parameters, different materials and different mathematical techniques. Some of them are listed below:

Table .1 Parameters and responses

S.No.	Paper title	Year	Parameters	Material	Responses
1.	General frameworks for optimization of plastic injection molding process parameters	**2014**	Melt temperature, mold temperature, injection pressure, injection time, packing pressure, packing time etc.	Polycarbonate	Warpage, clamping force. tensile strength, residual stress, cooling time
2.	Optimization of Injection Moulding Process using Taguchi and ANOVA	**2013**	Melt Temperature, Injection pressure, cooling time	-	Tensile Strength
3.	Analysis Of Injection Moulding Process Parameters	**2012**	Injection pressure, mould closing speed, mould pressure, back pressure	PC and ABS Blend polymer (PC/ABS) made by Chi- Mei Company (Taiwan)	Warpage
4.	Warpage control of thin-walled injection molding using local mold temperatures	**2015**	Mold temperature behavior of filling With Mold flow software	Reprocessed ABS polymer is used	Warpage
5.	Effect of reprocessing on shrinkage and mechanical properties of ABS and investigating the proper blend of vergin and recycled ABS in injection molding	**2014**	Young's modulus	Carbon steel AISI 1050 used as a Mold material and ABS used as plastic material used	Warpage
6.	The use of Taguchi method in the design of plastic injection mould for reducing warpage	**2007**	Melt temperature (240-900C),Filling Time (.1-.5sec.), Packing pressure, (C 60-90) Packing Time(.6-1)	PP material with40% calcium carbonate	Warpage

7.	The impact of process parameter on test specimens deviations and their correlation with AE signals captured during the injection moulding cycle	**2013**	Cooling time (6- 10 sec),Packing time (3-5sec), Packing pressure (300-500 bar) ,injection pressure (1000-1200 bar), injection speed (40-50 mm/sec), Melt temperature (230-2400C)	Polyacetal POM C9021	Shrinkage and warpage
8.	Comparison of the warpage optimization in the plastic injection molding using ANOVA, neural network model and Genetic algorithm	**2006**	Mold temperature (60-900C),Melt temperature(120- 2800C),Packing Pressure(60-75 Mpa), Packing Time(10-20sec) Cooling time (9-15 sec)Runner type(Circular, Hexagon, Trpeze,Gate location	PMMA-80 is used	Warpage
9.	A study of the effects of process parameters for injection molding on surface quality of optical lenses	**2009**	Melt temperature (220-2300C), screw speed (5-15 m/min), injection speed (50-90 mm/sec), injection pressure (1100-1300 bar), Packing time (7-13 sec), mold temperature (60-800C), Cooling rate(s)	Phenolic molding compound is shown	Surface waviness, roughness, light transmission
10.	Optimization of plastic injection molding process parameters for manufacturing a brake booster valve body	**2014**	No of gates, Gate size (18.68 mm to 22.86 mm),mold temperature (147.6 - 180.4), resin temperature(85.5- 104.5),switch over by volume filled (69.57-85.03%) ,switch over injection pressure (10.8-13.2Mpa), Curing time (108- 132 s)	Polybutylene terephthalate (PBT)	Resin viscosity, curing percentage
11.	Improvement of injection moulding processes by using dual energy signatures	**2014**	Processing time, power level	Poly propylene	Energy consumption
12.	Application of Taguchi method in the optimization of injection moulding parameters for manufacturing products from plastic blend	**2010**	Injection peed(10.74-10.98),Melting temperature (9.79-12.50), Injection pressure (10.70-11.12),holding pressure(10.48- 11.47),holding time(10.36-11 . 15), cooling tim (10.54- 1.60)	Polypropyle ne	Shrinkage in cm
13.	A principal component analysis model-based predictive controller for controlling part warpage in plastic injection molding	**2015**	Cavity pressure, cavity temperature		Warpage by coolant flow rate and cavity pressure temperature
14.	Optimal cooling design n injection moulding process –A new approach based on morphological surfaces	**2013**	Cooling time, injection time	GE Cycoloy C2950 PC/abs	Warpage, shrinkage, thermal residual stress, sink marks etc.

15.	Finding efficient frontier of process parameters for injection molding	**2013**	Injectiontime (.5- 1.5),injection pressure(100 to 140MPa),packing pressure(80-120 Mpa),Packing time (7.5-12.5)cooling time (14- 24 sec) cool and temperature(20-30), mold open time (4-6 sec),melt temperature(270- 280),mold surface temperature (65-75)	Polyamide PAT considered	Shrinkage and warpage
16.	Simulation and experimental study in determing Injection molding process parameters for thin-shell plasticparts via design of experiment analysis	**2009**	Melt temperature (310- 330),Mold temperature (115- 135),injection Speed (%65-85), Packing pressure (40-45 Mpa)	Polypropylene and polystyrene	Shrinkage and warpage
17.	Parameter study in injection molding process using statistical methods and Invasive WEED algorithm	**2011**	Melting temperature(240-260),Injection Pressure(50-70) ,Packing Pressure (50-70 MPA) ,Packing Time (5-15 sec)	Ultramid B3S (un-reinforced PA6 material)	Shrinkage and Warpage
18.	Optimisation of injection moulded parts by using ANN- PSO approach	**2006**	Mold temperature(40- 80),Melt temperature (250-270),Flow rate (10-80 ,103 * mm3/sec),packing Pressure (25-40 Mpa)	-	Warpage
19.	Back propagation neural network modeling for warpage prediction and optimization of plastic products during injection molding	**2011**	Mold temperature(40- 80), Melt temperature(200- 280), packing pressure(80- 120),Packing time(8-12),Cooling time(15-25)	Polypropylene	Warpage
20.	Reducing the shrinkage in Plastic injection moulded gear by GREY based Taguchi optimization method	**2012**	Melt temperature (200-240),Packing pressure (60- 80) ,Packing time(5- 15), Cooling time (30-50)	Powder material is used	Shrinkage
21.	The use of Taguchi approach to determine the influence of injection-moulding parameters on the properties of green parts	**2006**	Injection speed, mould temperature, material temperature, holding pressure, holding pressure time, Cycle time (15-30 sec)	Polypropylene	Shrinkage
22.	A hybrid of back propagation neural network and genetic algorithm for optimization of injection molding process parameter	**2011**	Mold temperature, melt temperature, packing pressure, packing time, cooling time	-	Warpage and clamp force analysis
23.	Practical application of Taguchi method for optimization processing parameters for plastic injection moulding- A retrospective review	**2013**	Mould temperature, melt temperature, Gate dimension, packing pressure, packing time, injection time, filling time filling pressure, cooling time		Warpage
24.	Development of a smart plastic injection mold with conformal cooling channels	**2017**	Mold Temperature , cooling time, Flow nature, Cycle time, Selective laser melting		Cooling time

25.	Effect of Process Parameters on Repeatability Precision of Weight for Microinjection Molding Products	**2019**	Packing pressure, cavity pressure, mold temperature, injection pressure	Polypropylene(5 090T) (MFI=15g/10min) Formosa petrochemical Corp,Taiwan.	Tensile strength
26.	Intelligent Injection Molding on Sensing, Optimization, and Control	**2020**	Process sensing, process control, Taguchi method ,intelligent method (case based reasoning)		Warpage, shrinkage, mechanical properties, clamping force
27.	Sequential design of an injection molding process using a calibrated predictor	**2018**	Bayestan analysis, melt temperature, packing time, packing pressure, cooling time		Shrinkage
28.	Numerical Simulation during Short-Shot Water-Assisted Injection Molding Based on the Overflow Cavity for Short-Glass Fiber-Reinforced Polypropylene	**2020**	Melt short shot size, water injection delay time, melt temperature, water injection pressure	Glass fiber reinforced polyethylene (SGFPP, Grade Hostacom SB224-1, Lyondell Basell Industries, Germany)	Residual wall thickness
29.	Design and development of injection moulding machine for manufacturing laboratory	**2017**	Flow rate, packing time		Design process
30.	Research of Injection Molding Parameters with Acrylonitrile Butadiene Styrene Composition Recycled Against Mechanical Properties	**2019**	melting temperature, injection pressure, holding pressure	Recycled ABS combined with pure material on 10%:90%, 20%:80% and 30%:70%	Impact strength and tensile strength

Since raw materials are scarce and expensive, and energy costs are also increasing, mold design strategy should reduce costs and reduce resource consumption. Contraction, warpage, sink marks, and weld lines are the four most challenging defects in the injection mold. In many cases, their formation is inevitable, especially for complex geometric components

2. CONCLUSION

There is a lot of effort in this area. But some of them have been successful, so this area needs special attention. This is because we know that many errors are caused by processing parameters based on this study. So the production control of processing parameters is necessary for the product. . Based on the above table we find that each researcher focuses mostly on warpage and contraction. They also pay attention to the sink marks. But some researchers pay attention to weld lines and tensile strength. We have found from above that the study of recycling of plastics is necessary for the benefit of the community. It requires environmental friendly, recyclable material identification.

Therefore processing in this area should be done. So in order to increase the production of quality-based plastic products, studies on other process parameters are needed, which should be free of flaws.

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