Minimization of Plastic Injection Molding Defects Using Hot Feeding System

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Abstract: ***This objective of this thesis was to development and analysis a development and analysis of "Minimization the defect of product made by the injection molding by both cold and hot feeding system". A literature review concern available experimental techniques for injection molding products was presented. But we used Autodesk simulation moldflow 2014 MFA is complete suites for definitive, validating, optimizing, analyzing plastic parts, and mold design in plastic injection molding. In this we used some of the steps for calculation of the work. Firstly import a CAD model and then mesh the cad model with software then material we used to form the product is GENRIC PP(polypropylene) then choose the simulation type selection (cooling quality) and then we set the process parameter like mold temperature, melt temperature, injection pressure, cooling time, runner system, (hot and cold) and after that we get the results of our product by using DOE (design of experiment) technique by Taguchi Method.We have made some of the result tables based on the software analysis***

Keywords: Autodesk mold flow advisor, taguchi method, hot flow, cold flow, Analysis of variance (ANOVA).

1. Introduction

Injection moulding is a manufacturing process for producing parts by injecting material into a mould. Injection moulding can be performed with a host of materials, including metals, glasses, elastomers, and most commonly thermoplastic and thermosetting polymers. Material for the part is fed into a heated barrel, mixed, and forced into a mould cavity where it cools and hardens to the configuration of the cavity. The manufacturing of thin-wall products is very important for the automotive industry because thinner components allow considerable overall weight savings, beneficial effects on the reduction of fuel consumption and improvement of environmental impact. In addition, the decrease in thickness allows significant cuts in production costs due to less material being used and shorter cycle times. All materials used for automotive applications such as metals, foams, plastics and composites are investigated in order to achiever eductions in product thickness. In particular, thin-wall fabrication of plastic products allows the realization of smaller and lighter parts which can withstand day-to-day use while maintaining their aesthetic appearance.

2. Literature Survey

B. Ozcelik and T. Erzurumluused the Computer-aided analysis and engineering softwares for the analysis of plasticinjection process, one of the commercial computer-aided engineering software is the MoldFlow Plastic Insight. In this study, best gate location,filling and flow, warpage applications have done for minimum warpage of plastic part with this tool. Process parameters such as mold temperature,melt temperature, packing pressure, packing time, cooling time, runner type and gate location are considered as model variables. The effects ofprocess parameters for thin shell plastic part were exploited using design of experiment (DOE), Taguchi orthogonal array and finite elementsoftware MoldFlow (FE). The most important process parameters influencing warpage are determined using finite element analysis results basedon analysis of variance (ANOVA) method.

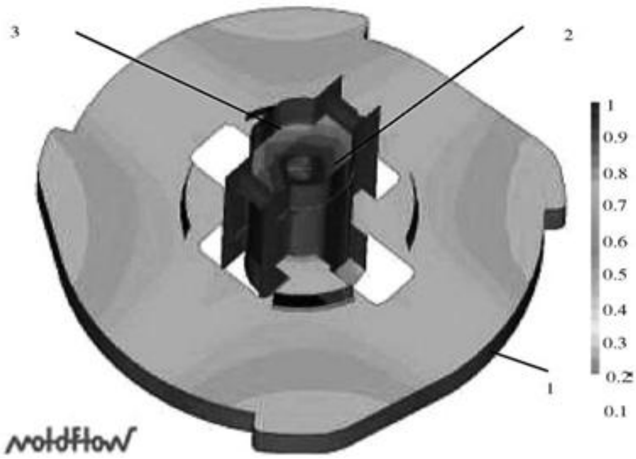

Figure 1: The gate location for analysis

R. Spina has investigated the product fabrication by evaluating different hot runner systems, gating and product configurations. The SIM phases for the production of parts with these complex geometries have been studied in order to assess the product manufacturability and process feasibility through finite element (FE) analyses. FE analyses are used to study the filling, post-filling and cooling phases of the injection process. Using the FE system, a deeper investigation of thermal stress and strain distributions was performed to predict defect presence in the final product

3. Methodology

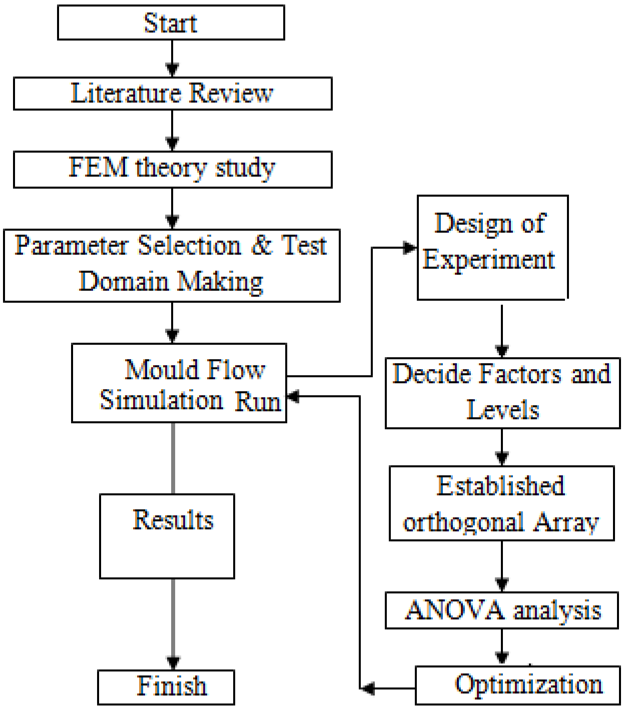

Figure 2: Simulation flow chart

4. Material and Method

In order to achieve the optimization of the plastic injection molding process of the rectangular lid and the roof tile with minimum residual stress and minimum shrinkage, respectively, there are many tasks that have to be undertaken in these many cases (Cold and Hot Runner system). First, the simulation models of the rectangular lid and the roof tile are both created with mesh geometry by MFA 2014 and run for the results. Thermoplastic material is used in this study and PP (POLYPROPYLENES) is one of the general plastic which is used for injection molding process and in this study this family martial named **Generic PP** is used. All required thermal and mechanical properties are show in table 3.1 respectively.

Table 1: Summary of properties of PP

S.NO.	*Properties*	*Value*
1	Family Name	POLYPROPYLENES (PP)
2	Material structure	Crystalline
3	Mold Temperature Range	20^{o} -60^{o}C
4	Melt Temperature Range	200^{o} -260^{o}C
5	Specific Heat (C_p)	2740 J/kg C
6	Elastic Modulus	1340 MPa
7	Poisson's Ratio	0.392
8	Shear Modulus	481.3 MPa
9	Density	0.89163g/cm^3
10	Thermal conductivity	0.164 W/m-C
11	Viscosity	See Figure no.7

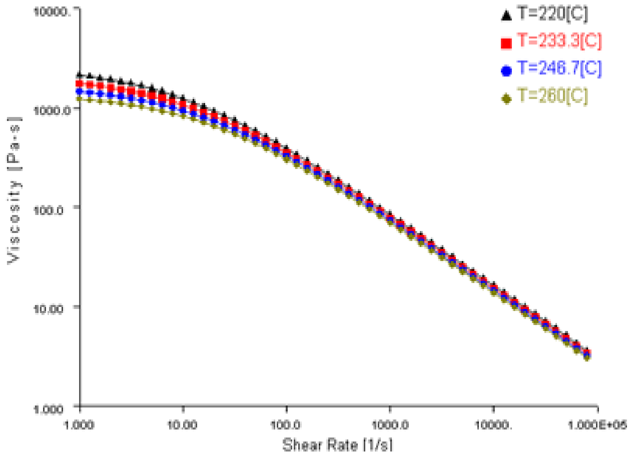

Figure 3: Viscosity rate

5. Result

Signal to Noise Ratio Analysis

In current study taguchi method is used for signal to noise ratio analysis for both cases. Signal to noise ratio is chosen “smaller is better” for current study. For current study static design of taguchi is analysis and all formulas are according to this methodology. Formula for smaller is better is given in following section.

Smaller is better: The single to noise (S/N) ratio is calculated for each factor level combination. The formula for the smaller is better S/N ratio using based 10 log is:

$$S/N = -10 * \log\left(\sum (y^2)/n\right)$$

Where y = response for the given factor level combination and

n= number of response in the factor level combination

Final results from FEM solver is presented in table 5.2 and table 5.3 for hot runner and cold runner system. A special comparison is performed between these two cases are shown in next section and are shown in figure

Table2: L16 Orthogonal Array with Result Parameter of Hot Runner

No. of Exp.	*P1 (Mold Temp)*	*P2 (Melt Temp)*	*P3 (Inj. Pr. %)*	*P4 (Packing Pr. %)*	*Fill time*	*shrinkage*
1	30	220	140	75	0.842	8.503
2	30	230	150	80	0.8267	8.387
3	30	240	160	85	0.6994	7.631
4	30	250	170	90	0.6961	7.561
5	40	220	150	85	0.9315	7.871
6	40	230	140	90	0.8083	7.237
7	40	240	170	75	0.8297	8.186

Table3: L16 Orthogonal Array with Result Parameter of Cold Runner

No. of Exp.	*P1 (Mold Temp)*	*P2 (Melt Temp)*	*P3 (Inj. Pr. %)*	*P4 (Packing Pr. %)*	*Fill time*	*shrinkage*
1	30	220	140	75	0.9012	8.689
2	30	230	150	80	0.8829	8.575
3	30	240	160	85	0.7452	7.83
4	30	250	170	90	0.7421	7.74
5	40	220	150	85	0.9933	8.008
6	40	230	140	90	0.8611	7.415
7	40	240	170	75	0.8841	9.289

According to figure hot runner system has less volumetric shrinkage values than cold runner system and that's why hot runner system is mostly used in industry. The figure is generated between design points created by DOE and volumetric shrinkage of plastic product.

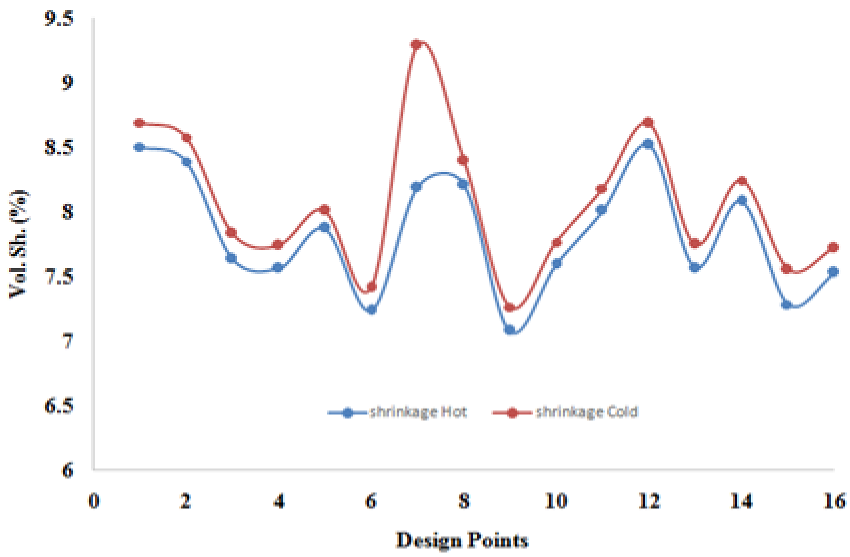

Figure 4: Vol. Sh. Comparison between hot and cold runner system

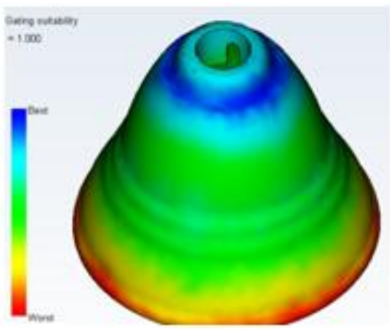

Figure 5: Gating Suitability of the product

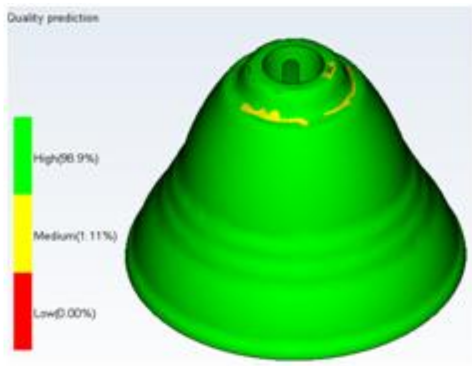

Figure 7: Confidence fills of the mould material

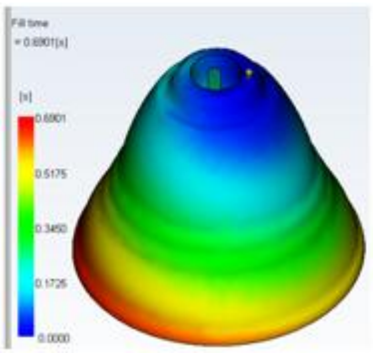

Figure 6: Fill time in second

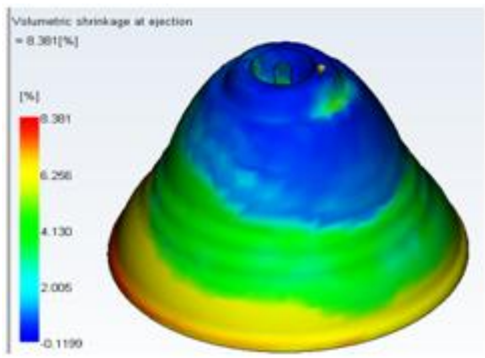

Figure 8: Volumetric shrinkage at ejection of the product in %

6. Conclusion

The aim of this study is to minimization of plastic injection molding defects using hot and cold feeding system by FEM simulation results for mold flow plastic injection process. This study utilizes L16 orthogonal array for data analysis for two different design of runner system (hot and cold runner). In this study Analysis of variance (ANOVA), and regression analysis was main key techniques to show response and factor relations strongly with each other

References

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