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DESIGN AND DEVELOPMENT OF PLASTIC INJECTION MOLDFOR AUTO COMPONENT

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ABSTRACT

Injection molding is one of the most important processes in the plastic manufacturing industry. More than one-third of all plastic materials are injection molded, and the mold is one of the main components in the injection molding process. Design for the 'plastic' component part is followed by the Design for its mold. The intricateness for the geometry over is features offer a challenge to the mold Design Engineer. The characteristics of the material and the associated process of manufacturing further underline the need to undertake the assessment of 'Design' for the mold in a critical manner and outlook. This dissertation work deals with design of plastic injection mold for Housing retainer. This dissertation work shall focus on the Design aspects of the mold.

KEYWORDS: *Plastic Injection Molding, Mold flow,. fill time, weld line, warpages, sink mark.*

I. INTRODUCTION

The main concept of plastic molding is placing a polymer in a molten state into the mold cavity so that the polymer can take the required shape with the help of varying temperature and pressure. Injection molding is perhaps the most common and important of all plastic processing processes. The process is extremely versatile, and can produce very complex shaped parts, with the use of multi-sided molds. Even parts with metal inserts can be produced. While injection molding dies are expensive to produce, each die can be used to make tens of thousands of components at very rapid rate, so that per-part cost is very low.

II. LITERATURE REVIEW

For this entire research work following literature is reviewed and some conclusions are made through this literature review;

Lu *et al*[1]Investigated an adaptive decoupling temperature control for an extrusion barrel in a plastic injection molding process. The decoupling control design was derived based on the minimization of a generalized predictive performance criterion. The set-point tracking, disturbance rejection, and robustness capabilities of the proposed method can be improved by appropriate adjustments to the tuning parameters in the criterion function. Through the experimental results, the proposed method has been shown to be powerful under set-point changes, load disturbances, and significant plant uncertainties.

Erzurumlu*et al*[2]Investigated on minimization of the warpage and sink index in terms of process parameters of the plastic parts have different rib cross-section types, and rib layout angle using Taguchi optimization method. Considering the process parameters such as mold temperature, melt temperature, packing pressure, in addition to rib cross-section types, and rib layout angle, a series of mold analyses are performed to exploite the warpage and sink index data. Confirmation analysis test with the optimal levels of process parameters are carried out in order to demonstrate the goodness of Taguchi method.

From this, it can be concluded that Taguchi method is very suitable to solve the quality problem occurring the injection-molded thermoplastic parts.

Jianga*et al* [3] investigated an implicit control volume finite element method for simulation of injection molding, the time steps were controlled for both flow and thermal simulation by local flow information, and then the computing complexity analysis was conducted. The implicit scheme was based on updating the melt–air interface.

Hassan *et al*[4]Investigated gate location is among the most critical factors in achieving dimensionally accurate parts and high productivity of the molding process. To investigate the effect of the gate location on the cooling of polymer by injection molding, have carried out a full three dimensional time-dependent analysis for a mold with cuboids-shape cavity having two different thicknesses. The cooling of the polymer material is carried out by cooling water flowing inside six horizontal circular channels.

Chen *et al*[5]Optimal process parameter is important parameter influences productivity, quality, and cost of production in the plastic injection molding (PIM) industry. Previously, production engineers used either trial-and-error method or Taguchi's parameter design method to determine optimal process parameter settings for PIM. However, these methods are unsuitable in present PIM because the increasing complexity of product design and the requirement of multi-response quality characteristics. have proposed an approach in a soft computing paradigm for the process parameter optimization of multiple-input multiple-output (MIMO) plastic injection molding process

Baltussen*et al* [6]Studied the viscoelastic flow front instability in the full non-linear regime by numerical simulation. A two-component viscoelastic numerical model is developed which can predict fountain flow behavior in a two-dimensional cavity. The extended Pom-Pom (XPP) viscoelastic model is used. The level set method is used for modeling the two-component flow of polymer and gas. The difficulties arising from the three phase contact point modeling are addressed, and solved by treating the wall as an interface and the gas as a compressible fluid with a low viscosity. The resulting set of equations is solved in a decoupled way using a finite element formulation.

Rajalingam*et al*[7]Investigated the process parameters which will affect the shrinkage defect on a plastic cell phone shell component. The process parameters selected in this study are the mould temperature, injection pressure and screw rotation speed. The Design of Experimental (DOE) approach was used to investigate and identify the optimal moulding process parameters setting. Statistical results and analysis are used to provide better interpretation of the experiment.

Ahamed*et al*[8]Have worked on Designing and Optimizing the Parameters which affect the Molding Process using Design of Experiment In injection molding the processing condition have critical effect on the finished molded products. the effect of various factors like Melt temperature, Injection pressure, and Cooling time are selected for the experiment. A Plastic product polycarbonate plastic material was taken for the experiment with optimal injection molding conditions and its tensile stress test was conducted in order to minimize defects and increase its strength.

III. PROBLEM DEFINITION

The sponsoring company being an ESP (Engineering Service Provider) support assignments in the domain of Design & 'Finite Element Analysis '.Further with the competency in Die / Mold Design .It is working on 'Automotive 'projects for design of Plastic injection mold. One such assignment offered by the client specters the use of thermoplastic as the raw material that would need at least two cavity mold for meeting the demand. The component design received from the previous stage need to be studied further for evolving the 'mold' design .The potential problem areas in the form of defects in the molded component should be minimized through on the part of the mold Design Engineer.

IV. OBJECTIVES

1. Use the geometry for product as input to mold design
2. Calculate the tonnage for the given mold
3. Determine mold layout by specifying the gate location, sprue diameter, gate thickness , gate location or other design parameters for flow analysis
4. Using Mold Flow to simulate the flow and finding fill time, weld line, warpages, sink mark etc.
5. Using the above evaluation for determining mold design

6. Validation through trials and testing

Software Used:

CATIA V5 is used for designing CAD model
Moldflow is used for Flow simulation.s

Mold flow analysis result:

1) Fill Time Analysis Result:

Fill time is the time taken to fill up the part inside the cavity it is also to show how the plastic material flows to fill the mold. This result shows the flow path of the material through the part by plotting contours which join regions filling at the same time. From that we know that the short shot part will be displayed. From that result one can also understand how the weld line and air trap will form.Fill Time Analysis Result is shown in fig.1

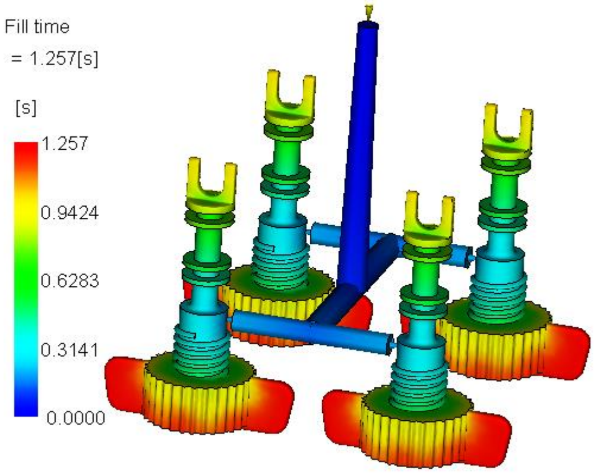

Fig 1. Fill Time Analysis Result

2) Injection Pressure:

The colors at each place on the model represents the pressure at the place on the model. Two colures show the highest pressure (red) and lowest pressure (blue) as shown in fig 2.

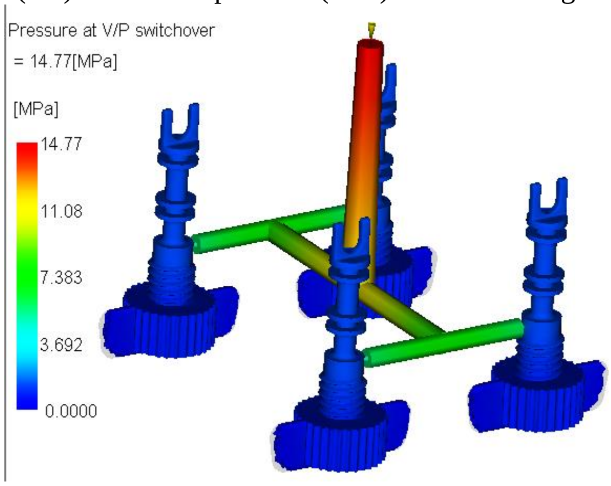

Fig 2. Injection Pressure

3) Temperature at Flow Front:

The flow front temperature result uses a range of colors to indicate the region of lowest temperature (colored blue) through to the region of highest temperature (colored red). The colors represent the material temperature at each point as that point was filled. The fig 3 shows the changes in the temperature of the flow front during filling.

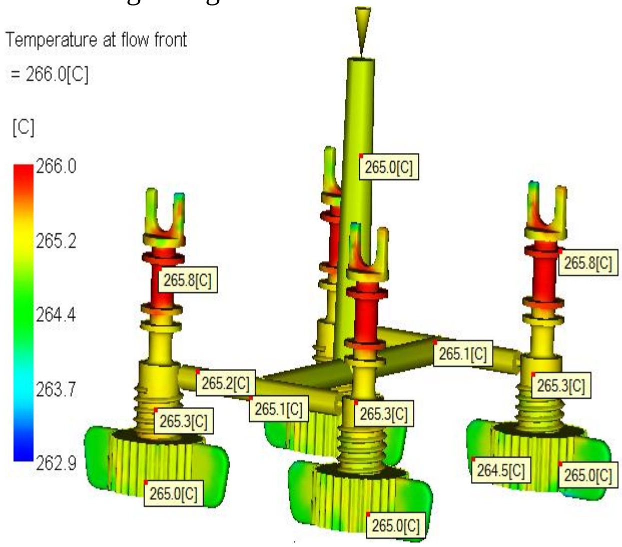

Fig 3. Temperature At Flow Front

4) Sink Marks Analysis Result:

The Sink mark as shown in fig 4 is an indication of the potential shrinkage due to a hot core. It is calculated for each element at the instant when local pressure has decayed to zero during the packing stage, and reflects how much material is still melt and left unpacked.

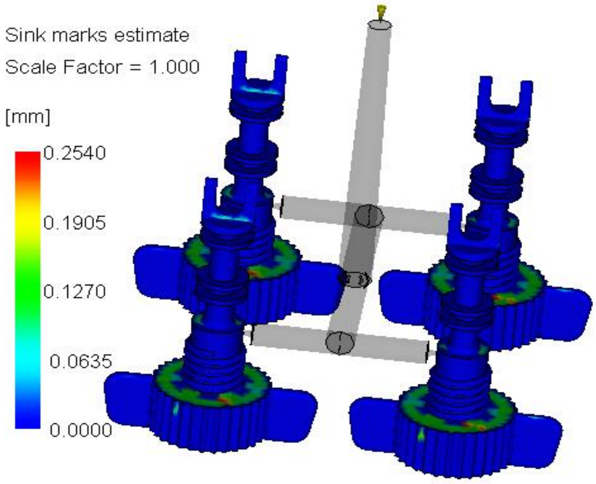

Fig 4. Sink Marks Analysis Result

5) Weld Lines Analysis Result:

When a weld line forms, the thin frozen layers at the front of each flow path meet, melt, and then freeze again with the rest of the plastic. The orientation of the metal at the weld is therefore perpendicular to the flow path. These are places where two flow fronts have converged. The presence of weld may indicate a weakness or blemish. Weld Lines Analysis Result is as shown in fig 5

Weld Lines

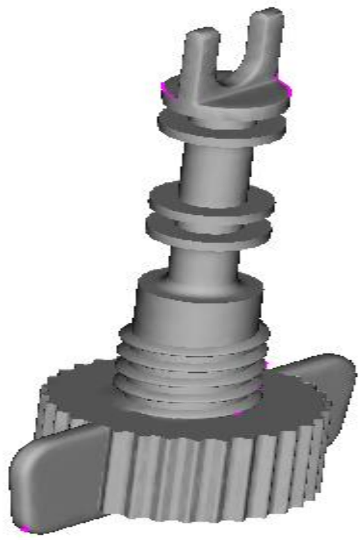

Fig 5. Weld Lines Analysis Result

6) Air Traps Analysis Result:

Figure 6shows the air traps result after analysis. The small blue bubbles are showing the air traps in the parts. Air traps result shows the regions where the melt stops at a convergence of at least 2 flow fronts or at the last point of fill, where a bubble of air becomes trapped.

Air Traps

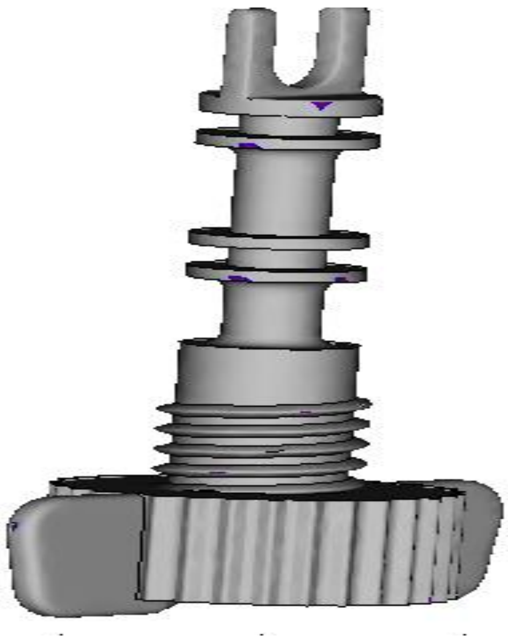

Fig 6. Air Traps Analysis Result

7) Warpage analysis result:

Warpage is change of shape of the part after it has been ejected from the injection mold. it is also known as deformation. The fig 7 shows the displacement of component in overall direction. The displacement value is the combination of shrinkage and warpage.

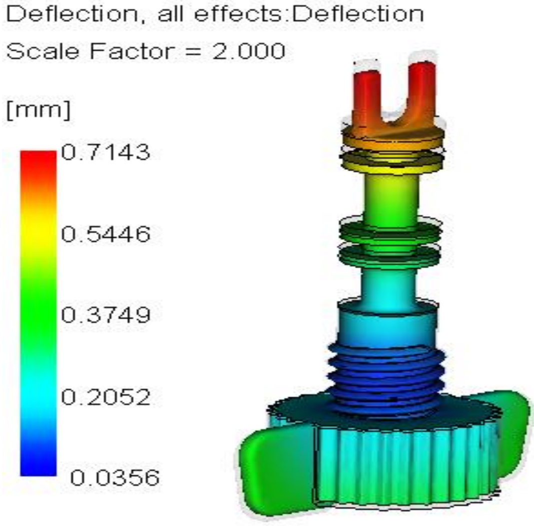

Fig 7 Warpage analysis result

V. EXPERIMENTATION

From the simulation and analysis, Mold flow software provides sufficient information regarding its filling time, injection pressure and pressure drop. With these results, users canavoid the defect of the plastic in actual injection such as sink mark, weld line, air traps, and warpage. The analysis will also help the mold designer to design a perfect mold with minimum modifications and which will also reduce the mold setup time. The design will be validated by producing the component with the help of the designed mold without affecting the component's functionality. Flow of plastic will be observed. Dimensional accuracy will be measured and checked with the specified dimensions. Visual and actual inspection will be done while attempting to identify the defects. Further, the component will be checked for fitment in the sub-assembly.

VI. CONCLUSION

1) The Design of the Mold and the processing parameters has an influence over the quality of the component produced. hence while designing a mold, the designer needs to take many factors into account such as material, type of gate selection and position of gate, feed system details like gate size, sprue dimension & runner dimension and various defect such as warpage, sink mark, air traps and weld line. etc

2) Mold flow analysis was carried out on the component and feed system of injection molding tool. This gave satisfactory results and the same was confirmed from analysis such as injection pressure, fill time, flow front temperature, quality of fill, weld line, air traps etc. The results indicated that the injection molded components could be manufactured with minimum molding defects.

3) Thus mold flow software is a preventive and corrective tool, helps the engineer to analyze the process to decrease the cycle time and to improve the Quality of the Product.

REFERENCE

[1] Chi-Huang Lu, Ching-Chih Tsai "Adaptive decoupling predictive temperature control for an extrusion barrel in a plastic injection molding process" IEEE transactions on industrial electronics, vol 48, october 2001 pp 968-975

[2]Tuncay Erzurumlu, Babur Ozcelik "Minimization of warpage and sink index in injection-molded thermoplastic parts using Taguchi optimization method" Materials and Design vol 27, March 2005 pp 853-861

[3] Shunliang Jianga, Zhiguo Wang, Goufa Zhou, Weimin Yang "An implicit control-volume finite element method and its time step strategies for injection molding simulation" Computers and Chemical Engineering vol 31, December 2006 pp 1407-1418

[4] "Hamdy Hassan, Nicolas Regnier, Guy Defaye" A 3D study on the effect of gate location on the cooling of polymer by injection molding" International Journal of Heat and Fluid Flow vol 30, June 2009 pp 1218-1229
[5]Wen-Chin Chen a, Gong-LoungFub,c, Pei-HaoTaib, Wei-Jaw Deng d"Process parameter optimization for MIMO plastic injection molding via soft computing" Expert Systems with Applications vol 36, 2009 pp 1114–1122
[6] M.G.H.M. Baltussen, M.A. Hulsen∗, G.W.M. Peters, "Numerical simulation of the fountain flow instability in injection molding" Journal of Non-Newtonian Fluid Mechanics vol 165, March 2010 pp 631-640
[7] S. Rajalingam, Awang Bono and Jumat bin Sulaiman"A statistical experimental study on shrinkage of injection-molded part" International Journal of Humanities and Management Sciences (IJHMS) Volume 1, Issue 1, 2013 pp 2320–4044
[8] Dr. A. Riaz Ahamed, Dr. A. K. Shaik Dawood, R. Karthikeyan "Designing and optimizing the parameters which affect the molding process using Design of Experiment" International Journal of Research in Mechanical Engineering Volume 1, Issue 2, October-December, 2013 pp.116-122
[9] Mr. Anandrao B. Humbe, Dr. M.S. Kadam "Optimization Of Critical Processing Parameters For Plastic Injection Molding For Enhanced Productivity And Reduced Time For Development" International Journal Of Mechanical Engineering And Technology (Ijmet) Volume 4, Issue 6, Nov - Dec (2013), pp. 223-226
[10] Mr. Prashant A. Dhaware, Prof. M A. Sayeed, Prof. A.M. Kalje "Design and Analysis of Injection Molding Die for Churner-A Review" International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 3, Issue 4, April 2014 pp 292-295
[11]Technical Directory on design and Tooling for plastics, CIPET, Guindy , Chennai

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