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CHARACTERIZATION & OPTIMIZATION ON AIR VENT LOCATION IN INJECTION MOLD DESIGN BY USING MOLD FLOW ANALYSIS

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Abstract

Injection molding parts has wide use in automotive applications that need to have good quality and durability. For which product design followed by tool design plays an important role. In tool design each & every element should have well in design so that better injection molded parts could be molded with minimum defects. For better injection mold design Mold flow analysis is used in this experiment & particularly to predict the air vent location. By using the Mold flow analysis results the tool design get optimized & manufactured, that saves cost & time and also gives concrete information to tool designers to optimize the injection mold design that helps in producing quality molded parts.

Keywords—Injection mold design; Mold-flow analysis; air vent; gate location; injection molding process parametrs

INTRODUCTION

The automotive industry produces most of injection molded parts those used widely with tough compete in market. So as the parts to produce with good quality and durable and with less cost & time. Injection molding process facilitates the plastic part to produce with injection molding machine with help of injection mold. Mold-flow analysis represents the most comprehensive suite of definitive tools for simulating, analyzing, optimizing, and validating plastics part and mold designs. Mold-flow analysis (MFA) software which is an integrated suite of analysis tools that utilize CAD files and apply advanced Finite Element Analysis (FEA) techniques to quickly and easily enable a virtual “what if” design environment before initiating mold construction. MFA provides in-depth part/mold design and process parameter optimization [14]. It gives detailed information about the processing conditions Mold flow simulation enables the tool designer to decide & incorporate the correct tool design elements such as gate location, weld line, air trap position and increase the quality and efficiency of the process for the particular plastic part and finally reduces machine setup time [1, 9, 10, 11]. It is important to note that injection molding products required high precision as well as quality part. Therefore, monitoring and control of quality part during production is the need of today’s market [17]. The injection molding part design depends to a great extent on experience & intuition. The mold-flow analysis inputs helps substantial improvements resulting in reduced rework and time savings for the entire mold design process [2]. On account of manufacturing defects such as weld line, sink mark, air traps or voids, short filling could be predicted from simulation results [3, 19, 20]. Mold-flow analysis used to check injection molding process parameters like fill time, shrinkage, sink marks, weld lines, clamping force, and air traps which in result avoids conventional trial-and-error methods & minimizes molding defects that leads improved part quality [4, 5, 6, 7, 8]. As the analysis was done to find best gate location, accurate fill time and also to find air traps [13]. The most difficult issue is to predict the correct locations of weld lines and the air traps during the tool design stage, but by taking the simulation results we could provide these elements, so as to reduce air traps & mold trials [12]. This analysis provides a prediction of the void location and an insight on the appropriate parameters to minimize void problem [18].

MATERIALS AND METHODOLOGY

The plastic raw material PA-66 with 30 % glass filled is used for this work. The part need to be optimized in different areas such as injection molding processing, part design & tool design, etc., so the 3D CAD model is developed from the existing CAD data and then the part design optimized through the Mold-flow analysis and followed by tool design optimization by taking best injection molding process parameters for the particular polymer characteristics.

EXPERIMENTS & OPTIMIZATION

The part design get optimized from the mold-flow results and the CAD data is developed by using CAD software. The CAD data taken to mold-flow analysis software and get simulated. All the injection molding parameters are taken from BASF's product information sheet as, raw material: A3WG6 (PA-66-GF-30 %), injection pressure: 180 MPa, melt temperature 290 ^{0}C, mold temperature 85 ^{0}C.

A. Analysis of the part

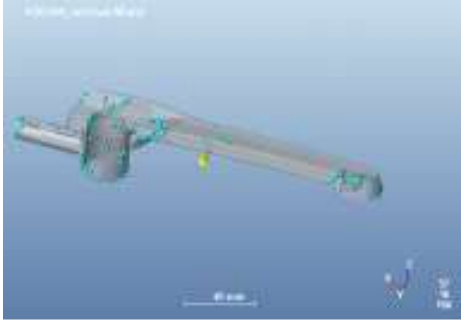
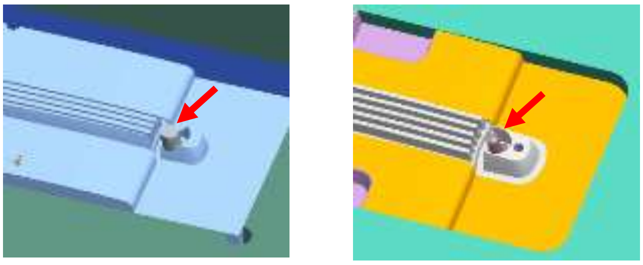


Fig. 1 | Mold-flow analysis results for air trap location

Number of analysis simulation has carried out with different gate locations for the part. The simulation result gives the complete input for sink marks, fill time, injection pressure, pressure drop, quality prediction, weld lines, air trap, cooling quality, etc. In this research we focus on the air trap location. This analysis provides a prediction of the void location and an insight on the appropriate parameters to minimize void problem [18]. The MFA result indicates the presence and location of air traps in the filled part model. These are places where two flow fronts have converged and wall thickness could be more [14]. The green dots on the plastic part as shown in fig. 1, indicates the air may trap at that particular point, which may create shot filling in part during injection molding. Hence it is need of special attention should give on those areas to release air during cavity filling by providing air vent channels or holes in tool design. The simulation result as shown in fig. 1, are the most prone to void traps. Hence it could be avoided also by reducing the wall thickness of those areas.

B. Tool design Optimization



(a) no vent release element (b) core pin with vent channel

Fig. 2 | Tool design optimization for air release

Tool design plays an important role on injection molding part quality. The analysis helps the tool designer to design a perfect mold with minimum modifications and which will also reduce the mold setup time. With this analysis and simulation, it will help to reduce time and cost [16]. From this simulation results and the physical part surface sink marks, it is vital need of vent location underneath the clamping pin of the part as shown in fig. 2. The air vent release is given by a little flat surface at two sides of the core pin as shown in fig. 2(a). The air passage should be given as a minimum opening, so as during filling the melt could not able to come out to form unwanted flash on part [15].

RESULTS & DISCUSSIONS

A brief simulation done with mold-flow analysis software and number of experiments has done by altering the feeding point and the part geometry. Thin wall sections are less prone to air traps or voids [15]. The best choice of gate location & size is obtained from the analysis and subsequently implemented in tool design. When converging flow fronts surround and trap a bubble of air, it could be avoided by changing part wall thickness, polymer gate locations & finally air release passage to get defect free parts. Most of the air traps are located on the surface, which can be removed by providing suitable air vents in the mold [14]. It could be identified on void trapping simulation results from the extensive list of process and design parameters, including filling time, mold temperature, different gap sizes above and under the die. These insights can be used as upfront guidelines to predict and reduce potential product defects and failures [18]. The simulation results shown that it is better to provide air vent elements in the core side rather in the cavity. As the cavity has class-A surface that should not to be damage. The pin provided, as shown in fig. 2 (b), with vent channels serves multi benefits such as (i) easy to manufacture, (ii) easy to maintain, (iii) easy to control the vent channel dimensions, (iv) it also facilitates easy of ejection and less force is required, as air release ensures no vacuum will be created.

CONCLUSION

After conducting the mold flow analysis on this injection molding part we may conclude as follows;

(a) Identification of proper location for air vent provision during tool design itself.
(b) Make adequate provision for vent in the areas of mold that fill last.
(c) Avoid a large thickness ratio in part, to minimize the converged flow front.
(d) Air vent facilitates better flow of melt during filling inside cavity.
(e) Air vent avoids short filling of part.
(f) Air vent helps easy of ejection.
(g) Comparatively less injection pressure is required to fill inside the cavity, if adequate vents provided at correct locations.

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