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Influence of Gating System for Strut Bearing Component by Simulation Flow Analysis Using Solid Works Software

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A B S T R A C T

Optimization of cycle time, avoid scrap and to improve productivity of process. this paper describe the influence of gate location and size through analysis carried out by solid works 2018 software to reduce the fill time, scrap and autodegating. The gate connects the runner to the mould cavity, making it an essential flow path in the feed system. Sprue, runner systems, and gates, the channels through which the polymer flows, make up the injection moulding feed system. Cycle time optimization, scrap avoidance, and manual interface play a crucial role in enhancing process productivity while ensuring that the quality of the finished product is not compromised in the manufacture of plastic parts. A created mould and an injection moulding machine were used to test the new, optimized gate position. The new optimized parameter (pressure of 40 MPa and a temperature of 207 °C) was tested in software while designing the mould.

Keywords: Plastic Injection Mould, Solid Works, Feeding Unit, Nylon6, Gate Contribution.

1.INTRODUCTION

Injection moulding is the most popular process for producing plastic products. They are very popular due to their versatile applications in automobiles, day to day applications, medical field and many more. The present work is the design of the strut bearing which is a part of suspension assembly of Renault automobile. During injection moulding, in order to evaluate mould flow knowledge, a 3D model was created with solid works 2018 software which was loaded into an IGS file. The3D model was meshed, and assigned with material and the best gate location was determined. The criteria of processing are established using the conventional trial-and-error method. As a result, to achieve the best outcome, proper outputs were considered for satisfactory results for all parameters, thereby deciding to go ahead with the design and manufacturing.

2. METHODOLOGY

Specific planned procedures or techniques used (identify, select, process, and analyze information) to design an injection mould to achieve the necessary result is called Methodology.

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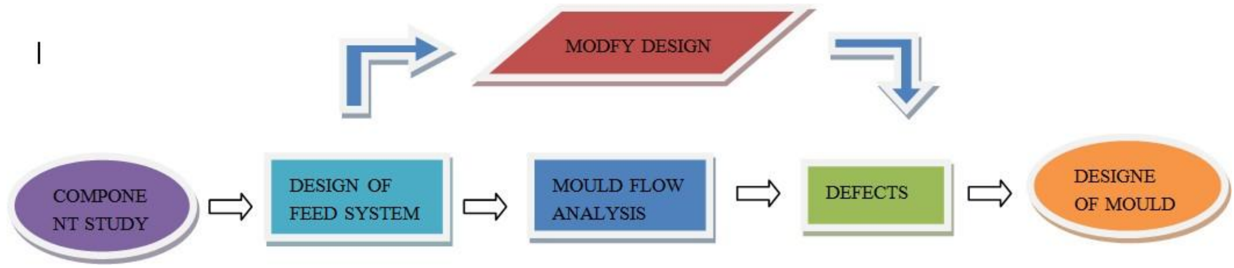

Fig. 1 – flow chart of methodology.

3.COMPONENT STUDY

The component is strut bearing used in the suspension of car assembly. It allows torsional moment of the shock absorber with low friction and positive influence on the steering of the vehicle. Nylon 6 with 30 % glass filled is used as the component material. The component is black in colour. To make the component of the desired colour, black master batch is used. The component's volume is 107.06 cm^3. The total weight of the components is 143.48 g. Thecomponent has a density of 1.34 g/cc. The melting point is 270 °C. The component 3D model is shown in Fig.2.

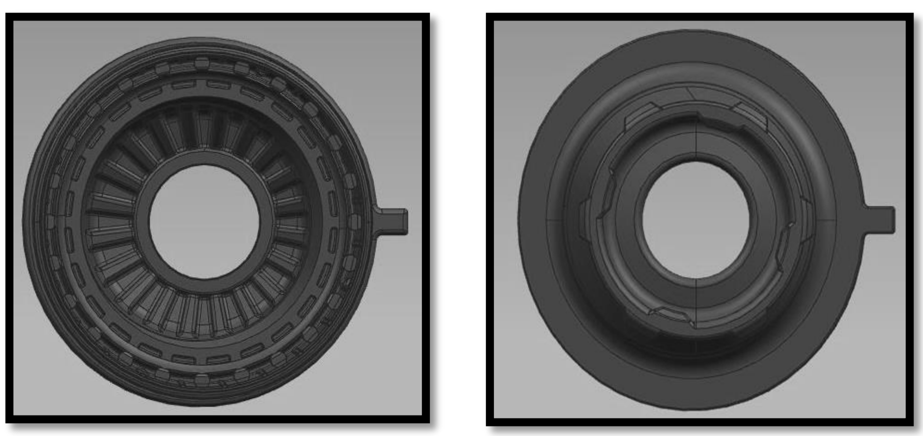

Fig. 2- 3D model of Strut Bearing

3.1 Design of the tool

Calculations are made to choose the machine suitability to run the production of mould.

Major calculations are as follows,

- Determining the shot weight of the component as well as the machine.
- Plasticizing capacity of the machine at required material selected.
- Clamping tonnage required for the component.
- Injection pressure required to fill the mould completely.
- From the above calculation it is possible to select the parting line/surface, number of cavities, feed system, thickness of the plates, inserts, finally cooling line and cooling location are selected.

4.OBJECTIVES

- Various molding technique for different type of components
- About injection molding machine
- Feed system and mould flow analysis
- Undercut and removal procedure
- Injection mold calculation and conceptual design.
- To manufacture a component that is free of fundamental flaws.

5.DESIGN OF FEED SYSTEM

Sprue design

D2= D1+2Ltan A

Where,

D1 = diameter of sprue at upper end = 6
mmD2 = diameter of sprue at lower end

L = length of sprue selected by the designer
= 60 mmA = tapered angle (2˚ to 5˚) = 2˚
D2 = D1+2Ltan A
D2 = 6+2(60) × tan (2˚)
D2 = 10 mm

Runner design

$$\text{Diameter of runner} = \frac{\sqrt[4]{L}}{3.7} \times \sqrt{W}$$

Where,

w = weight of the component in g =
143.4 gL = length of the runner
L = 9 mm

$$\text{Diameter of runner } (\emptyset) = \frac{\sqrt[4]{9}}{3.7} \times \sqrt{143.4}$$

Diameter of runner (∅) **= 6.02 mm**

Gate design

To find the diameter's arithmetical mean value. The average gate diameter d2 is calculated as follows,

$$d = \frac{d_{2a} + d_{2b}}{2}$$

Using the equation of a straight line, the equation for determining gate diameter d2a is derived from this proportion from the Mould engineering text book (written by Herbert Rees, Vienna Publications 1995). When the component mass of the pieces reaches a median level,

$d_{2a} = 0.0042\ m + 1.08$ (Equation for medium size component)

$d_{2a} = 0.0042\ m + 1.08$ where m =143.48 g

$d_{2a} = 0.0042\ (143.48) + 1.08$

$\mathbf{d_{2a} = 1.68\ mm}$

The procedure for calculating gate diameter d_{2b} is as follows:

$d_{2b} = k\ s$

Where **s** = inner wall thickness and k = coefficient that varies with wallthickness. k = 0.5 to 0.8

The straight-line equation was used to derive this coefficient, as well as the gate diameter d2b, which ranges from 0.8 to 2 mm. When s = 0 mm, k = 0.8, and when s = 4 mm, k = 0.5, according to the data. Straight line equations were used to calculate the coefficient k and gate diameter d2b equations.

k = - 0.075 s + 0.8

k = - 0.075 s + 0.8 where s

= 2.6 mmk = - 0.075 (2.6) + 0.8

= 0.605

$d_{2b} = k \times s = 0.605 \times 2.6$

$\mathbf{d_{2b} = 1.573\ mm}$

$$d = \frac{d_{2a} + d_{2b}}{2}$$

$$\mathbf{d_2} = \frac{1.522 + 1.573}{2} = \mathbf{\mathit{1.547}}$$

Therefore Diameter of the gate $\mathbf{d_2}$ is **1.547 mm**.

6.MOULD FLOW ANALYSIS

In order to make high-quality parts, mould flow analysis was carried out to study the flow of plastic materials that helps to evaluate the component, parameters, and mould design. Solid works Analysis is controlled by the Moldex3D application. Early in the process of developing a product, designers can test the Mouldability of plastic part designs using this integrated tool for mould flow simulation. Additionally, developers can make changes in advance to enhance gate number/locations, material selection, part design, process conditions, or material selection.

Table 1 Input data for analysis

Material selected	Nylon6-30%GF
Supplier	DU PONT
Trade name	PA6-ZYTEL 7 3 G30 HSL NC010
Density	1.34 g/cc
Melt Temperature	270 °C
Mold Temperature	95 °C
Max. Pressure	2100 kg/cm^3

7.SOLID WORKS ANALYSIS RESULTS

The mould flow simulation is run several times, and the best iteration is chosen for manufacturing based on gate contribution, fill time, pressure and air traps.

- The solid works is used to optimize the component fill. It's also shown in Fig. 5 (a) with a 100 % high confidence fill.
- Figure 5 (b) shows the component's actual filling time. It takes 7.1 s to fill the component completely.
- The pressure required to inject the material into the mould space is predicted by the Solid works to be 40 MPa, as illustrated in Fig.5 (c)
- Temperature (207 °C) increase causes flaws like surface cracks and weld lines, which reduce the quality of the finished component inFig.5 (d).
- Air traps are more common in the last fill stages. A common source of air traps is the absence of properly sized design and vents. Figure 5(e) shows trapped air in the outer region, which can be evacuated by building suitable vent pathways.
- Figure 5(f) displays the available weld lines for the component that has the fewest weld lines.

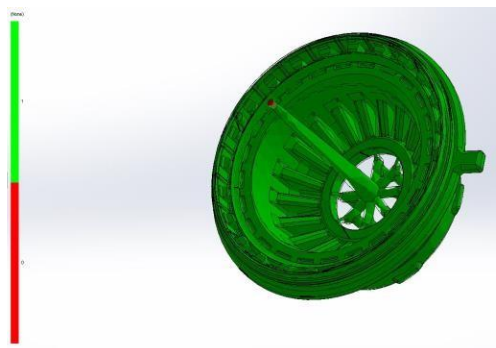

Fig.5 (a)- Gate Contribution

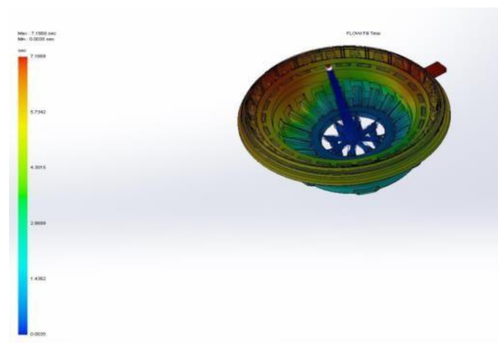

Fig.5 (b)- Fill time

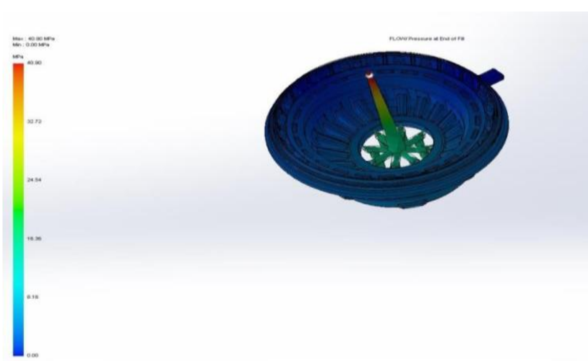

Fig.5 (c)- Pressure

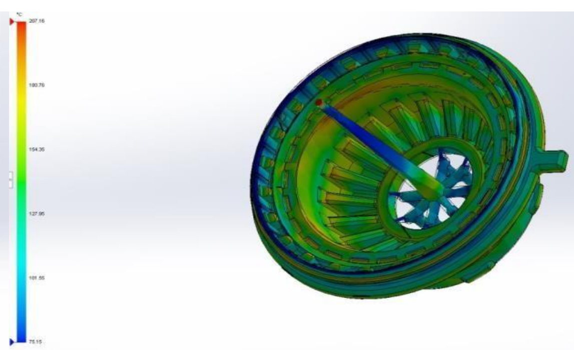

Fig.5 (d)- Temperature

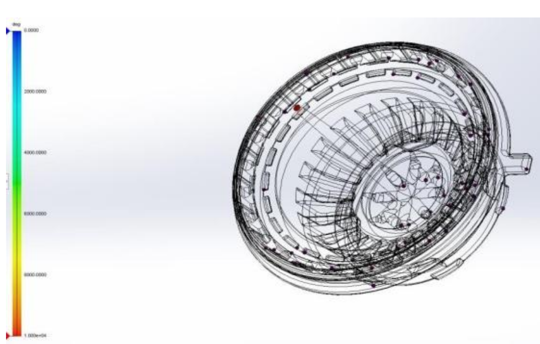

Fig.5 (e)- Air traps

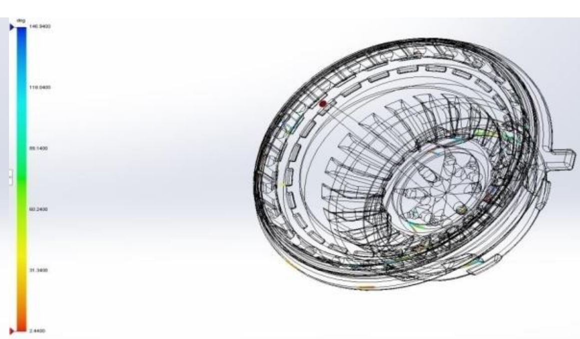

Fig.5 (f)- Weld lines.

Table 2 Results

Sl. No.	PARAMETERS	RESULTS
1	Gate contribution	Balanced flow
2	Melt front time	7.1 s
3	Pressure	40 MPa
4	Temperature	207 °C
5	Air traps	Acceptable
6	Weld lines	Acceptable

Conclusions

By comparing the above results in one finding, the analysis for the ideal gate and runner locations was clarified, and faults such air traps and weld lines were removed from the flow simulation and parts free of flaws. Air traps can be minimised by incorporating air vents in the core and cavity. By monitoring injection pressure of 40 MPa, barrel velocity, and mould temperature of 207 0C, weld lines can be controlled.

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