International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

INFLUENCE OF GATING SYSTEM FOR TOP COVER STRUT BEARING COMPONENT BY SIMULATION FLOW ANALYSISUSING NX-EASY FILL ADVANCED SOFTWARE

Vishnu Darshan M. [1]* *, Mr. Govind Vatsa.*[2]*,Dr. S. N. Ravi Shankar.*[3]

Student, M.Tech in Tool Engineering, GT&TC, Mysuru-16, Karnataka, INDIA
Deputy General Manager GT&TC, Mysuru-16, Karnataka, INDIA
Principal, Post Graduate Studies, GT&TC, Mysuru-16, Karnataka, INDIA

ABSTRACT

The gate is a vital flow path in the feed system because it links the runner to the cavity. The feed system in injection molding is made up of sprue, runner systems, and gates, which are the channels through which the polymer flows. In the manufacturing of plastic parts, cycle time optimization, scrap avoidance, and manual interface play a critical role in increasing process productivity while ensuring that the quality of the end product is not compromised.This research focuses on the impact of an ideal gate location on melt front time anddefects using NX-Easy Fill Advanced software through number of iterations.The new optimized gate position was tested in an injection molding machine with a developed mold.

Keywords:*Plastic Injection Mould. NX Easy- Fill Advanced, Feeding unit,PA 6-30% GF, Tunnel gate, Gate contribution, Defects.*

1. INTRODUCTION

Plastic items are in high demand in today's world due to their numerous helpful characteristics. Injection molding is one of the most used methods of producing plastic items. A molding tool is required to create the appropriate mold. This study focuses on the molding of the bearing's upper cap. In this case, a 3D model was produced with NX -11.0 software and then loaded into an IGS file to assess mold flow insight. All of the procedures were completed in the first phase, which included meshing the model, assigning the material, and finding the optimum gate location. The traditional trial - and - error technique is used to set the processing criteria, which is often insufficient and impractical for complicated parts. As a result, three iterations with increasing injection positions were conducted to obtain the best result, and one of the outputs was deemed satisfactory for all parameters, encouraging the designer to proceed with the design and manufacturing process and procedures.

2. OBJECTIVES

- Component research and development.
- One whole shot was designed and analyzed.
- Injection mold calculation and conceptual design.
- To manufacture a component that is free of fundamental flaws.

3. METHODOLOGY

---

* *Corresponding author.*
E-mail address: vishnudarshanm1997@gmail.com

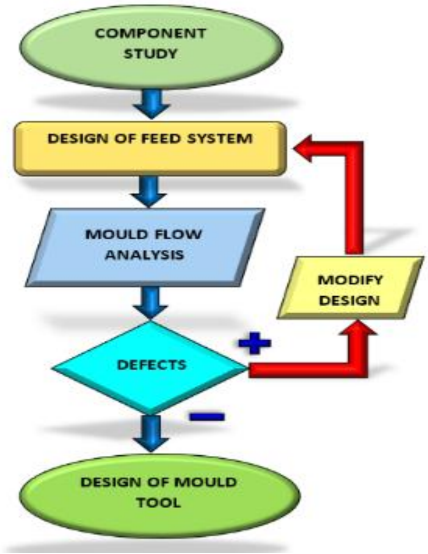


Fig. 1 – Flow chart of Methodology.

3.1.Component study

Component details:

The component's name is Top cover strut bearing. PA6 is used as the component material, which is 30 percent glass filled. The component is black in color. To make the component of the desired color, black masterbatch is used. The component's volume is 77.38cm^3. The total weight of the components is 105.23 grams. The component has a density of 1.36 grams per cubic centimeter and has reduced by 0.8 percent of its original volume. The melting point is 270°C. The component's 3D model is shown in fig.2.

Fig. 2- Top cover strut bearing 3D model

Component Research:

Upper cap bearing is mounted on suspension system of car body shown in fig. 3. Suspension is the mechanism that links a vehicle to its wheel and permits relative motion between the two. It includes tires, tire air, springs, absorbers, and linkages. Because of all the road or ground forces occurring on the vehicle, it is critical for the suspension to retain the road wheel as many as possible in touch with the road surface.Although, it's a rare occurrence, a damaged or compromised upper bearing cover (located on top of the strut, where it bolts to the car) might force a coil spring to bend and twist in ways it wasn't supposed to. To avoid damaged upper bearing cover, a great care must be taken while designing the mold. Before making mold, analysis should be carried out and redesign the mold by changing suitable parameters if there is any defect noticed on the component.

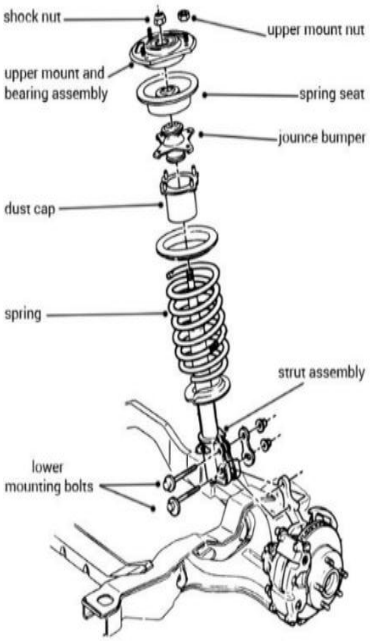


Fig. 3- Bearing assembly on strut

3.2. Design of Feed system

- **Runner design**

Diameter of Runner $(d_r)= \frac{\sqrt[4]{L}\times\sqrt{W}}{3.7}$where, W = mass of the component =105.23 gm,L= Length of the runner =35 mm

$(d_r) = \frac{\sqrt[4]{35}\times\sqrt{105.23}}{3.7}= 6.74$ mm

Therefore, diameter of runner selected is **6 mm**forease of manufacturing.

- **Sprue design**

The designer chooses a standard sprue and adjusts the diameter based on the diameter of the runner with one end and another diameter analyzing the relationship given below,

$$D_1 = D_2 + 2(SH)\tan A$$

where,

D1 is the sprue diameter at the lower end

D2 is the sprue diameter at the upper end = diameter of runner = 6mm,

SH is the length of sprue chosen by the designer = 60mm and

A is the tapered angle (2 to 5 degree) =2 degree taken.

$$D_1 = 6 + 2(60)\tan(2) = 10.19\ mm$$

As a result, the sprue diameter is 10.19 mm, which is rounded to **10 mm**.

- **Gate design**

The arithmetical mean value of the diameter must be determined[ ].

The following formula is used to calculate the average gate diameter d2.

$d_g = \frac{d_a + d_b}{2}$ where, d_a = 0.0042m +1.08 (Equation for medium size component i.e., m$<$ 150gm)

= 0.0042(105.23) +1.08

= **1.52 mm**

d_b = **k×s** where s stands for inner wall thickness and k stands for a wall thickness-dependent coefficient

k = $-$0.075 s + 0.8, where s = 2.7 mm

k = - 0.075 (2.7) + 0.8 = 0.59 mm

d_b = k×s =0.59×2.7 =**1.61 mm**

$$d_g = \frac{1.52+1.61}{2} = 1.56\ mm$$

Therefore, the gate's diameter is **1.56 mm.**

Because the part is made for a single impression mold and has a circular profile, we can only create a submarine gate for feeding. In two-plate mold fabrication, a submarine gate is used. The tunnel must have a good taper and be able to bend in order to de-gate. Typical gate diameters range from 0.8 to 1.5 mm, while sizes for glass reinforced materials may be greater.

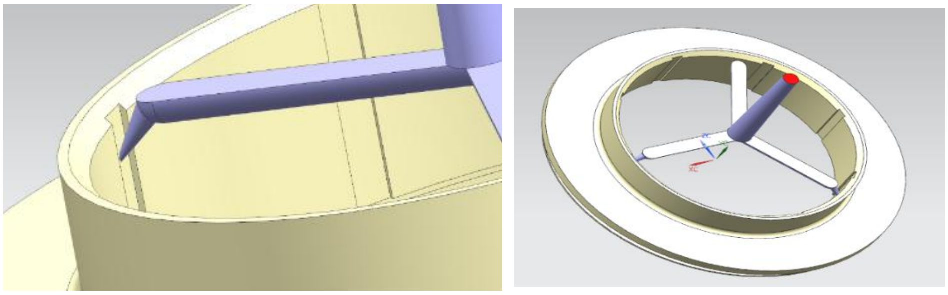


Fig. 4- Submarine or Tunnel gate and feeding system design

3.3 Mould flow Analysis

Mould flow analysis is a study of plastic material flow that aids in the evaluation of the part, parameters, and mold design in order to produce high-quality parts. Moldex3D program controls NX Easy-Fill Analysis. It's an integrated mold flow simulation tool that lets designers test the moldability of plastic part designs early on in the product development process. Developers can also make adjustments ahead of time to improve gate number/locations, material selection, part design, process conditions, or selection of materials.

Table 1 Input data for analysis

Material selected	PA 6 30% GF
Supplier	DuPont
Trade name	Zytel®73G30HSL NC010
Density	1.36 g/cc
Melt Temperature	270°C
Mold Temperature	95°C
Max. Pressure	177.5 MPa

3.4NXEasy Fill Advanced Results

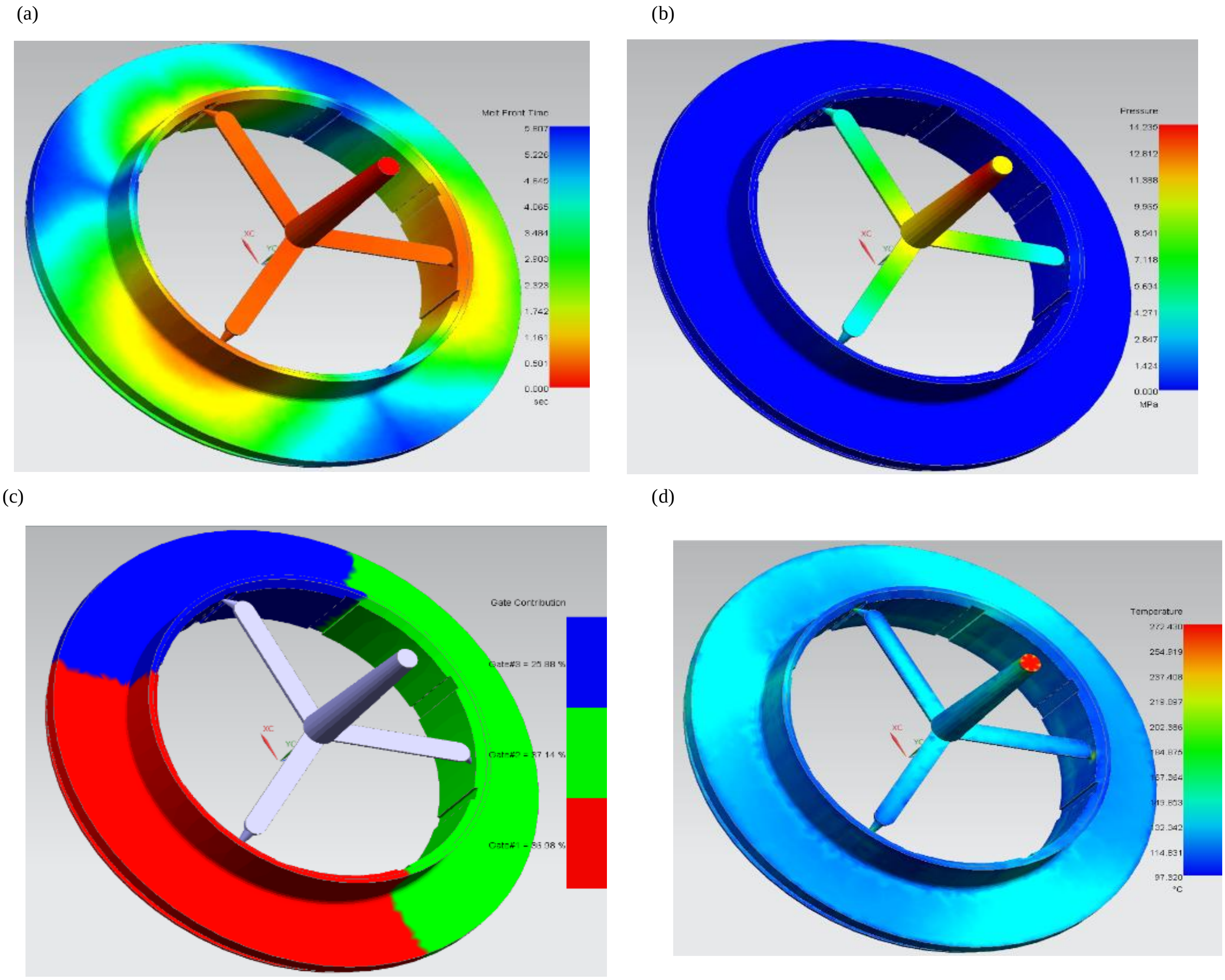
The mold flow simulation is run several times, and the top three iterations are displayed, with the best one being chosen for manufacturing based on gate contribution, fill time, pressure and air traps.

1st Iteration results

The time it takes the polymer to completely fill the core and cavity is referred to as fill time. It's an essential aspect to assume about because it determines how quickly the polymer is injected into the mold. In the first iteration depicted in Fig 5, the part filling is unbalanced and fills in 5.80 seconds with a pressure of 14.23 MPa, and at a temperature of 272.43°C. If the fill pressure is too high or too low, defects such as mould flashing appear, affecting the component's surface quality. From the fig. 5 d) it is clear that Pressure is more while filling the cavity and core. The blue region or dots visible in fig 5 e) are areas where air has been entrapped as a result of air not being able to escape through the vents or inserts given in the mold. Weld lines are caused by the material used, as well as the design and structure of the component. They happen when polymer flows from opposite directions contact at the same area. The red lines visible infig. 5 f) indicating weld lines formation in the component. Furthermore, ejection is problematic because 2 mm gates shred/tear the component surface due to shear stress induced by Ejector Pins.

Table 2 Results from 1st Iteration

SL.NO.	PARAMETERS	RESULTS
1	Gate contribution	Unbalanced flow
2	Melt front time	5.80 s
3	Pressure	14.23 MPa
4	Temperature	272.43°C
5	Air traps	Less
6	Weld lines	Less
7	Ejection	Complex and Difficult


(a) (b) (c) (d)

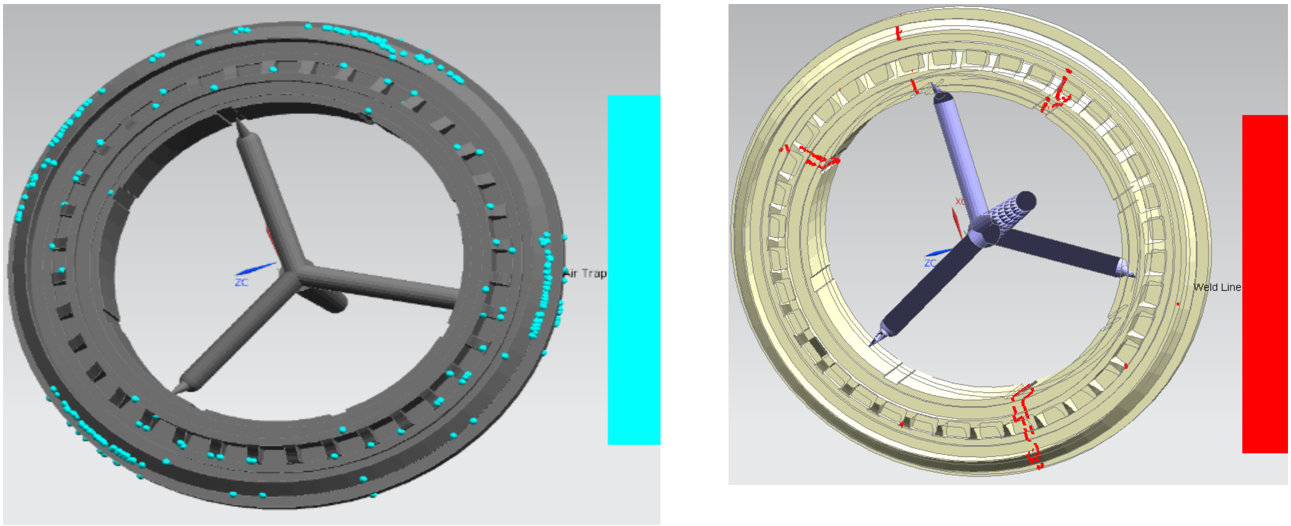

(e) (f)

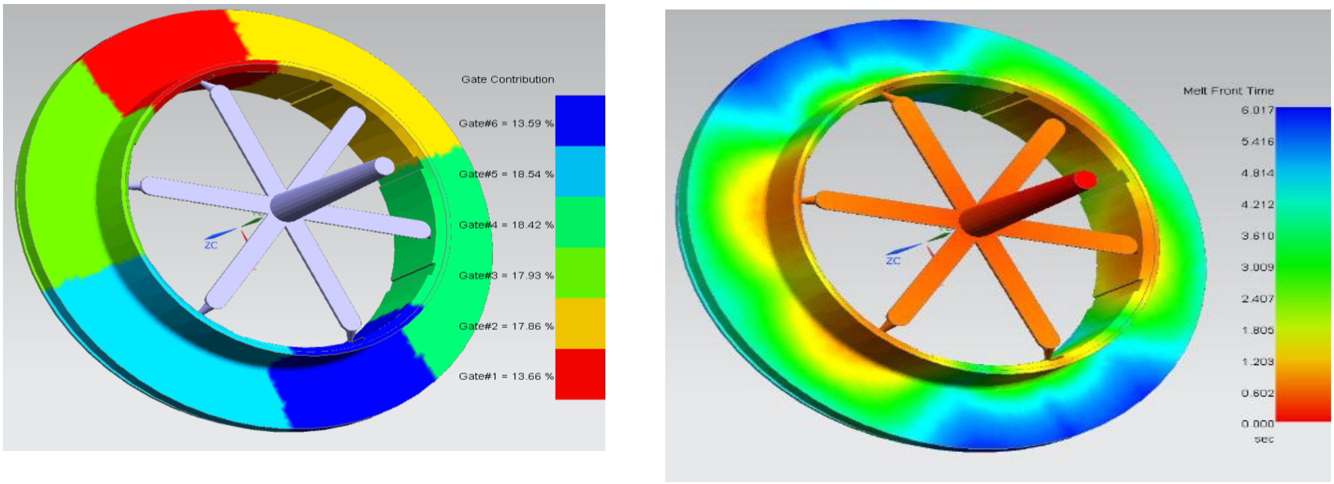
Fig. 5 Flow simulation with 3 gates for a) Gate Contribution b) Melt front time c) Pressure d) Temperature e) Air traps f) Weld lines.

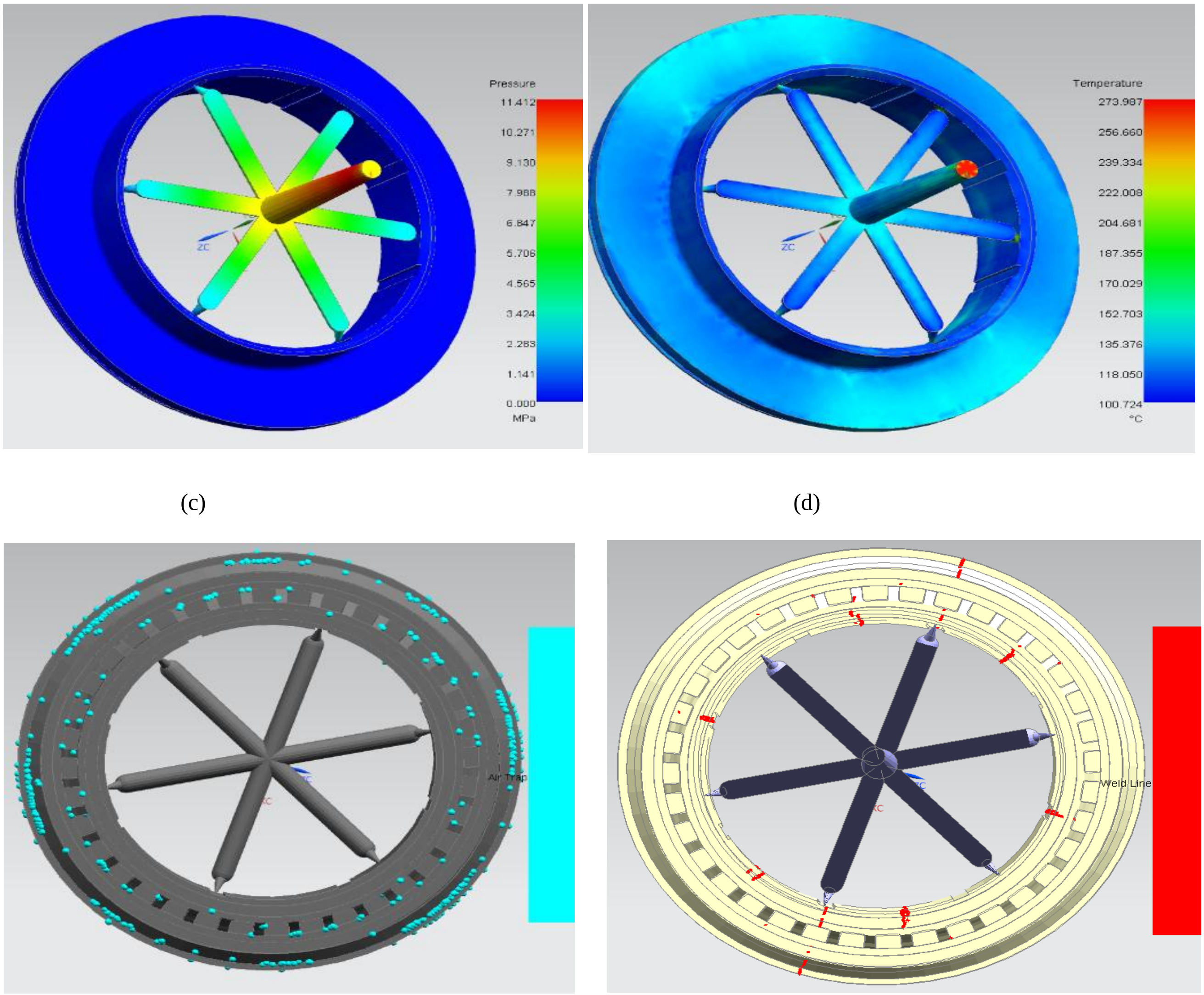
2nd Iterations

Since the 1st iteration's results were unsatisfactory, the feeding system was modified and simulated with 6 Gates, 1.8 mm diameter, and 5 mm runner width, as illustrated in Fig 6, where the portion fills in 6.01 seconds with a pressure of 11.41 MPa, with less air traps but marginally higher weld lines than previous results. Ejection is quite difficult.

Table 2 Results from 2ndIteration

SL.NO.	PARAMETERS	RESULTS
1	Gate contribution	Unbalanced flow
2	Melt front time	6.01 s
3	Pressure	11.41 MPa
4	Temperature	273.98°C
5	Air traps	More
6	Weld lines	Minimum
7	Ejection	Difficult


(a) (b)



(c) (d)

(e) (f)

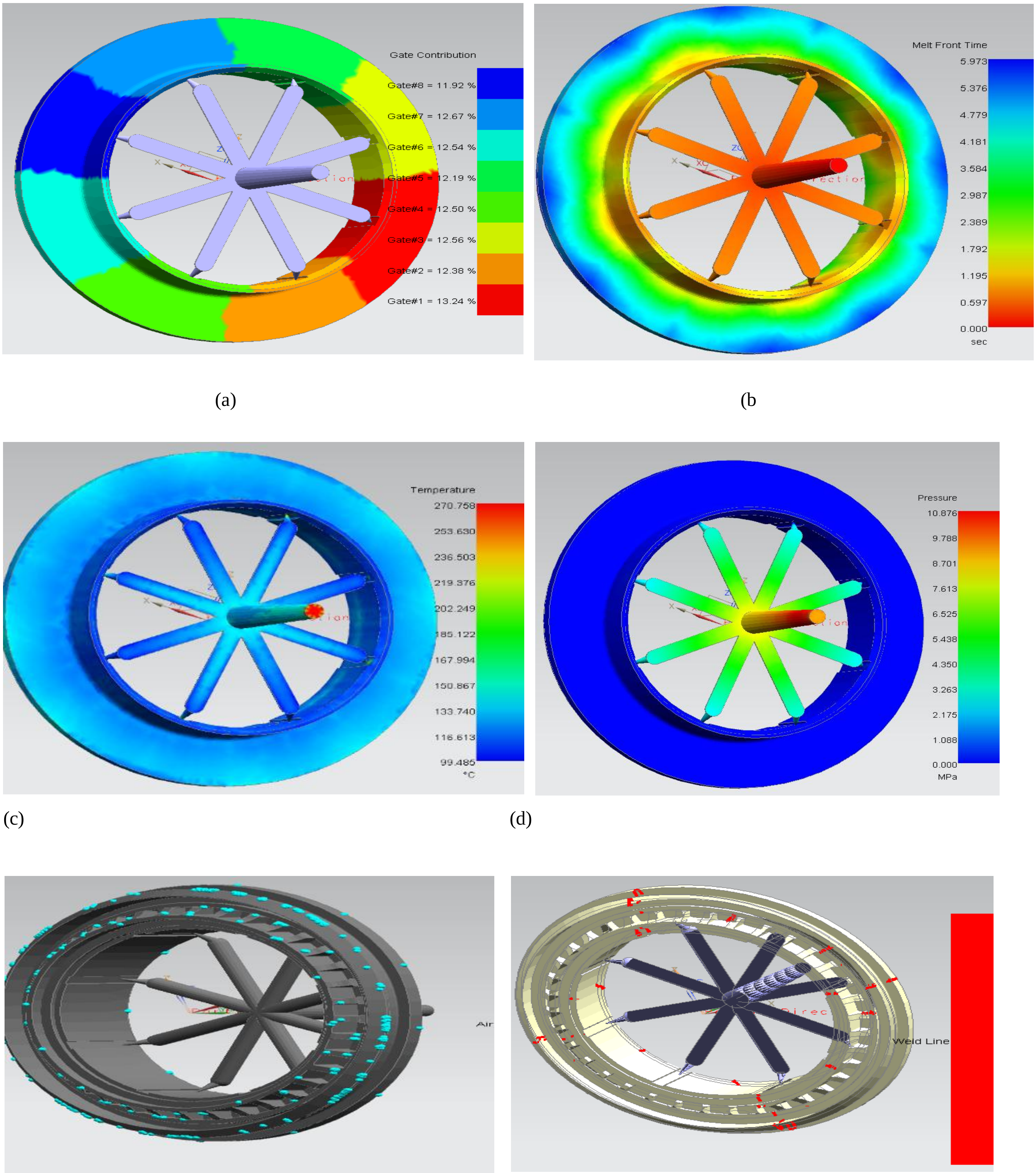
Fig. 6 Flow simulation with 6 gates for a) Gate Contribution b) Melt front time c) Pressure d) Temperature e) Air traps f) Weld lines

3rd Iterations

The results from the second trail can be further adjusted by adjusting simply the gate size and simulating with 8 gates, 1.56 mm diameter gate in fig. 7, where the component fills in 5.97 seconds, which is better than previous result with a pressure of 10.87MPa. The pressure is decreased compared to previous results. Air traps, weld lines were acceptable and ejection is easy. This result leads to good surface finish of the component. Hence 8 gates system has been approved for further manufacturing process.

Table 3 Results from 3rdIterations

SL.NO.	PARAMETERS	RESULTS
1	Gate contribution	**Balanced flow**
2	Melt front time	5.97 s
3	Pressure	10.87 MPa
4	Temperature	270.75°C
5	Air traps	Acceptable
6	Weld lines	Acceptable
7	Ejection	Easy



(a) (b

(c) (d)

(e) (f)

Fig. 7 Flow simulation with 8 gates for a) Gate Contribution b) Melt front time c) Pressure d) Temperature e) Air traps f) Weld lines.

CONCLUSIONS

The analysis for optimum gate and runner location was explained, and flaws such as air traps and weld lines were eliminated in the flow simulation by comparing the above three results. Automatic de-gating is achievable because the gate is placed in the ideal location for easy production and defect-free components.By including air vents in the core and cavity inserts, air traps can be reduced. Weld lines can be regulated by checking up on injection pressure, barrel velocity, and mold temperature. From the table 4,8 gate points result has been approved for further manufacturing process.

Table 4 Comparison of three iteration results

Sl. No.	PARAMETERS	3 GATE POINTS	6 GATE POINTS	8 GATE POINTS
1	Gate contribution	Unbalanced Flow	Slightly Unbalanced	Balanced Flow
2	Moldability	Good	Good	Better
3	Melt front time	5.80 s	6.01 s	5.97 s
4	Pressure	14.23 MPa	11.41 MPa	10.876 MPa
5	Temperature flow	272.43℃	273.98℃	270.75℃
6	Air traps	Minimum	More	Acceptable
7	Weld lines	Less	Acceptable	Acceptable
8	Ejection	More Difficult & Complex	Minimum Difficulty	Easily & Automatically Ejected

REFERENCES

[1] Vikas B J 1, Chandra Kumar R 2, "Influence of feeding system in injection moulding for lower washer of a bearing",International Journal of Research in Engineering and Technology.Volume: 02 Issue: 08 | Aug-2013.
[2] Thanusha Nandish1*, L.G Sannamani2, "The influence of gate location in a Vertical injection moulding part Connecting plate",International Research Journal of Engineering and Technology,Volume: 07 Issue: 05 | May 2020.
[3]Kiran Tom Thomas1* and Ramesh Babu K1 "Conceptual design of two plate injectionmould tool for five pin Daimler regulator",Int. J. Mech. Eng. & Rob. Res. 2014, Vol. 3, No. 4, October 2014.
[4] Gaikwad Mahesh Digambar, Gaikwad Mahesh Digamber1, Sharif Mohiuddin Akbar2, Dhomase Datta Govind3, Ravale, Shivshankar Ashokrao4, Mr Bidve Mangesh Angadrao5, Mr Devshette Ashish Rajkumar6,"Plastic Injection Molding Machine", Volume: 06 Issue: 03 | Mar 2019.
[5]Xuejing Zheng, Jun Zhang, Jiasong HE,"Mutual Influence of the Morphology and Capillary Rheological Properties in Nylon/ glass-fibre/liquid crystalline-polymer blends",Received 12 February 2003; revised 17 November 2003; accepted 14 December 2003.
[6] Prof. Patil Satish N1, Prof. Shinde V.B2, Prof. Borkar B.R, "Design & analysis of plastic injection mould using NX-UG & DELCAM software", Vol.5, Issue no. 2, Feb 2016.
[7] S. Kamaruddin, Zahid A. Khan and S. H. Foong, "Application of Taguchi method in the Optimization of Injection Moulding Parameters for Manufacturing Products from Plastic Blend", IACSIT International Journal of Engineering and Technology, Vol.2, No.6, December 2010, ISSN: 1793-8236.
[8] Gyung-Hwan Oh a, Ji-Hye Jeong b, Sung-Hyeon Park a, Hak-Sung Kim, "Terahertz Time-Domain Spectroscopy of Weld line Defects formed during an Injection Moulding Process", Received 27 October 2017, received in revised form, 26 December 2017, accepted 15 January 2018.
[9] Practical guide to injection moulding, Arburg Vannessa Good-ship, 2nd Edition, Smithers Group Company.
[10] Injection mould design, R.G.W Pye, 4th Edition, Affiliated East-West Press Pvt Ltd.