International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 10 No. 4, 2024
https://theaspd.com/index.php

Effectiveness of Hot Runner Injection Mould Compared to Cold Runner Injection Mould for Process Optimization

P. D. Kale[1] , P. D. Darade[2]
[1] Ph. D Research scholar, G H Raisoni College of Engineering and Management, Pune, prachidkale@gmail.com
[2] Associate Professor, Sinhgad Institute of Technology and Science, Narhe, Pune, daradepd@gmail.com

Abstract
The major parts of injection moulding are core-cavity plate, runner and gate systems. Runner system plays an important role in scrap quantity and quality of product. Two types of runner systems namely cold and hot runner systems are in practice. A hot runner system is an assembly of heated components used in plastic injection molds that inject molten plastic into the cavities of the mold. By contrast, a cold runner is simply a channel formed between the two halves of the mold, for the purpose of carrying plastic from the injection molding machine nozzle to the cavities. In cold runner system component is ejected along with the runner which creates the waste. Concealed box used for the casing of electrical switches is used for analysis purpose. The component is manufactured by both hot and cold runner systems to compare the design and simulation in both cases for the process optimization through scrap reduction, cost analysis and defects.
Keywords: *Injection moulding, hot runner, cold runner, scrap , cost analysis, mould defects.*

1. INTRODUCTION:

A cold runner is simply a channel formed between the two halves of the mold, for the purpose of carrying plastic from the injection molding machine nozzle to the cavities. Each time the mold opens to eject the newly formed plastic parts, the material in the runner is ejected as well, resulting in waste. A hot runner system usually includes a heated manifold and a number of heated nozzles. The main task of the manifold is to distribute the plastic entering the mold to the various nozzles which then meter it precisely to the injection points in the cavities. Hot runners usually make the mold more expensive to manufacture and run, but allow savings by reducing plastic waste and by reducing the cycle time. The function of hot runner nozzle is to keep the plastic melt in injection sprue in a stable temperature, so the plastic parts will be molded without sprue and have a bright surface.

It do not have to wait until the conventional runners freeze.The function of hot runner nozzle is to keep the plastic melt in injection sprue in a stable temperature, so the plastic parts will be molded without sprue and have a bright surface.

Cold runners typically generate more shear in the molten resin causing imbalance and higher fill pressures. The extra shear in the resin from moulding with cold runners can cause undesirable effects in the moulded part, affecting part strength, hinge performance and gate quality. These higher pressures create a greater chance for mould core shift on long cores, resulting in part weight and wall thickness variations. These variations can lead to downstream moulded part failures and product liabilities. Higher fill pressures attributable to cold runners can also create more wear and tear on the injection moulding machine with maintenance implications and higher energy consumption rates.

Though HRS is most effective as compared to CRS, It has not yet been used by many plastic industries due to its higher production cost. Modifications in the design using HRS with low cost have not yet been implemented and studied extensively. There is a gap between theoretical approvals of effectiveness of HRS with its practical implementation. A mould with HRS which can be used for more than three to four different components can be the solution for cost reduction so that HRS can be implemented practically

Most of the thermoplastic resins were molded by using Injection molding with Cold Runner System. Cold runner system is widely used in many of the plastic industries due to its simplicity in design and less investment cost in tooling. It doesn't require highly skilled manpower and gives moderate quality component. The product quality can be confirmed through simulation results for cold runner system. This paper covers design and simulation of concealed box using mold flow software. The essential material properties for the application of concealed box are fire and heat resistant, insulator, high rigidity and dimensional stability. ABS (Acrylonitrile Butadiene Styrene) material offers most of these hence can be suited for electrical appliances widely. Simulation of the component with respect to various process parameters such as Injection pressure, mould temperature, shear stress, cycle time are discussed so as to minimise the mould defects such as sink marks, weld lines and air traps in moulded component. This paper elaborates suitability of cold runner system for ABS as a better substitute for such applications with better productivity.

2. LITERATURE REVIEW:

Mr. P. Vinod, Mr. K. Vijaykumar [1] have designed multicavity injection mould with HRS and CRS. They studied the effect of runner systems, mould cooling and venting by comparison of both the designs with its simulation in ANSYS.

Rashi A. Yadav, S. V. Joshi, N. K. Kamble [2] have done the review of the recent research in designing and determining process parameters of injection molding. A number of research works based on various approaches have been performed in the domain of the parameter setting for injection molding. They have Determined optimal process parameter settings critically influences productivity, quality, and cost of production in the plastic injection molding (PIM) industry.

Gurjeet Singh, Ajay Verma [3] have studied primary processing conditions of moulding from concept development to manufacturing of the product. They studied effect of various factors on the basis of processing parameters. Since quality and productivity are the two important contradictory objectives in any machining process. Some extent of quality has to be compromised while assurance giving for high productivity. It is concluded that productivity get decreased while the efforts are channelized to enhance quality. Machining parameters need to be optimized to ensure high quality and productivity. Authors have studied various responses of quality of injection moulding process on the basis of performance parameters and methods.

Lee and Lin et al. [4] Built a multi-cavity mould runner and gating system. Use Finite Element Theory (FEM) network. Optimal runner unit parameter used to minimise injection mould warp, FEM, Taguchi phase and adductive framework. Processes during mould filling, enhancing moulding condition. Model injection mould simulation at steady flow rate. Finite differences method offers strong consent for methodological solutions. Different gate sizes and locations using flow simulation have been detected for defects reduction such as weld lines and air traps, air traps and warpage can be managed by varying process parameters

Different gate sizes and locations using flow simulation have been detected for defects reduction such as weld lines and air traps, air traps and warpage can be managed by varying process parameters [5].

Part flow-reducer studied using Autodesk Mould Flow tools. The mould flow analysis is used to predict the piece's deformation and change the design accordingly. [6].

3. Experimentation: Component Name - Concealed box

Application: Electrical parts to hold socket, switches etc.

Material: ABS (Acrylonitrile Butadiene Styrene)

Component is manufactured using plastic injection moulding with cold runner system

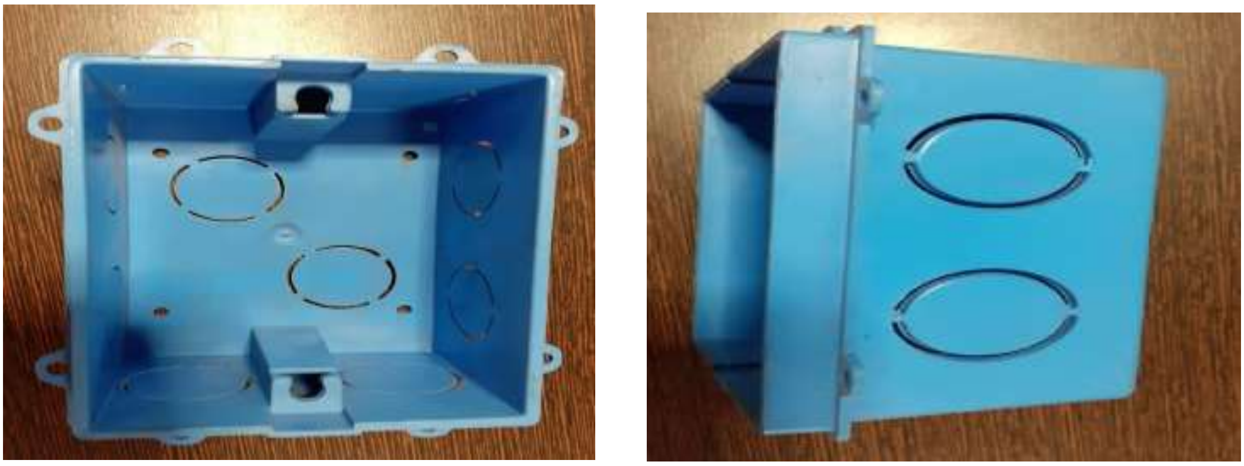

Fig 1: Component model for concealed box

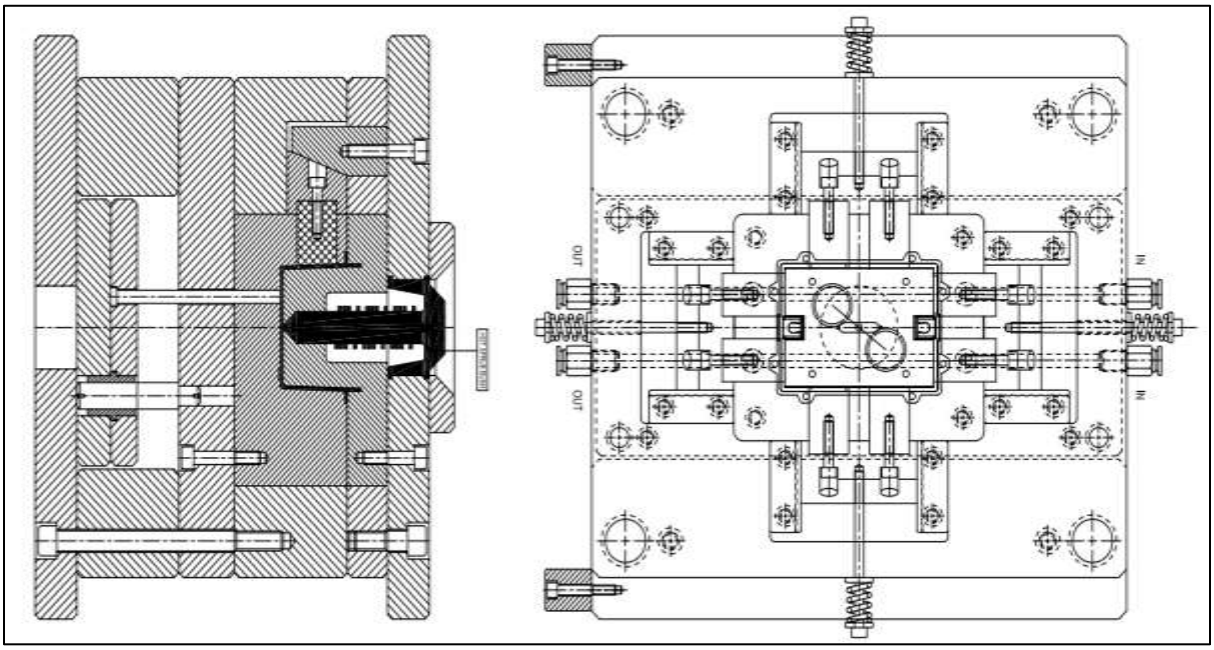

Fig 2: Mould design for Concealed box

4. Simulation for CRS and HRS using mould flow software

Input Parameter:

Name: Concealed box, Volume: 57.19 (cm3), Mass: 63.01 (G)

Size: X: 116.90 (mm), Y: 90.90 (mm), Z: 93.40 (mm)

Material Name: ABS (Acrylonitrile Butadiene Styrene)

4.1 Material properties:

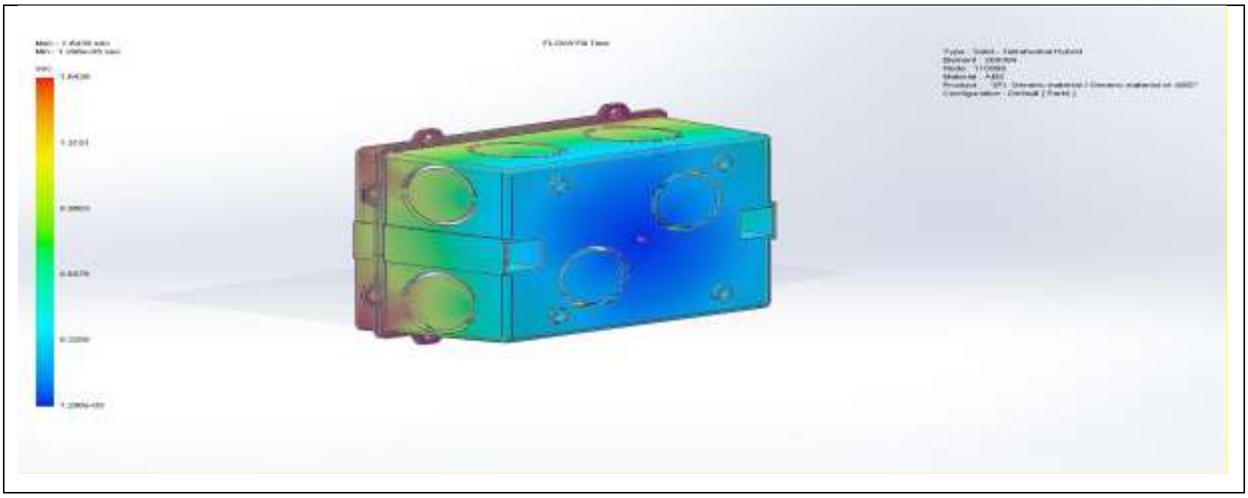

Fig 3: Fill time

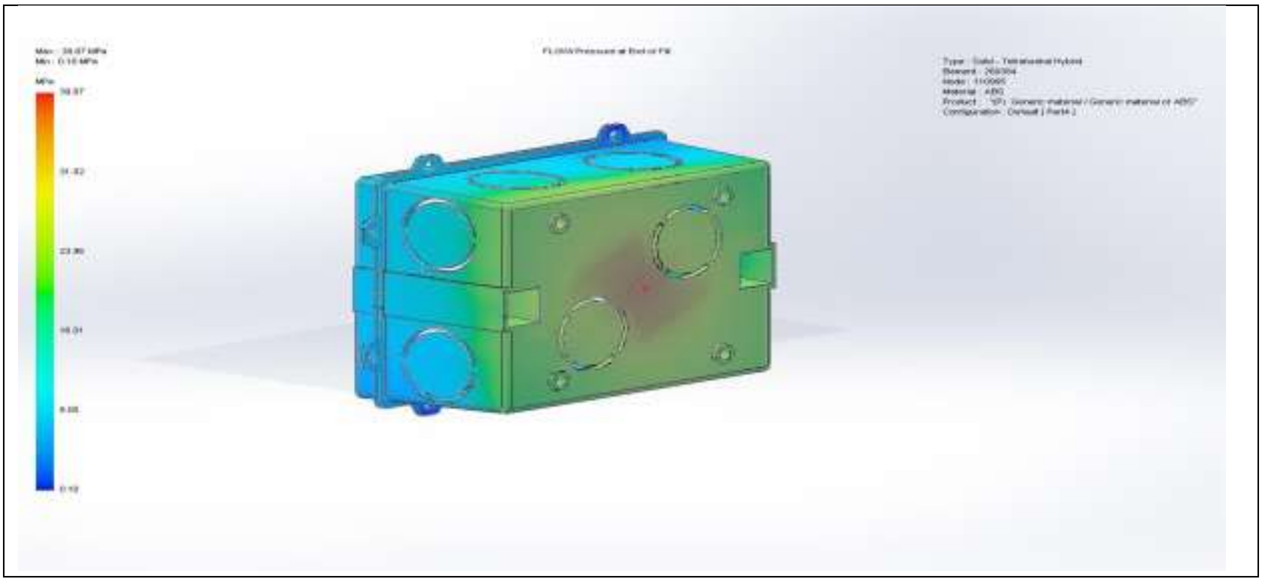

Fig 4: Pressure at end of fill

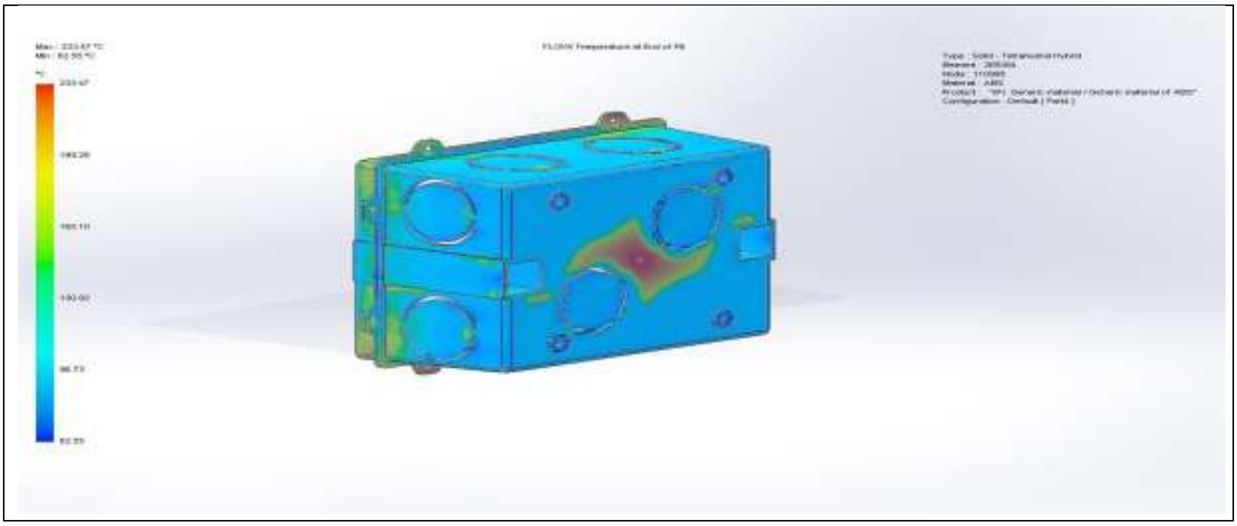

Fig 5: Temprature at end of fill

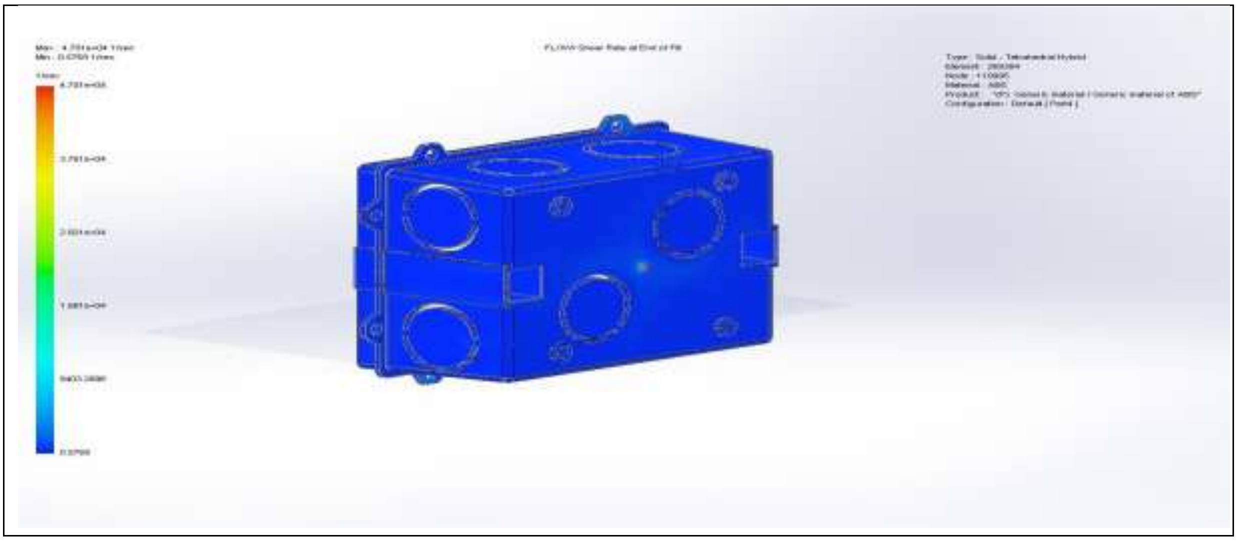

Fig 6: Shear rate at end of fill

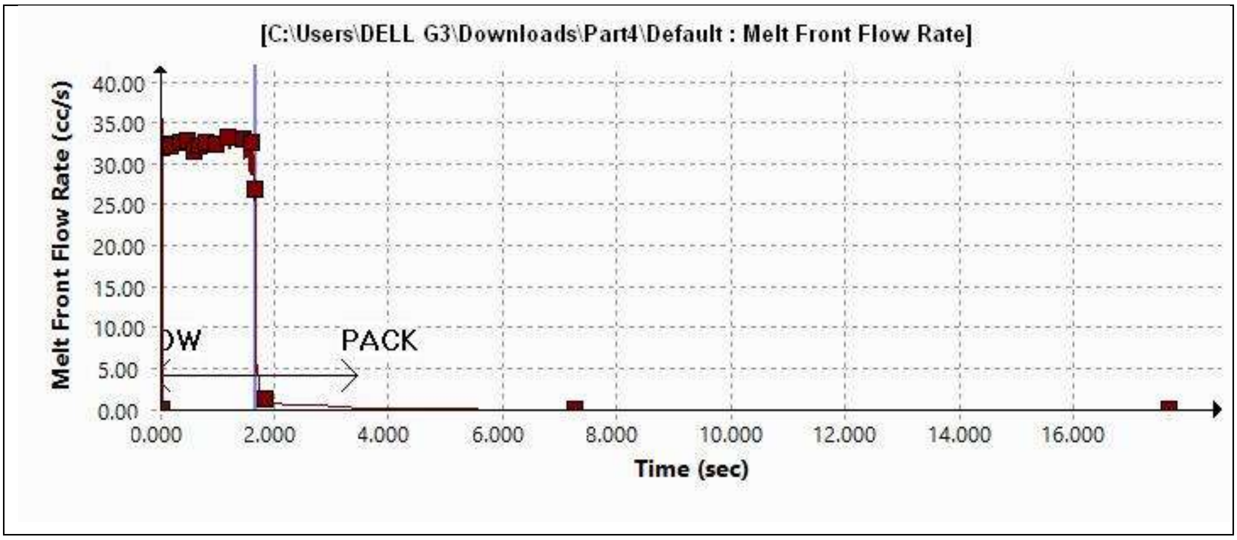

Fig 7 : Melt front floe rate

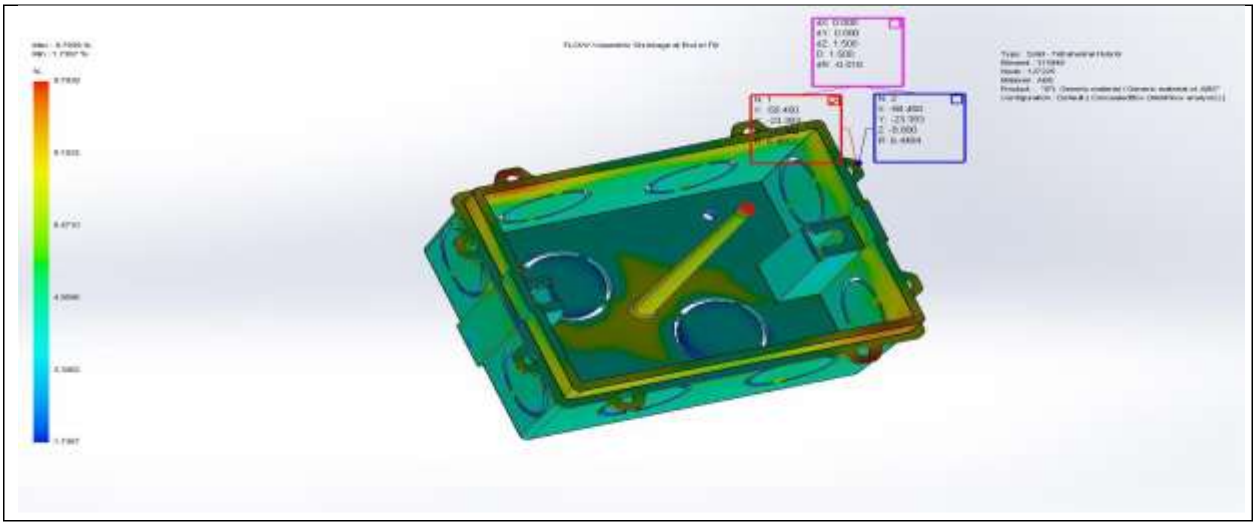

Fig 8 : Volumetric Shrinkage at the end of fill

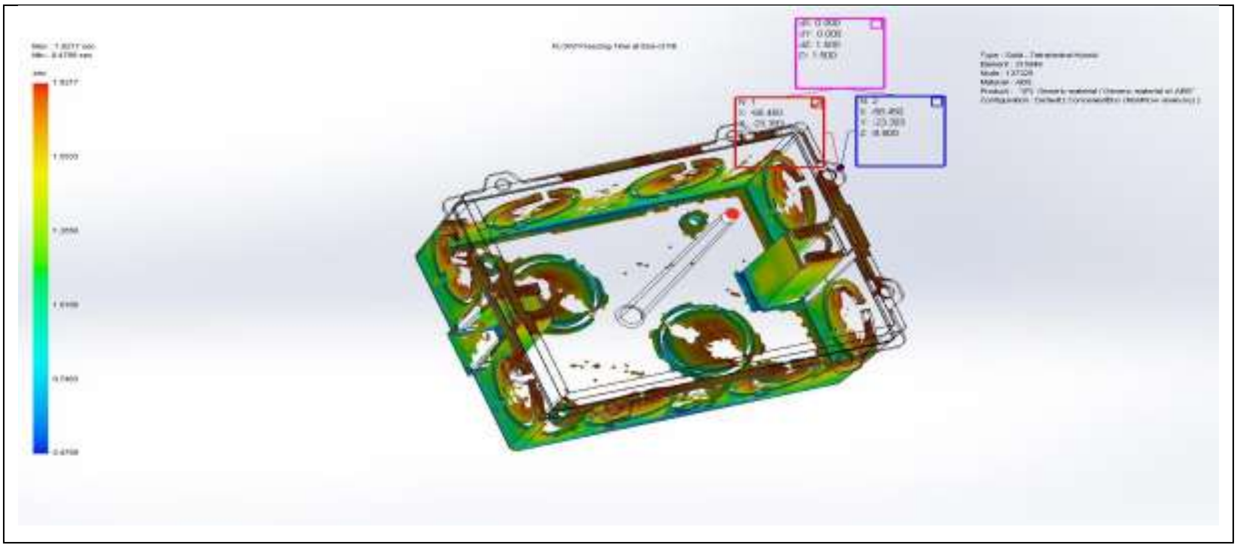

Fig 9 : Freezing time at the end of fill

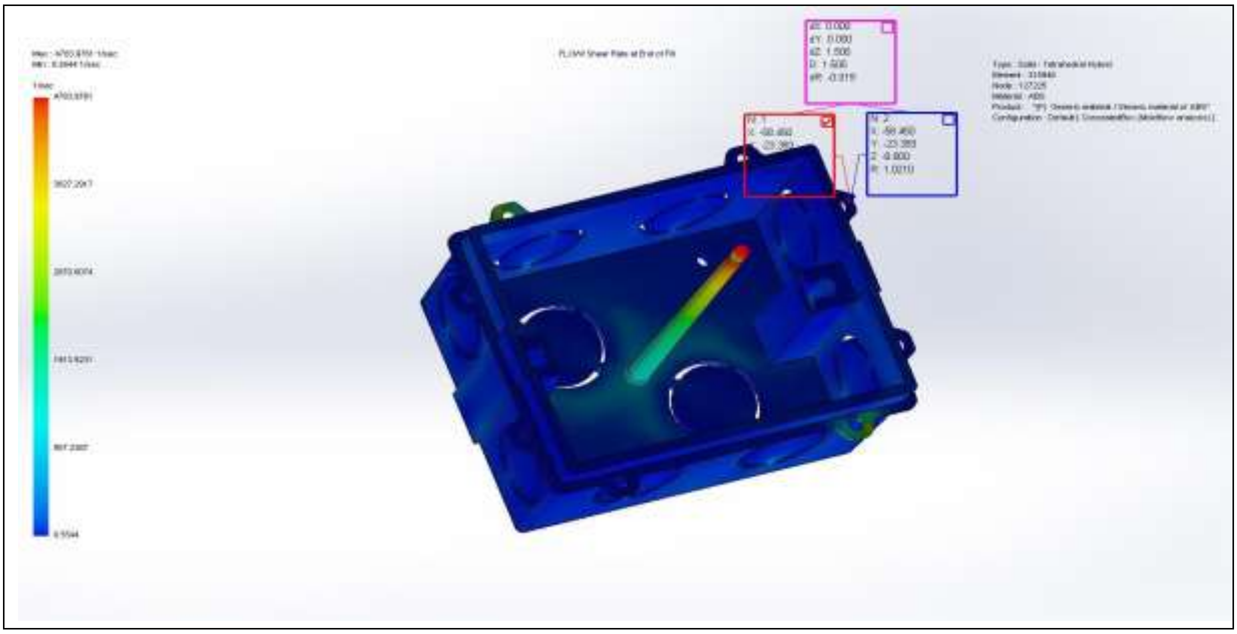

Fig 10 : Shear rate at end of fill

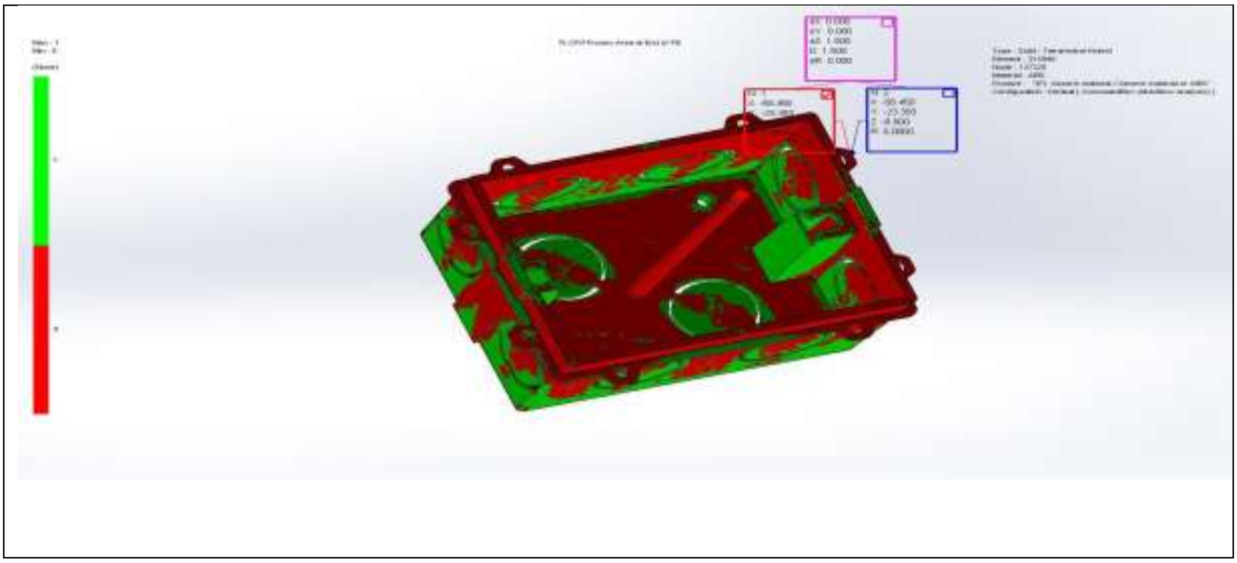

Fig 11 : Freezing time at the end of fill

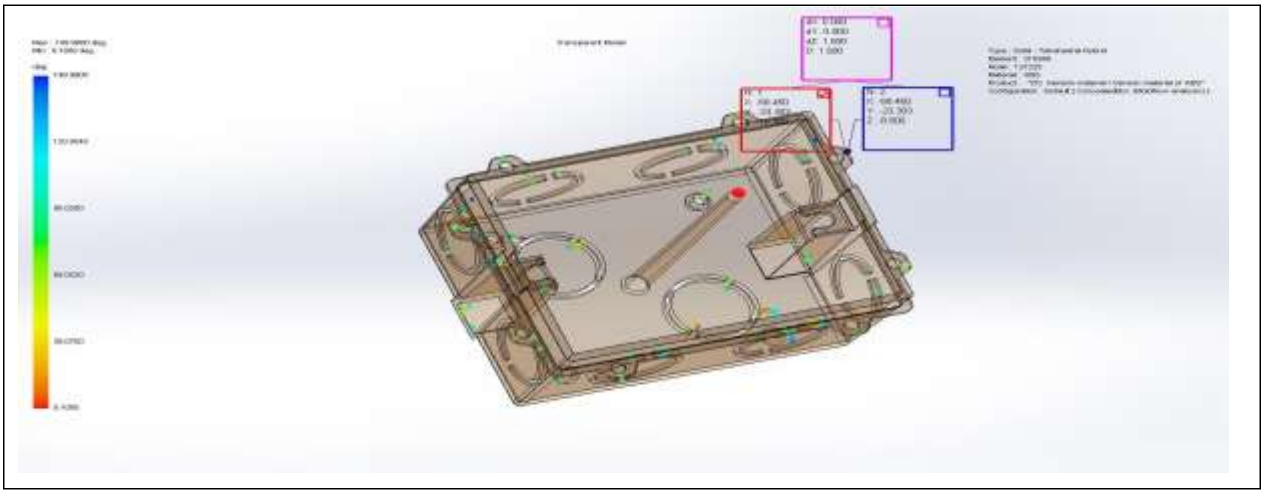

Fig 12 : Weld Lines

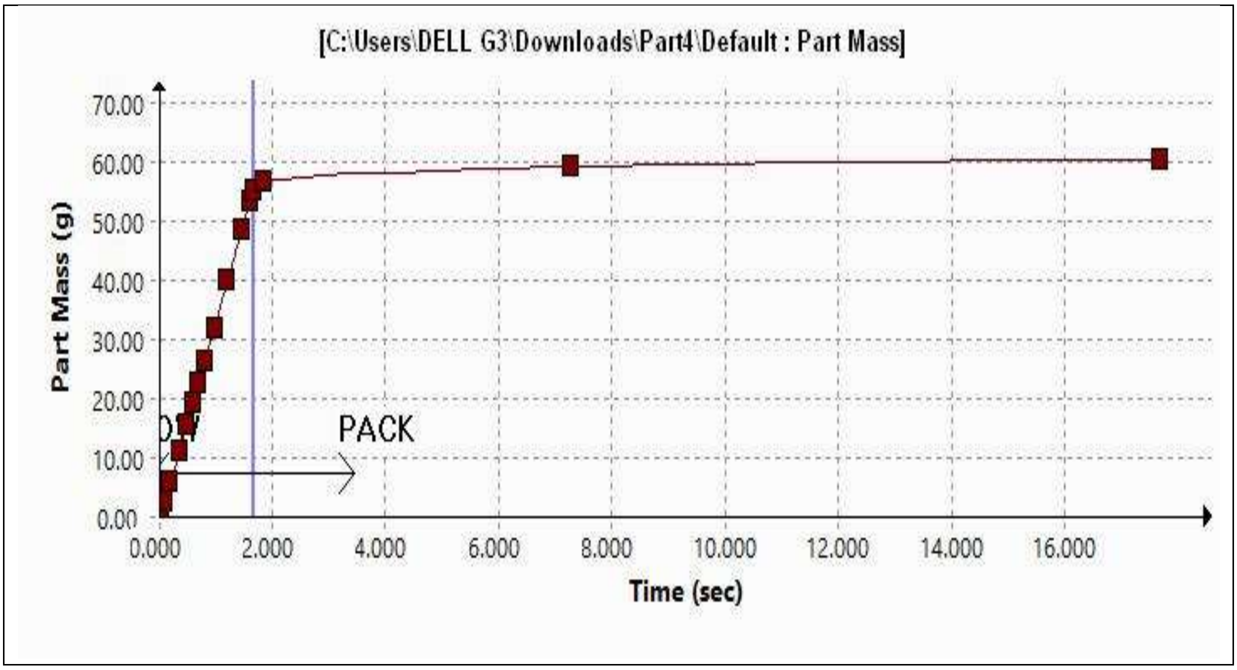

Fig 13 : Part mass

Table 1 : Comparative analysis and results of CRS and HRS

Sr. No.	Parameter	Cold Runner System	Hot Runner System
1	Material name	ABS	ABS
2	Melt temperature	230° C	230° C
3	Mold temperature	50° C	50° C
4	Ejection temperature	90° C	90° C
5	Transition temperature	100° C	100° C
6	Filling time	1.7 sec	1.7 sec
7	Main material melt temperature	230° C	230° C

8	Mold wall temperature	50° C	50° C
9	Injection pressure limit	100 MPa	100 MPa
10	Flow rate limit	194 cc/s	194 cc/s
11	Pressure holding time	3.8 sec	3.8 sec
12	Total time in pack stage	16.98 sec	16.98 sec
13	Cavity initial air pressure	0.101 MPa	0.101 MPa
14	Cavity initial air temperature	30° C	30° C
15	Temperature criteria for short shots	100° C	100° C
16	Clamp force limit	100 Tonne	100 Tonne
17	Ambient temperature	30° C	30° C
18	X-dir clamping force	10.2239 Tonne	10.2239 Tonne
19	Y-dir clamping force	13.2053 Tonne	12.5588 Tonne
20	Z-dir clamping force	16.4450 Tonne	17.5783 Tonne
21	Required injection pressure	52.8989 MPa	39.8703 MPa
22	Max. real temperature	236.8954° C	233.6239° C
23	Max. bulk temperature	236.9998° C	234.0574° C
24	Max. shear stress	2.1743 MPa	2.3337 MPa
25	Max. shear rate	4783.9760 1/sec	47014.1400 1/sec
26	CPU time	19058.05 sec	23669.89 sec
27	Cycle time	27.64 sec	27.29 sec
28	Filling time	1.82 sec	1.64 sec
29	Cooling time	20.82 sec	20.64 sec
30	Mold open time	5.00 sec	5.00 sec

5. CONCLUSION:

Comparative analysis of hot runner and cold runner system for moulding process is carried out through simulation using mouldflow software. The results shows that filling time and cooling time could be saved which will increase the production rate by minimizing the production time. Moreover injection pressure and clamping force required is also less for hot runner system as compare to cold runner system. Hot runner system could be better solution regarding scrap and process optimization of moulding process considering cost and production time. Sink marks and weld lines are observed because of changes in temperature distribution in case of cold runner Air traps are also likely to be appear in some of the region of component. These defects can be minimized using hot runner system. Overall we can conclude that hot runner system is more efficient than cold runner system for defect minimization and cost optimization.

REFERENCES

1. Mr. P. Vinod, Mr. K. Vijaykumar, Multi-cavity hot runner injection mold tool polymer", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395 -0056, Volume: 04 Issue: 05, May -2017

2. Rashi A. Yadav, S. V. Joshi, N. K. Kamble, Recent Methods for Optimization of Plastic Injection Molding Process - A Literature Review, International Journal of Scientific & Engineering Research Volume 3, Issue 12, December-2012 1 ISSN 2229-5518
3. Gurjeet Singh, Ajay Verma , A Brief Review on injection moulding manufacturing process, 5th International Conference of Materials Processing and Characterization (ICMPC 2016), ScienceDirect Materials Today: Proceedings00 (2015) 000–000
4. Spina R. Injection moulding of automotive components: comparison between hot runner systems for a case study.J. Mat. Process. Tech. 155-156 (2004) 1497-1504.
5. Vikas. B. J and Chandra Kumar. R, "Influence of Feeding System in Injection Moulding for Lower Washer of Bearing," International Journal of Research in Engineering and Technology, pp. 396-399, 2013.
6. V. V. Andhalkar and Dr S. R. Dulange, "Injection Molding Methods Design, Optimization, Simulation of Plastic Flow Reducer Part by Mold Flow Analysis," International Research Journal of Engineering and Technology, vol. 4, no. 6, pp. 1742-1746, 2017.