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DESIGNING AND MOLD FLOW ANALYSIS OF PLASTIC COMPONENTS

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Abstract — The twenty first century is an era where everything is minimized and optimized. Demand for more design freedom, weight reduction, lowers tooling costs and durability continues to drive OEM's (Original Equipment Manufacturers) towards plastics. Due to this increased design freedom, innovative but complicated plastic components have emerged into the market. These complicated designs of the components and stringent quality requirement has made the mould industry to reorient the approach to satisfy the needs of the customer. This trend fostered the advent of CAE tool for assisting and accelerating the mould manufacturing process. The simulation of the injection molding process is now regarded as a standard practice. The entire injection moulding process can be optimized from the filling phase via the holding pressure, right through to the warpage of a moulded component. Proper interpretation of the results from simulation, can help save, cycle time, material to be used, costs on mould alteration, etc. In this work we successfully designed and develop an optimized feed system, and processing parameter using catia software and developing an optimized design and process parameters for the given components will be forwarded for mould production using mold flow analysis software.

Keywords-component; Injection Moulding; CATIA; Mold Flow Analysis; Moulding Defects

I. INTRODUCTION

Injection molding technology constantly growing, with major milestones including the introduction of the first thermoplastic materials, the reciprocating screw design, the first hot runner systems, engineering materials, the introduction of microprocessors for machine control, Computer Aided Engineering flow simulation software, and recently the application of expert systems for optimized machine setup. This piece of writing presents a vision of injection molding for the next millennium to address current industry needs, and then describes some needed developments to convert that vision to reality. The injection molding machine for the next millennium will pull together the whole injection molding story, i.e. 'the big picture' integrating existing fragmented ideas of machine, material, process, production, and information control with CAD techniques to produce a fully optimized manufacturing strategy. In this paradigm, automation of machine setup procedures will become the normal practice, with each machine in a manufacturing plant having consistent setup/optimization procedures, eliminating the 'black art' of injection molding. Injection molding setters will re-focus their efforts on more complex molding issues that have eluded the design process, providing a specific direction for improving product quality. The ultimate aim is a machine that produces no scrap material and increased product quality with reduced labor skill requirements, low energy consumption, and minimal maintenance. [1]

Worldwide plastic consumption is at least 125,000 million pounds (by weight). About 36% is processed by extruders, 32% percent is processed by injection molding, 10% by blow molding, 6% by calendars, 5% in coating, 3% in compression molding, 2% in power form, and 6% using other processes these percentages do not correlate with the number of machines used, for example there are three times more injection machines than extruders. Major advantages of using plastics include formability, consolidation of parts, and providing a low cast to performance ratio. Knowledge of all processing methods, including their capabilities and limitations, is useful to a processor in deciding whether a given part can be manufactured and by which process. [2]

II. METHODOLOGY

- Solid model of the component: Modeling is done using Catia. It is a process of producing drawings in which computer software are used.
- Mould flow analysis: mold flow software is used to analyze the flow of plastic melt into mold in injection molding it is an important analytical tool available for various analysis of injection molded components. [3]

The sequence of work involved in mold flow analysis is given under. [4]

1. Converting the 3D model in STEP format.
2. import the converted file to the solver package specifying the boundary condition, loads such as injection pressure, injection time, mold temperature, material properties etc.

3. Build the feed system such as sprue, runner and gate, cooling lines.
4. Mesh the feed system and cooling lines.
5. Run the analysis for different analysis types like fill, flow, cooling, warpage etc. [5]
6. Study the result, interpret them.
7. Set up the optimized data for runner, gate, sprue dimensions, coolant temperature etc.
8. Incorporate this value in the design; send the optimized process setting to molding shop for trial.

When CAE is used early in the design stage the cost saving are substantial not only because of time saving, but also the avoidance of expensive and common last minute mold modifications.

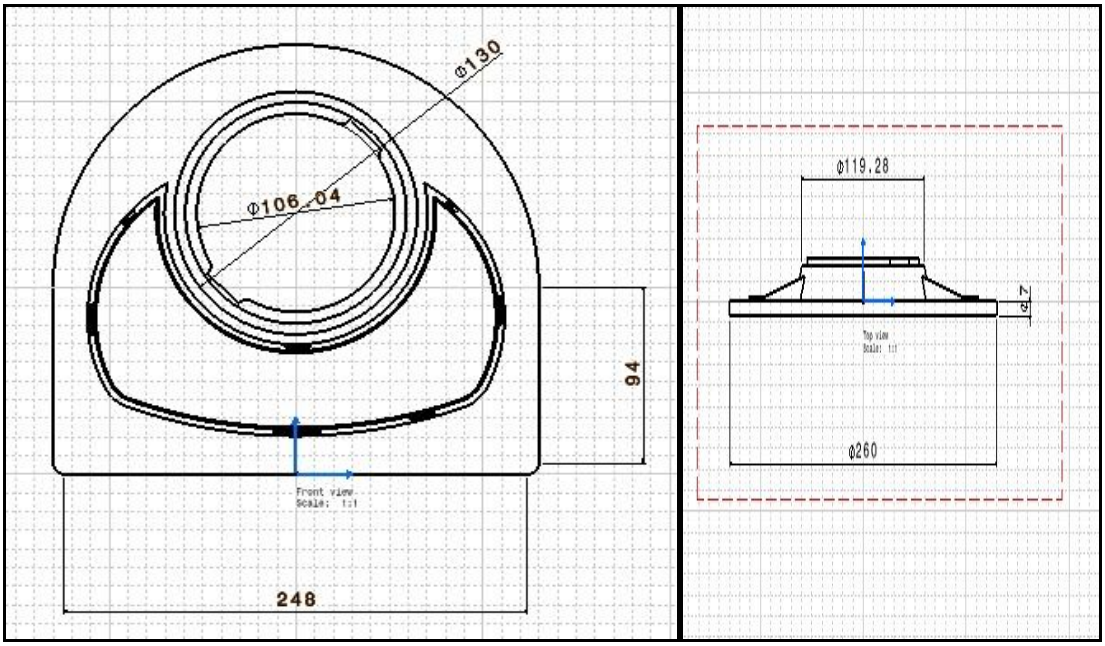
After the analysis we will have the following results.

1. Best gate location
2. Temperature at flow front
3. Pressure at end of fill
4. Weld lines
5. Air Traps
6. Meshed model
7. Cooling analysis
8. Processing conditions
9. Analysis of material flow

III. RESULT AND DISCUSSION

1. DESIGNED BY USING CATIA SOFTWARE:

1. THE COMPONENT IS DESIGNED BY USING CATIA SOFTWARE



FRONT VIEW TOP VIEW

FIG 1

2. MOLD FLOW ANALYSIS OF DESIGNED PLASTIC COMPONENT:

2.1 MESHED MODEL

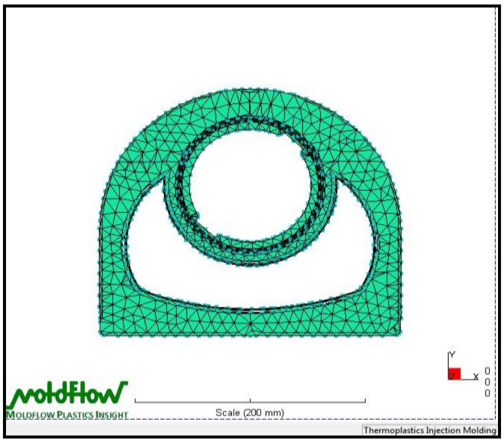


FIG 2

Mesh type = fusion mesh
Initial Global edge length =3.81
Final Global edge length = 1
Mesh statistics = 85.7%
Material selected = Generic PP (Default)
Edge Details
Free edges = 0
Non manifold edges = 0
Free edge = A free edge is an element tat is not shared by other elements.
Manifold edge = A manifold edge is a mesh edge that has two entities attached to it .

2.2 BEST GATE LOCATION

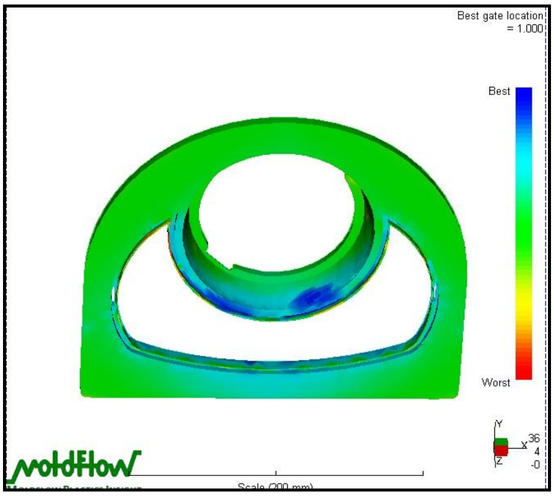


FIG 3

From these results, it will help to determine the best location to locate the gate Point. Results of the analysis will be displayed by the colors Blue, Yellow and Red on the Parts. Blue is the best area to locate the gates and the Red area must be avoided.

2.3 FILL TIME

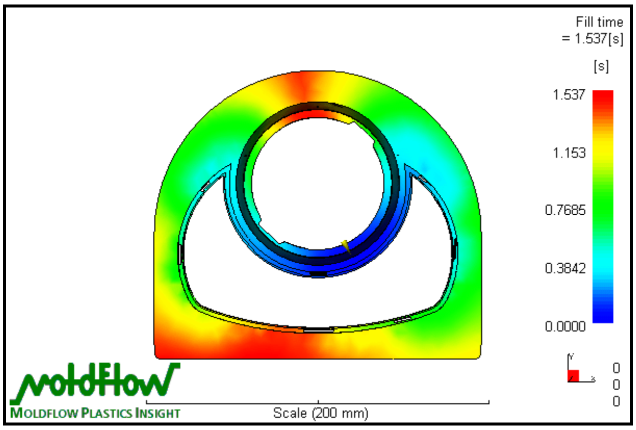


FIG 4

The fill time result shows the position of the flow front at regular intervals as the cavity fills. Each color represents the parts of the mold which were being filled at the same time. At the start of injection, the result is dark blue, and last place to fill is red. A short shot will be displayed as translucent. The primary use of fill time result is to determine if all the flow paths fill at the same time. [6]

2.4 TEMPERATURE AT FLOW FRONT

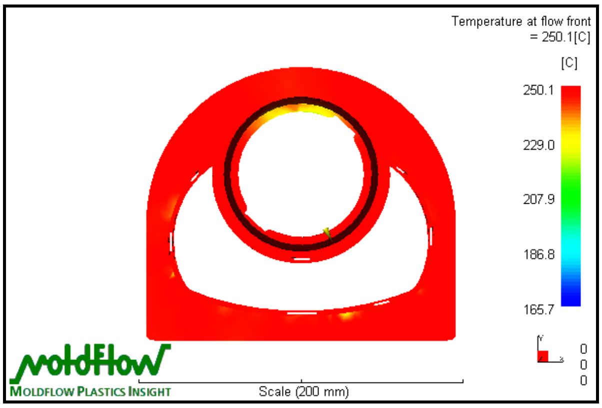


FIG 5

The flow front temperature result uses a range of colors to indicate the region of lowest temperature(colored blue) through to region of highest temperature(colored red).The colors represent the material temperature at each point as that point was filled. The result shows the changes in the temperature of the flow front during filling. . The result shows the changes in the temperature of the flow front during filling. If the flow front temperature is too low in a thin area of the part, hesitation or short shot may be occurred. If it is too low in an area where weld lines are present, the weld lines may appear worse.

2.5 PRESSURE AT END OF FILL

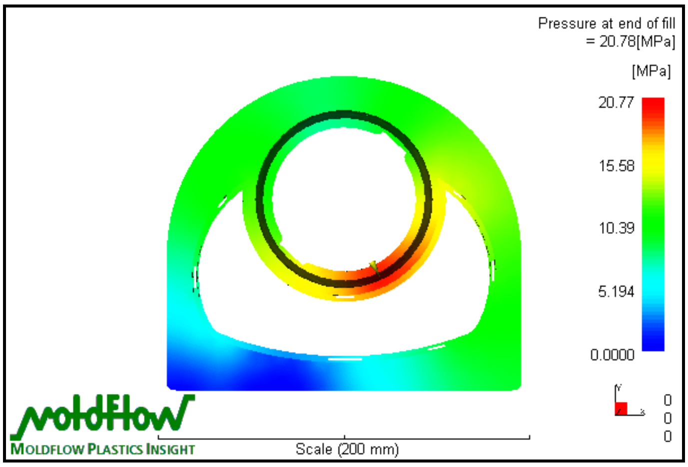


FIG 6

This shows pressure at end of fill. This analysis results shows the pressure distributed over the entire part. Red color indicates maximum pressure and blue color indicates minimum pressure. In the above figure, the maximum pressure is 20.77 MPa.

2.6 WELD LINES

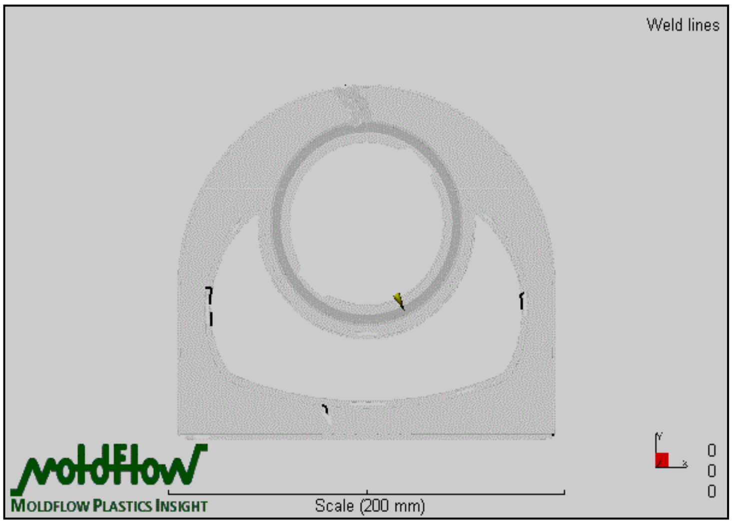


FIG 7

This result indicates the presence and location of weld lines in the filled part model. Weld lines form the thin frozen layers at the front of each flow path meet, melt, and then freez again with the rest of the plastic. Weld lines appears as black lines on the model and indicates weakness. These can be minimized by proper gate location and by altering melt and mold temperature.

2.7 AIR TRAPS

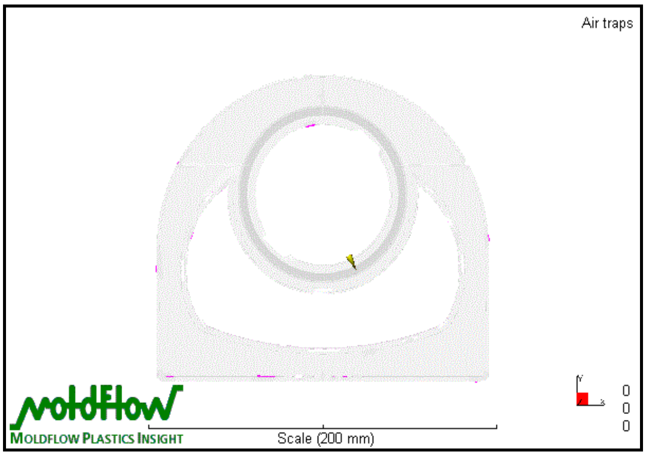


FIG 8

This reults show the regions where the melt stops at last point to fill.And show dark spots where ever and air trap is likely to occur. Air trapped is one of the factors of short shot problem. The mold flow software will show the estimated air trap based on the type of material used, gate located and shape of the part.

- To prevent air traps: Reduce the injection speed, Decrease the part wall thiclness ratio, Proper Venting.

IV. CONCLUSION

The presented work deals with the design and analysis of plastic components. The design was carried out with Catia, and analysis was carried out using Autodesk Mold flow Plastic Insight. Throughout the project, an attempt has been made to understand the fill analysis.

- The possible changes in the dimension that help to be reduce the feature problems are known.
- The cost of molding and manufacturing is reduced.
- Certain variable characteristics can be optimized like cycle time, injection pressure etc.
- The analysis suggests that best locations for injection, gate systems.

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