Defect Analysis of plastic Utility Bin by using Mold Flow Analysis.

Mr. Hariom Thakare
ME Design Student
Anantrao Pawar College of Engineering & Research, Pune
Pune, India

Prof. K. H. Munde
Department of Mechanical Engineering
Anantrao Pawar College of Engineering & Research
Pune, India

I. Abstract— Now a day plastic products have huge demand so that plastic industries is expanding in a faster rate. Plastic part development start with part design in Catia and mature product by using mold flow software virtual study it helps to making and manufacturing of difficult shape with decent dimensional precision. To develop plastic part frst time right need to adopt various advance technologies like CAD/CAM/CAE/MFA for the development of injection moulded parts. Plastic utility bin design and mould flow analysis of injection mould for a given parts were taken to allowing to identify flaws before manufacturing to meet customer requirement. Material nominated for "Plastic part" was Polypropylene . The 3-D model of the part and extraction of core and cavities was done in CATIA V5 software. Auto Desk Mould Flow Analysis software is a great simulation tool to find gate location and predict the flaws in the plastic part.

Keywords— CAD,CAM,CAE ,MFA.

II. INTRODUCTION

Plastics are commonly used in the current world and it is hard to visualize our daily life without plastic. Alexander Parkes invented plastic 1855 and from that time plastics part widely used ad it became No.1 material used, by weight, in the last and current century.

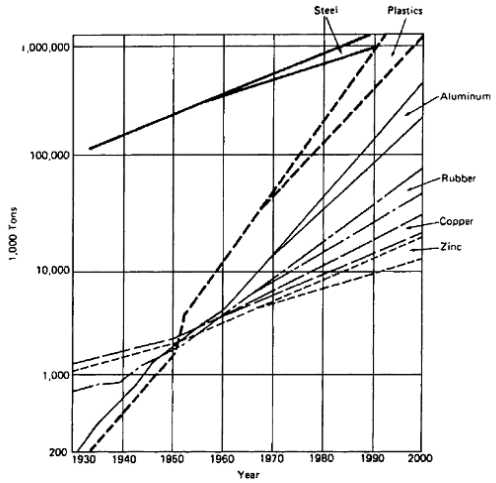


Figure 1 World consumption of plastics by weight

Plastics have benefits such as cost, lightweight structure, and resistance to corrosion, resilient, color fastness, transparency, comfort of processing, etc. Plastic are being used in a wide range of fields such as the medical industry, where they are used for detailed modeling of tissues. In the architectural design industry, plastic methods are used to create scale replicas of future buildings.

The extensive range and different types of plastic materials that are existing today can be designed and processed effectively while still meeting high quality, performance, and profitability requirements. Today and in the upcoming companies must continue to developed high superiority parts in order to remain modest in the global market. With the aid of computer technology plastic strategy and handling limitations have been steadily reduced while the quality has improved expressively.

Development of CAD/CAM/CAE technology particularly Mould flow Analysis, Will help to reduce the number of trails on mould can produce good quality product. In this paper, Mould Design for plastic which is a part of cockpit assembly used in car has been design in CAD software CATIA V5, MFA is done on the part for finding out moulding flaws and reducing product manufacturing time line, cost and man effots.

III. METHODOLOGY

Paper offerings a practical plastic part Design process of an injection mould Part Modeling: As per client necessity to developed plastic part by injection moulding process. The mould was prepare by using part design module of CATIA V5 software. CAD for Mould Design: Already starting mould design the designer should be in ownership of the following evidence's.

- Arrangement of Moulding machine.
- Quantity of impression.
- Material Shrinkage .
- Mold type
- Runner as well as gate type
- Parting line of mold
- Ejection system type.
- cooling system detail.
- Force of ejection

• Blast weight.
•Space between bars.
• mould shut elivation
• Machine height.
• Holding force.

Injection mould design is planned on basic design benchmark and constraints. CAD/CAM helps designers to develop part with least time and desire accuracy. List of factors to be consider while designing of plastic part as mention below :

•Shrinkage , Draft angle,Total no. of cavities ,Choice of parting surface , Feed system Ejector system ,Venting and Cooling system

The 3D model , Core and cavity is done by using CATIA V5 and 2D detailed sketch are prepared in CATIA v5 for the manufacturing of tool at supplier end.

Flow Chart: The flow chart of the procedure followed for the injection mould design is as follows:

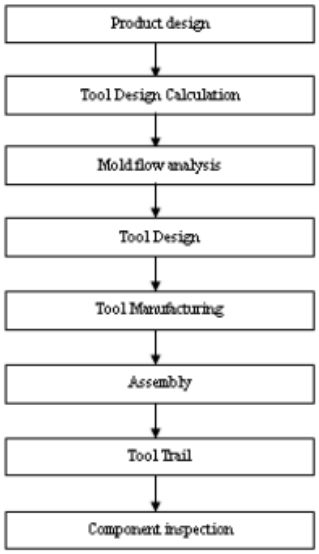


Fig 3. flow chart of injection mould part

Literature Review :

Plastic is one of the most versatile materials in the modern age which is widely used in many products in different shapes which are moulded through the application of heat and pressure [1]. Injection moulding has become the most important process for manufacturing plastic parts due to its ability to produce complex shapes with good dimensional accuracy [2]. The injection moulding process involves feeding raw material, plasticize the raw material, fill the mould, pack the mould, hold pressure, cooling of mould and lastly opening of mould and Part ejection [3].The main factor in the injection moulding are the temperature and pressure history during the process, the orientation of flowing material and the shrinkage of the material. The raw material is generally fed through an angular type sprue channel which feeds the resin pellets forward inside the heated barrel [4]. To start-up a new mould design, the designer should know some important points to avoid some mistakes before going further. i.e., Product outlook design, material usage, correction shrinkage of the material, number of cavities and selection of mould base. In injection moulding, there is an optimum gate size and it should large enough for suitable fill rate and small enough seal off and prevent back flow or over packing Cad/ Cam can help designer to speed up design for the plastic part and mould design process and reduce the long lead time [6].The introduction of simulation software has made a significant impact in the injection moulding industry. With the increasing use of computers in design engineering, the amount of commercially available software on the market has also increased [7]. Traditional trial runs on the factory floor can be replaced by less costly computer simulations. Now a day's, research on optimizing the plastic injectionvmoulding process has developed a lot. CAD/CAE tools are used to produce an optimal mould gating design using Catia and Mould flow applications. The mould flow analysis helps in reducing costs and time and also prevents other defects occurring in the process.

A.Experimental Validation :

Mould Flow Analysis Procedure :

Investigation is vital for designing and mould making of plastic utility bin through simulation by using mold flow sowftware and catia V5 .step-up and outcome of advanced software to show how changes the wall material , thickness, gate location, and geometry of plastic part and also tryouts with "what-if" situations before confirming a design

The Mould flow examination was done using Autodesk MFA software. Step of work of Mould flow analysis is given below.

1. Translating the 3D model into IGES format to ease of opning in other software.
2. Meshing the part by dual domain type of mesh.
3. Importing the meshed file to the solver.
4. Develop the feed method of sprue, runner and gate.
5. Mesh the fodder system and freezing lines.
6. Run the examination for different study types like fill, flow, warpage etc.
7. Study the report, understand them and take action.
8. Start to modify and improved data of gate, sprue, runner and coolant temperature etc. It gives the result of fill analysis, pack analysis, warp analysis and cooling analysis.

Mould Flow Analysis of Plastic Utility Bin:

3D View of Utility bin:

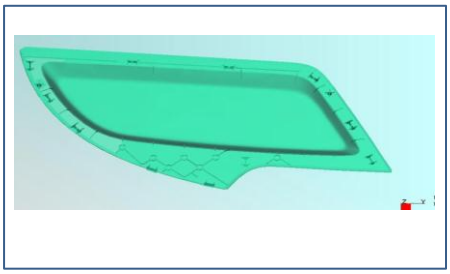


Fig.2 3D view of plastic utility bin

Aim: Perform analysis type (fill + warpage) analysis filling and warpage of the part of PP Material .

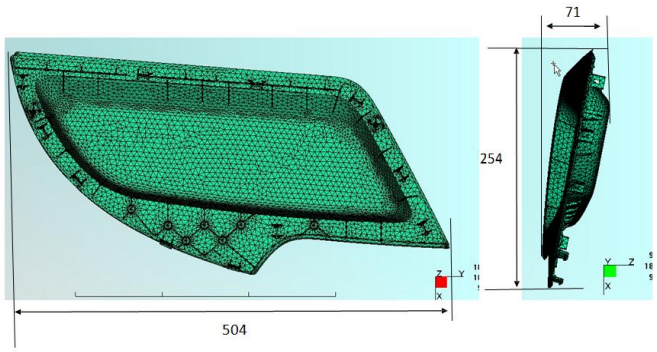
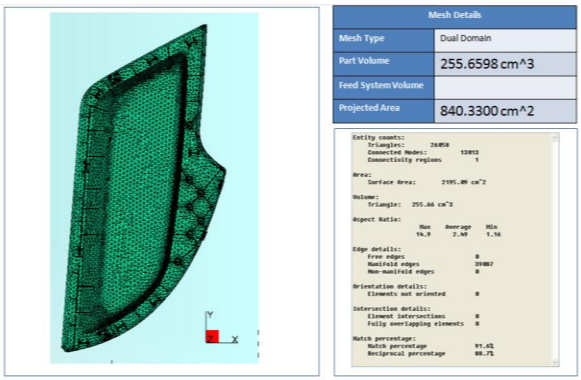


Fig.3 3D view of mesh model

Mesh model Detail:



Mesh Details	
Mesh Type	Dual Domain
Part Volume	255.6598 cm^3
Feed System Volume	
Projected Area	840.3300 cm^2

Fig.4 3D view of mesh model of utility bin

Material Detail:

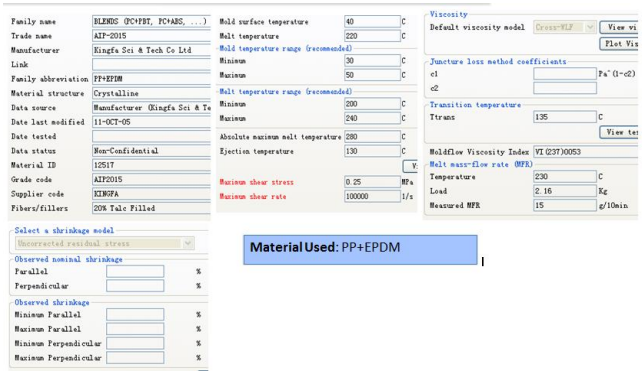
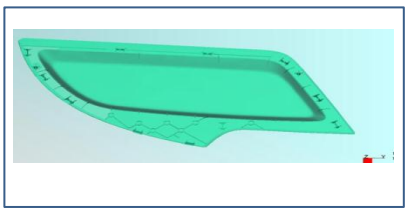


Fig.5 3D view of Utility bin



Feed System Detail :

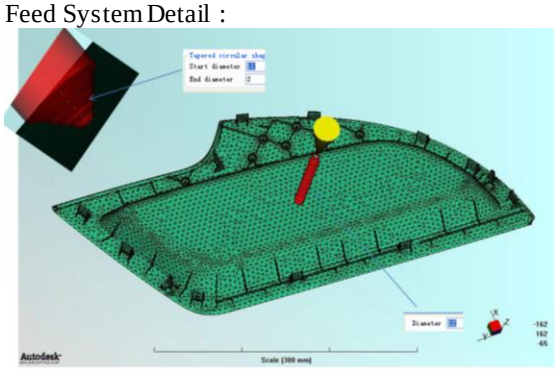


Fig.6 feed system detail

Process Parameter Used:

Material: PP+EPDM

Melt temperature used (^{0}C) :220 (^{0}C)
Mold temperature used (^{0}C) :40(^{0}C)
Injection time used (sec) :1.2 (sec)
V/P Swithover (%) : 97(%)
Pack time (sec) : 10 (sec)
Cooling time (sec) : 10 (sec)
Mold Open/Close time (sec) : 10 (sec)

Packing/Holding Profile	
Time (s)	%Filling pressure
0(s)	80
10(s)	80

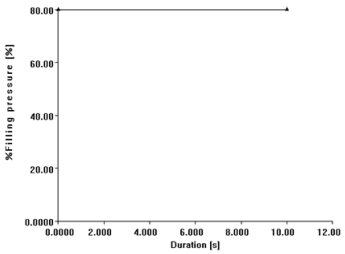


Fig.7 Filling pressure vs time

Fill Time Plot :

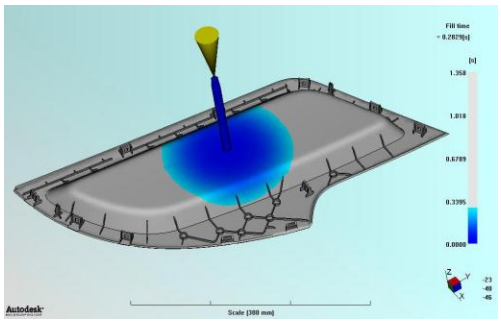


Fig.8 Feel time plot at 0.33sec

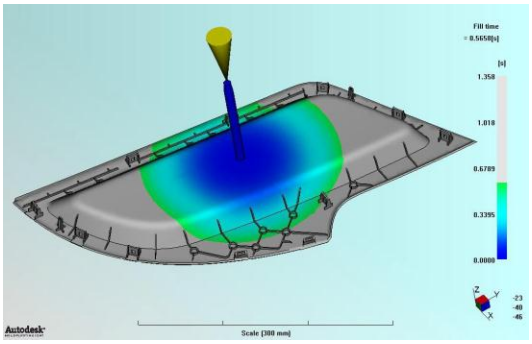


Fig.9 Feel time plot at 0.55sec

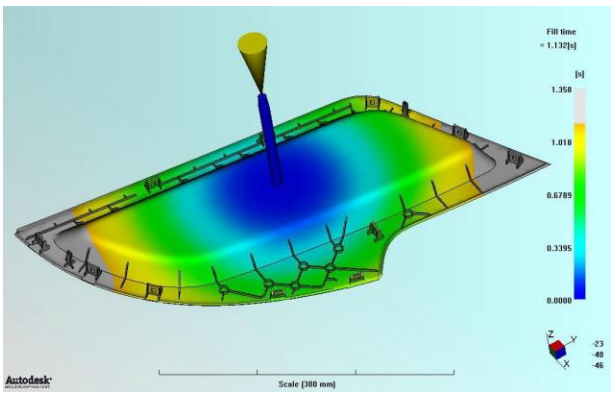


Fig.10 Feel time plot at 1.01sec

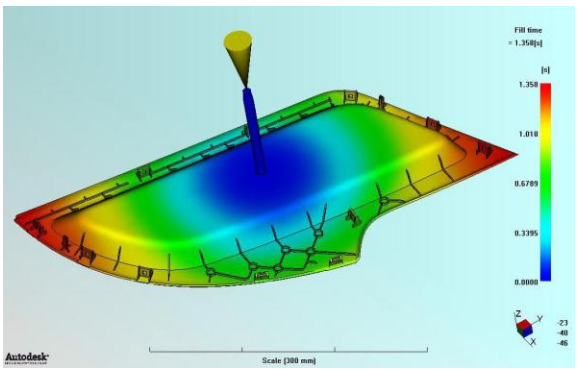


Fig.11 Feel time plot at 1.35sec

Temperature At Flow Front :

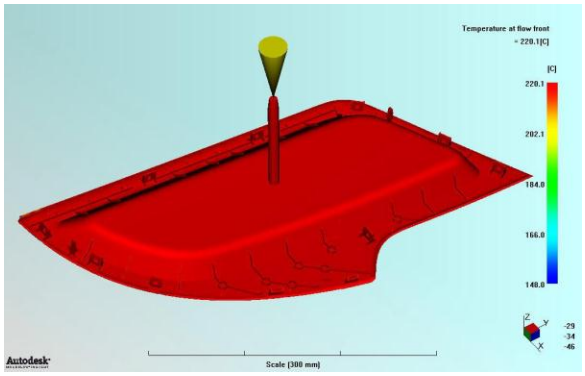


Fig.12 Temperature at flow front

Volumetric Shrinkage

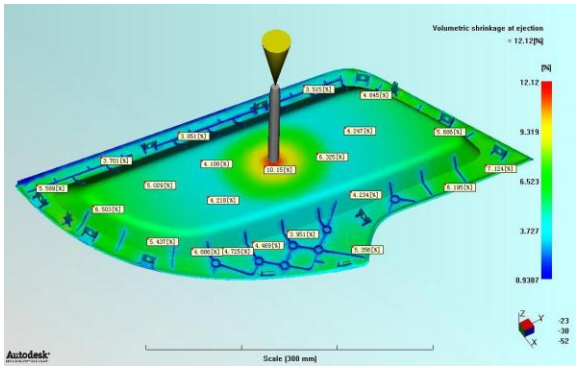


Fig.13 Volumetric Shrinkage
The overall volumetric shrinkage is acceptable

Time To Reached Ejection Temperature :

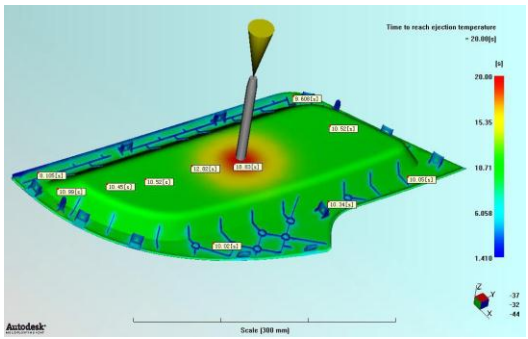


Fig.14 Time to reach ejection temp.

The part will be freeze for ejection within around 12 second

Clamp Force XY-Plot:

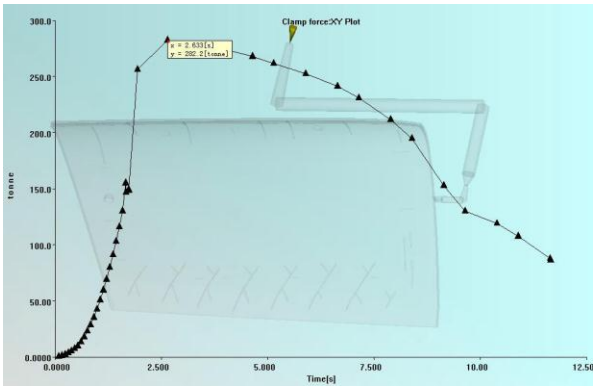


Fig.15 Clamp force

Mold flow Analysis Result:

Total deflection is within 1.7mm which including the factor of part shrinkage Fill time 1.4 sec Injection pressure23Mpa. Totally deflection:1.7-0.2mm. Cycle time:40S

Actual\ Physical Experiment Validation:

Experiment Validation done by CCM check and Measurement on Fixture

Soft tool part:

Image of soft tool first shot part shows sink mark defect due to more thickness of rib structure as well as accumulation of material & not optimization of melt temperature , mold temperature and holdig pressure

Weld Line Detail :

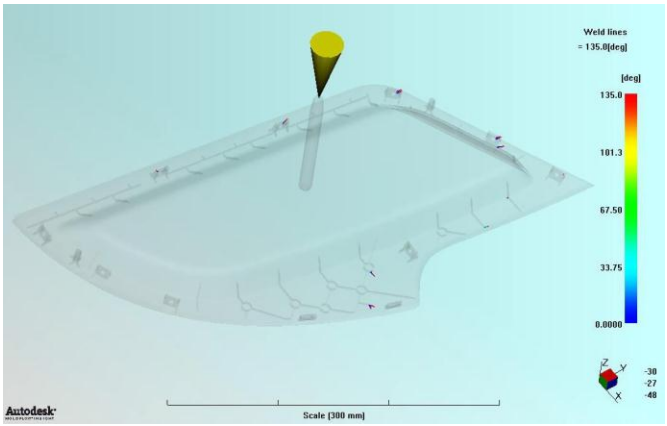


Fig.16 Weld line detail

Total Defection:

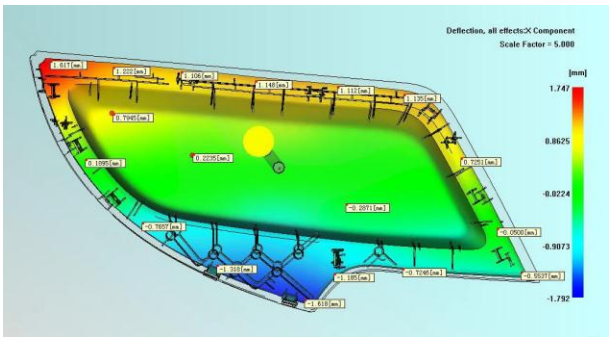


Fig.17 Total deflection

Fig -18. First sample of soft tool part with sink mark defect

Final Hard Tool Sample :

Fig-19. Final Hard tool defect free part :

Mold flow analysis all result are used as a input in hard tool injection molded part and optimize all parameter inline with mold flow analysis report which produce defect free part through out mold life.so mold flow analysis help to reduce product cost and product development time .

CMM check and Measurement on Fixture :

Fig-19. CMM Check and Measurement CMM Check and measurement on fixture shows all dimension variation is within limit.

A) **Acceptance criteria**

UTILITY BIN SHOULD BE DEFECT FREE .THERE SHOULD NOT BE WELD LINE MARK, SINK MARK ,WAR PAGE , SHORT FILL AND FLASH ON UTILITY BIN.

CONCLUSION:

The current study result prove that Design of plastic utility bin with CAD Tools and Mould Flow Analysis is the main requirements for plastic part to developed first time right. The study shows decrease of wastages and saved treasured man hours during product development phase and reduce part development time line .Investigation work shows the consideration of fill time, sink marks,fill time,weld line,air trap, flow mark etc. will affects the excellence of the finished plastic utility bin. The study also shows minimum moulding flaws in injection moulded part. Thus, it is prove mould flow software is a preventive and corrective tool and that benefits the engineer to analyse the process to reduce overall development cycle time and it's important to improve the Quality of the plastic part.

ACKNOWLEDGMENT

It is really a great wish to present this paper on "Defect Analysis of Plastic Utility Bin by Using Mold Flow Analysis". This provides me with the first and the best opportunity to put my engineering knowledge to practical use.

I take this chance with great pleasure to express my deep sense of gratitude towards our esteemed guide Prof. K.H.Munde (HOD Mechanical Engineering. Department) for his valuable guidance and incessant encouragement and co-operation extended to us during this paper work.and also thanks to Prof. G.E.Kondhalkar (HODMechanical Engineering. Department)
I would like to thank Prof. S. B. Thakare (Principal, AnantraoPawar College of Engineering & Research, Parvati, Pune) for their unflinching help, support and cooperation.

References

[1] J.A. Brydson, Plastic materials, British Cataloging sixth edition, 1995, Butterworth Heinemann Ltd.

[2] Bown, J., "Injection Moulding of Plastic Components", McGraw-Hill, 1979.

[3] Mould design,http://www.dow.com/Styron/design/guide.

[4] Technical paper by Johanna Lamminmaki, Totti Lindgren, Jukka Silen and Heli Vesanto, "Influence of

[5] injection moulding process parameter on mechanical properties of polyacetal –specimen".

[6] Design Solutions Guide, http://www.honeywellplastics.com

[7] Technical Directory on design and Tooling for plastics, CIPET,

[8] Manzione,L.T., Applications of Computer Aided Engineering in Injection Moulding,Hanser, NewYork,1987.

[9] Saman, A.M. Abdullah, A.H,Nor,MAM. Computer Simulation apportunity in Plastic injection

[10] Mould Development for Automotive part. International conference on Computer Technologyand Development.