INJECTION MOLDING METHODS DESIGN, ANALYSIS AND SIMULATION OF PLASTIC CUP BY MOLD FLOW ANALYSIS

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Abstract

Mold flow simulation helps designers to see how their designs will be resulted after injection molding process without needing to do the Injection Molding process. The use of simulation programs saves time and reduces the costs of the Molding system design. Injection molding design simulation holds an important role in analyzing the outcome of the design. In this paper plastic cup part is analyzed and studied to solve the problems frequent rejections due to as shrinkage, weld lines, air traps, and sink marks. All the designs were simulated with Autodesk Mold flow Adviser. Autodesk Simulation Mold flow effectively eliminates the use of trial and error method by validating and optimizing the design of plastic before production. This not only improves the quality but also help us to guide about the the selection of machines and the production planning.

Index Terms: Injection moulding, Mould design, Mold flow simulation, Optimization Plastic Injection mould, Mould Flow Plastic Advisor (MPA)

1. Introduction

Injection Moulding is one of the common methods to do the mass-production of plastic product.Thermoplastics are science's gift to the toy industry. They can be melted at fairly low temperatures, molded in colors with fine detail, and stand up well to play wear because of their resilience.. Injection moulding is the most commonly used manufacturing process for the fabrication of plastic parts. A wide variety of products are manufactured using injection moulding, which vary greatly in their size, complexity, and application. Injection Molding is the way most of our plastic toys are created. The material is injected under pressure into a two-part mold. The material is allowed to cool, the mold is opened, and the solid product inside is ejected into a collection hopper. Common problems associated with injection molding are numerous.

2 .Computer Aided Simulation

Nowadays, Computer Aided Design is not limited to sketching and drafting, but also helps to create analysable models as needed for computer based process simulation. Moldflow software, used solution for Digital Prototyping, provides injection molding simulation tools for use on digital prototypes. Providing in-depth validation and optimization of plastic parts and associated injection molds, Moldflow software helps study the injection molding processes in use today. The Autodesk Simulation Moldflow results help to identify the main problem areas before the part is manufactured that are particularly difficult to predict with traditional methods. In conventional optimization process includes actual shop floor trials in which pattern, feeder size, shape and location cores, mould layout, gating etc are required to be changed in each iteration which is associated with machining cost, tooling cost, modification cost, melting cost, fettling and transportation cost as well as energy, materials, time are wasted in each trial until and unless the required results are obtained. Analysis is essential for designing and mould making through simulation step-up and result interpretation to show how changes to wall thickness, gate location, material and geometry affects manufacturability and also experiments with "what-if" scenarios before finalizing a

design. Injection Moulding simulation software into the mould design process in order to analyze the product, foresee the possible defects, and optimize the design to achieve the maximum outcome of the products with minimum cycle time in each production cycle.

3. PROBLEM DEFINITION:

Here a plastic cup is analysed by taking different cases of Model and optimize runner .gating , sprue systems Determine potential part defects, such as weld lines, air traps, and sink marks, and then rework designs to avoid these problems. Create feed systems based on inputs for layout,size,and type of components, such as sprue, runners, and gates .

4. OBJECTIVES OF THE WORK

1.To analyze the behaviour of Thermoplastic material during the production cycle from the filling phase until the ejection phase .
2. To foresee the possible problem for a product design; and therefore able to op-timize the design in the mould design process .
3. To achieve the minimum production cycle time
4. To construct a rapid prototyping of the mould cavity design into a standard mould plate .

5.1 Model details

A 3d model of part toy is created in Mechanical Desktop

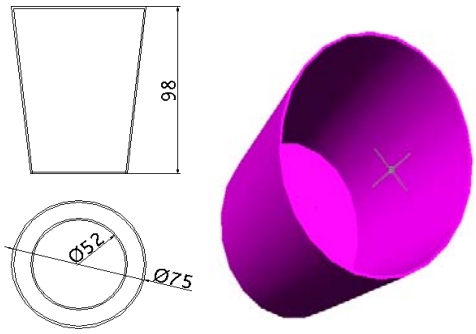

Fig5.1 a). CAD Model Of Plastic CUP

5.2 Process settings

Melt temperature: 240.0 (C)
Mold temperature: 40.0 (C) Injection locations: 1
Max. machine injection pressure: 180.000 (MPa)

5.3Mold Data

Mold material	Aluminium A1
Mold dimensions	X: 95.00 (mm) Y: 95.00 (mm) Z: 85(mm)
Mold plate dimensions	A plate: 118 (mm) B plate: 168 (mm)

Fig5.3 a) mold

5.4Material Data

	Family name-polyethylenes (PE)
Mold Temperature Range	20-60 °C
Melt Temperature	220°C
Ejection Temperature	80°C
Maximum Shear Stress	0.11 MPa
Maximum Shear Rate	400001/s
Modulus Of Elasticity	124 MPa
Poison Ratio	0.39
Shear Modulus	43.97 MPa
Melt Density	0.73537 g/cm^3
Specific Heat	4230 J/Kg-C
Heating/Cooling Rate	-0.3333c/s

6. Simulation Result

6.A Gate Location Analysis

Optimum gate locations may need to be examining by running the filling analysis on different best gate locations. Figureshows the result of gate location. Blue area represents the best gate locations for the part .

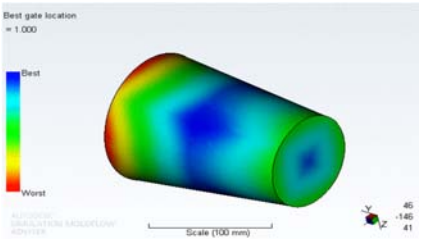

Fig. 6A) best gate location

6.B Fill Time Analysis result

The Fill time result shows the position of the flow front at regular intervals as the cavity fills. At the start of injection, the result is dark blue, and the last places to fill are red. If the part is a short shot, the section which did not fill has no colour. Fill time is the time taken to fill up the part inside the cavity; it is also to show how the plastic material flows to fill the cavity.

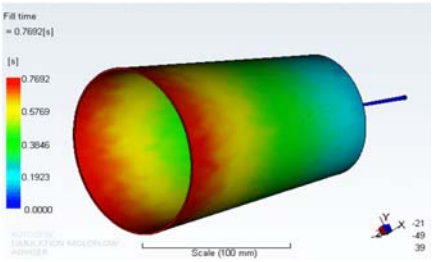

Fig .6B) Fill Time Analysis result

6.c) Confidance of fill analysis result

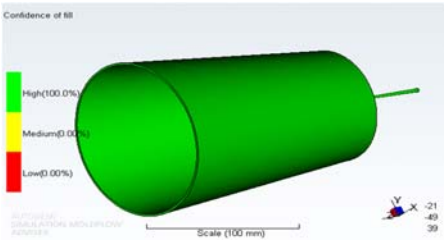

Fig . 6C)Confidance of Fill Time

6.D Quality prediction analysis result

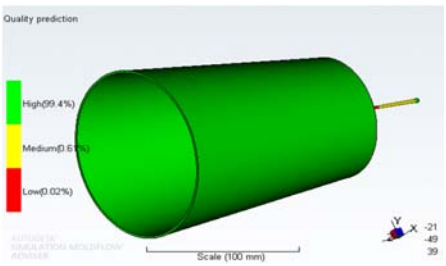

Fig .6D) Quality prediction

6.E)Injection Pressure

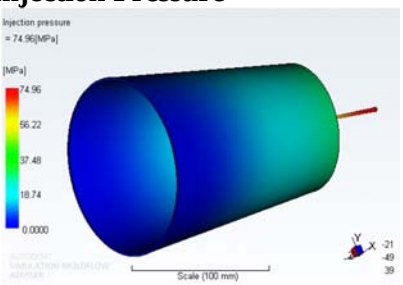

Fig . 6E)Injection Pressure result

6.F) RESSURE DROP

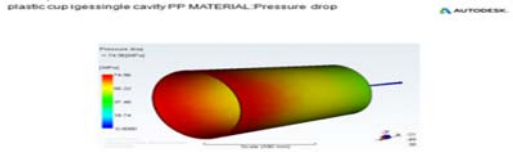

fig . 6F) pressure drop result

6 .G TEMPERATURE AT FLOW FRONT

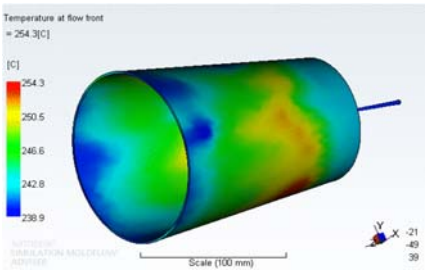

fig . 6G) temperature at flow front result

6 .H. Time To Reach Ejection Temperature

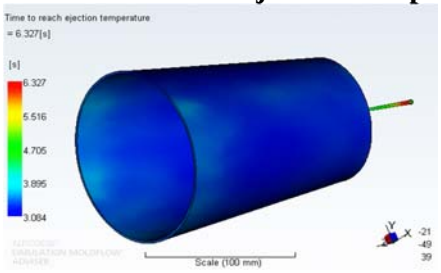

Fig.6H) Time To reach ejection temp .

6 .I). AIR TRAP Analysis result

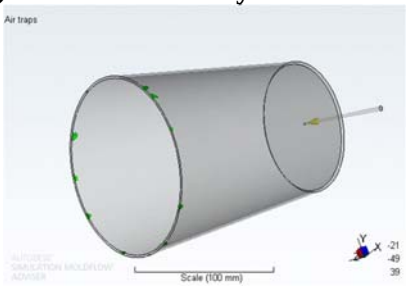

Fig. 6 .I)air trap analysis result

6 .J) weld lines analysis result

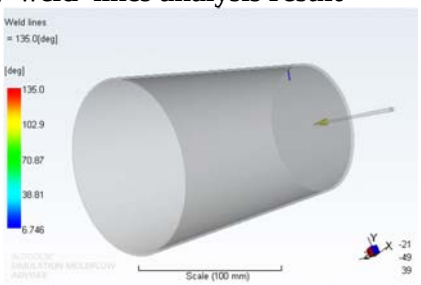

fig. 6J) weld lines analysis resul

6 .L) cooling quality analysis result

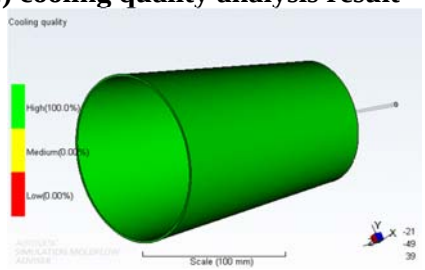

Fig.6 L)cooling quality analysis result

6 .M). Wrap Analysis Result

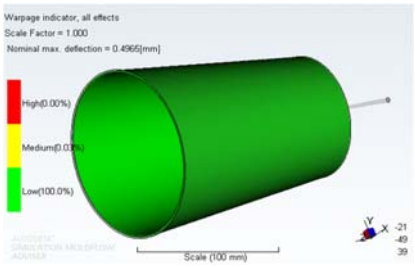

Fig.6M) wrap analysis result

7. RESULTS AND DISCUSSION

Fill tab	
Actual filling time	0.77 (s)
Actual Injection pressure	74.964 (MPa)
Clamp force area	44.1528 (cm^2)
Max. clamp force during filling	9.320 (tonne)
Velocity/pressure switch-over at % volume	97.78 (%)
Velocity/pressure switch-over at time	0.74 (s)
Estimated cycle time	13.06 (s)
Total part weight at the end of filling	18.146 (gm
Shot volume	21.8176 (cm^3)
Cavity volume	21.7426 (cm^3)
Runner system volume	0.0751 (cm^3)
Pack tab	
Maximum clamp force during cycle	16.276 (tonne)
Max. wall shear stress	0.346 (MPa)
Total part weight	18.146 (g)
Cycle time	15.74 (s)
Cooling Quality	
Maximum and minimum temperature variance	5.1 C & -1.2 C
Maximum and minimum cooling time variance	0.49 (s) & -0.57 (s)
Cool tab	
Maximum temperature, part	49.2 (C)
Minimum temperature, part	32.6 (C)
Average temperature, part	41.1 (C)
Mold exterior temperature	27.4 (C)

8. CONCLUSION

By observing the analysis results, The confidence of fill is high when One Gate Location is taken other defects like air traps, weld lines will be less.. By taking two gate locations, the wastage of material will be more. So it is concluded that using one gate locations and by given injection pressure gives better filling results. From the above results parameters like mold temperature, melt temperature, fill time, quality prediction, cooling time, cool quality, volumetric shrinkage, injection pressure and temperature and extent of warpage were successfully determined and later the gate position which shows the closest values to these parameters was taken into account and finally fixed as optimum gate position. For the mould maker and mould designer, the result of this study has shown how the Moldflow software has

been able to assists to get the most optimum design out of a part product, and how to predict the future issue that might appear so it can either be solved if possible or find the alternative solution for it .

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