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Computer Simulation for Finding Optimum Gate Location in Plastic Injection Moulding Process

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Abstract
As there is a demand in plastic products, plastic industries are growing in a fastest rate .hence plastic injection moulding process begins in manufacturing of complex shapes, in this process optimum gate location is one of the important criteria in mould design . plastic advisor simulation tool from Pro/E was used for the analysis to optimize the gate location with least defects and it requires less time to achieve a quality result with no material waste as compared with conventional trial error method on production floor. In this project an analysis has been performed by taking varying gate locations for a head light cover of an Alto car a plastic component
Keywords*: injection moulding process: Mould Flow Plastic Advisor (MPA), Gate location, moulding defects.*

I. Introduction

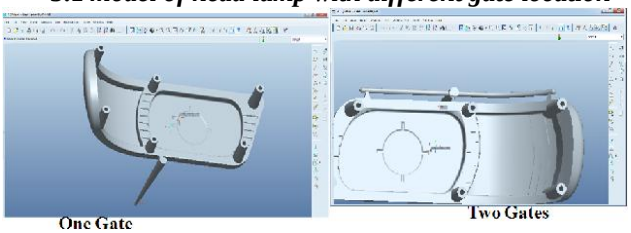
Injection moulding is the most commonly used manufacturing process for the fabrication of plastic parts. A wide variety of products are manufactured using injection moulding, which vary greatly in their size, complexity, and application. The injection moulding process requires the use of an injection moulding machine, raw plastic material, and a mould. The plastic is melted in the injection moulding machine and then injected into the mould, where it cools and solidifies into the final part Injection moulding is used to produce thin-walled plastic parts for a wide variety of applications, one of the most common being plastic housings. Plastic housing is a thin-walled enclosure, often requiring many ribs and bosses on the interior. These housings are used in a variety of products including household appliances, consumer electronics, power tools, and as automotive dash boards. Other common thin-walled products include different types of open containers, such as buckets. Injection moulding is also used to produce several everyday items such as tooth brushes or small plastic toys. Many medical devices, including valves and syringes, are manufactured using injection moulding as well

II. Literature review

Napsiah Ismail & A.M.S. Hamouda [15] This paper presents the design of plastic injection mould for producing a product. The plastic part was designed in different types of product, but in the same usage function. One part is using clip function and another part is using stick function. In the computer-aided design(CAD),two plastic parts were drawn in 3dimension(3D)view by using Pro-Engineer(Pro/E) parametric software .In the computer-aide manufacturing(CAM), Pro Manufacturing from Pro/E parametric software was used to develop the machining program For mould design, the product was designed into two changeable inserts to produce two different types of plastic production one mould base. Before proceeding to injection machine and mould design, this part was analyzed and simulated by using Part Advisor software. From the analysis and simulation we can define the most suitable injection location, material temperature and pressure for injection. The predicted weld lines and air trap were also found and analyze .OYETUNJI .A [16] Development of small injection moulding machine for forming small plastic articles in small-scale industries was studied. This work which entailed design, construction and test small injection moulding machine that was capable of forming small plastic articles by injecting molten resins into a closed, cooled mould, where it solidifies to give the desired products was developed. The machine was designed and constructed to work as a prototype for producing very small plastic components. Design concept, operation, and assembly of components parts were made. Also, working drawings and materials selection were made based on calculations of the diameter of injection plunger, number of teeth required for the plunger rack and spur gear, the angular velocity, number of revolution, torque and power obtained from the electric motor selected and the leverage on the handle of the machine. The machine parts/components were then assembled in line with the designed made, thereafter the constructed machine was tested using high density polyethylene and master batch. The results obtained from the test were satisfactory

III. Methodology

3.1 *model of head lamp with different gate location*



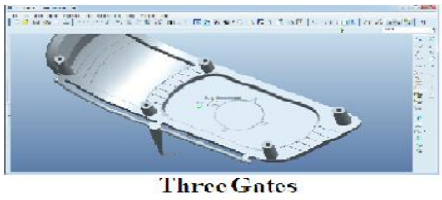


Fig1: Head lamp with different gate locations

3.2 *material assignment with different processing conditions*

The material chosen for analysis was plastic of trade name polymer HH3 belonging to the material, Acrylonitrile /butadiene/styrene (ABS) The appropriate material properties are already there in the plastic advisor's extensive database of Pro/E Plastic material. The mechanical properties for ABS are good for impact resistance even in low temperatures. The material is stiff, and the properties are kept over a wide temperature range

3.3 *Analysis on different gate location by Mould flow plastic advisor*

A good quality casting by providing a homogeneous filling pattern a well designed gating system is very important. During injection moulding process there are many process conditions in which the main processing parameter are tabulated below. The injection pressure given by the company is 130MPa,analysis is done by 180MPa for varying gate locations

SNo.	Max. injection pressur(MPa)	Mold temperature	Melt temperature	Injection time(sec)
1	130MPa	45ºC	180ºC	31.46
2	180MPa	60ºC	230ºC	25.88

Table 1 :Operating parametes for one Gate Location

SNo.	Max. injection pressure(MPa)	Mold temperature	Melt temperature	Injection time(sec)
1	130MPa	50ºC	150ºC	59.66
2	180MPa	60ºC	230ºC	26.29

Table 2: Operating parameter for Two gate location

SNo.	Max. injection pressure(MPa)	Mold temperature	Melt temperature	Injection time(sec)
1	130MPa	60ºC	180ºC	60.42
2	180MPa	60ºC	230ºC	26.4

Table 3:Operating parameter for Three gate location

3.3.1 Mould Filling Result Analysis on different gate location at 180MPa

3.3.1.1 single gate location

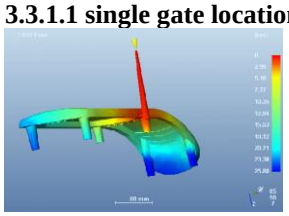


Fig 2: Fill Time

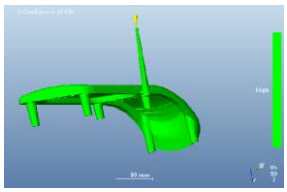


Fig 3: confidence of fill

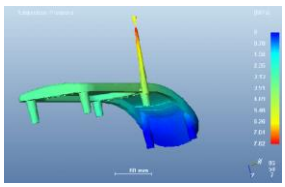


Fig 4: Injection pressure

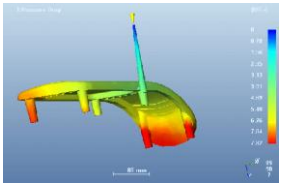


Fig 5: pressure drop

3.3.1.2 Two gate location

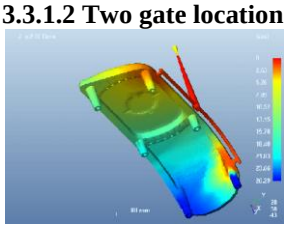


Fig 6: Fill time

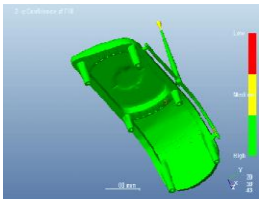


Fig 7: confidence of fill

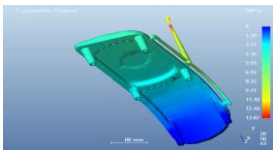


Fig 8: Injection pressure

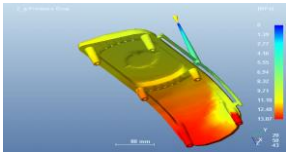


Fig 9: pressure drop

3.3.1.3Three gate location

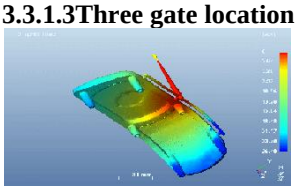


Fig 10: Fill Time

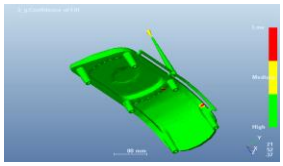


Fig 11: confidence of fill

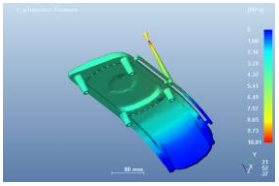


Fig 12: Injection pressure

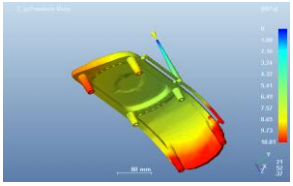


Fig 13: Pressure drop

The adviser declares all green color in the mould analysis shows, the part is acceptable and easily filled, as the yellow color on the part increases the quality of mould decreases , if the analysis part contain both yellow and red it is extremely difficult to fill

From the above figures **:**

Confidence of fill: the result displays the probability of a region within the cavity filling with plastic at conventional injection moulding conditions. This result is derived from the pressure and temperature results.

Injection pressure: The result uses a range of colours to indicate the region of lowest pressure (colour blue) through to the region of highest pressure (colour red). The colour at each place on the model represents the pressure at that place on the model, at the moment the part is filled completely. This is a 'snapshot' result, that is, it shows the pressure through the whole part at the end of fill.

Pressure drop: The result uses a range of colour to indicate the region of highest pressure drop (colour red) through to the region of lowest pressure drop (colour blue). The colour at each place on the model represents the drop in pressure from the injection location to that place on the model, at the moment that place was filled. That is, the pressure required to force material to flow to that point.

3.4 Minimum Defect Analysis On Different Gate Location

The following figure shows weld lines and air traps presence on different gate location Weld line result indicates the presence of weld marks in the filled part model Air traps result shows the region where the melt stops due to bubble of air becomes trapped

3.4.1 Single gate location

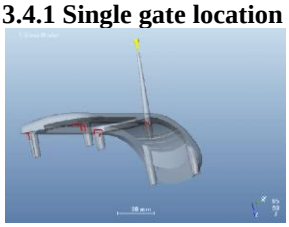


Fig 14: weld lines

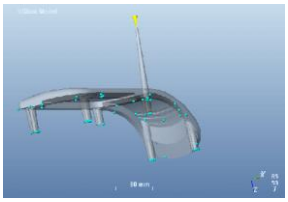


Fig 15 : Air traps

3.4.2 Two gate location

Fig 16: weld lines

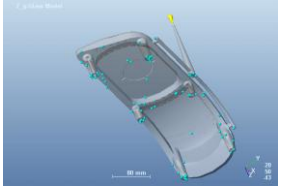


Fig 17: Air traps

3.4.3 Three gate location

Fig 18: weld lines

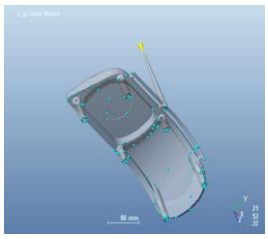


Fig 19: Air traps

IV. Result Discussion

In this present work totally Six variations of Head Lamp Model of Alto Car are analyzed by using plastic advisor pro/E engineer software (Injection Moulding). The Following table shows analysis and results in following parameters such as, Filling Time, Confidence Filling Level, Injection Pressure, Flow Front Temperature and Pressure Drop.

Table 4: Result Obtained at 130MPa Input Pressure

SNo.	Number of gate location	Fill in time (Sec)	Confidence of fill (mm)	Injection pressure (MPa)	Pressure drop (MPa)
1	Single	31.46	155	16.87	17.69
2	Two	58.60	63	37.07	43.15
3	Three	58.80	32	24.30	24.30

Table 5: Result Obtained at 180Mpa Input pressure

S No.	Number of gate location	Fill in time (Sec)	Confidence of fill (mm)	Injection pressure MPa	Pressure drop MPa
1	Single	25.88	85	7.82	7.82
2	Two	26.29	50	13.87	13.87
3	Three	26.40	52	10.81	10.81

V. Conclusion

By observing the analysis results, for all models of gates, locations the injection time is less when injection pressure is increased than the original injection pressure. The confidence of fill is high when One Gate Location is taken but other defects like air traps, weld lines will be more. The confidence of fill when two gates is taken is slightly less than that of One Gate Locations but the other defects can be minimized. By taking three gate locations, the wastage of material will be more.

So it is concluded that using two gate locations and by increasing the injection pressure gives better filling results.

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