Analysis for PH Meter Cover

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Abstract*— In development of a plastic injection mold, the goal of the designer is to achieve an optimal mold design with minimum material wastage and time per cycle, yet produces the product without defects and blemishes. To design the mold, the designer can vary the mold design by manipulate the shape of the part and also the runner and the gate locations. As a consequences of the cost involved in mold manufacture is very expensive, trial-and error experimentation in the design of the mold is not economical. To permeate this problem, the use of Computer aided design (CAD) or Computer aided engineering (CAE) application assisted in design and establishes the most optimal mold gating system. This research was conducted for implementing the use of CAD/CAE tools to produce an optimal mold gating design using Pro/E and Moldflow® applications. The application tremendously assist the designer in resolve the mold with best gating location in producing an automotive plastic part with low defects, fast time-cycle and the most important factor is to reduce the manufacturing cost

***Index Terms*— Computer aided design (CAD); Computer aided engineering (CAE). Mould flow, Plastic Mould.**

I. INTRODUCTION

Injection moulding is considered the most prominent process for mass production plastic parts. Today, around 30% of manufactured plastic goods rely on injection molding, which is based on the injection of a fluid plastic material into a closed mould. The use of plastics has become increasingly important as weight; cost and quality are standard points to stay competitive in the industry. Besides that, plastics can be moulded into extremely complex shapes, good dimensional accuracy [1], making them suited to be used in high technology products. However, the injection moulding operations can also sometimes be quite a challenge to the mould designer as to design a mould that produce products with less defects as weld lines and air traps. Currently, the process of trial and errors required at the tryout stage can be reduce through the CAE by simulation resin flow pattern and plastics material are easily tend to have warpage, shrinkage, and predicting possible defects that can be avoided by improving flow balance with the proper selection on gate location. In this research, the uses of CAD/CAE applications are completely used in determine the best gating location for Ph meter cover plastic part.

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II. PART DESIGN AND MODELLING

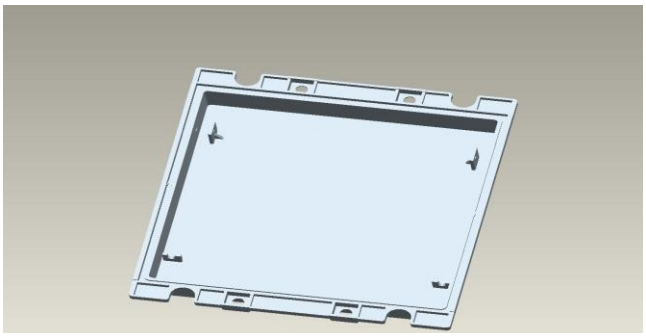
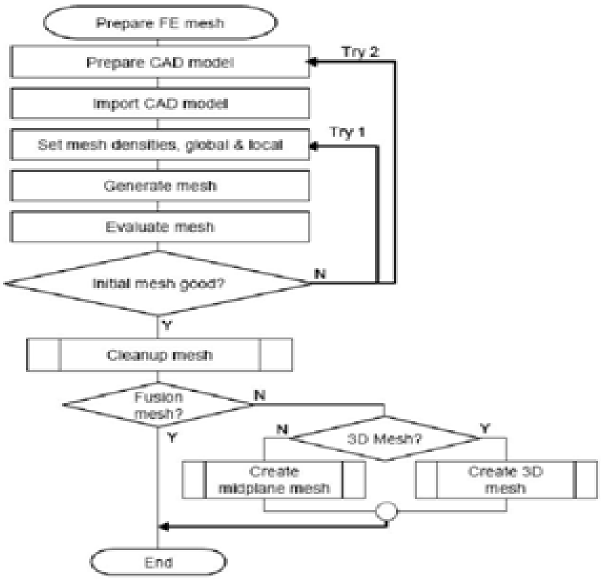


Fig. 1. Component of Ph meter cover

The actual part is first created in CAD Figure 1 shows the original part and the solid model of the Ph meter cover that has been developed by using Pro/E. Conversion the part model to STL data format is essential which is companionable with Mould flow Plastic Insight (MPI) software, and ready for pre-processing stage.

III. PRINCIPLE OF FINITE ELEMENT METHOD

Flow Chart 1. Illustrates the procedure in preparing a finite element method for Mouldflow® analysis. The mesh density then can be set locally or uniformly depending on shape and features complexity. There are three types of meshing available; fusion mesh, midplane mesh and 3D mesh. Fusion meshing was used since a collection of 3-noded triangular elements was used in describing the surface of the part. Using fusion mesh thin walled component can be meshed very finely which is created in CAD solid model.



Flow Chart 1. Steps in Finite Element Method for Mold flow analysis [4]

The next pre-processing step is to define the part material. The plastics material used for this application is Polycarbonate (PC).

IV. EXPERIMENTAL GATE LOCATION

Placing a gate appropriately is the most critical factor in determining the quality of the part. The analysis result, the gate location on the part may be preset or appeared with two or three choices; then the optimum gate locations may need to be examining by running the filling analysis on different best gate locations. Figure 2(a) show the result of gate location.

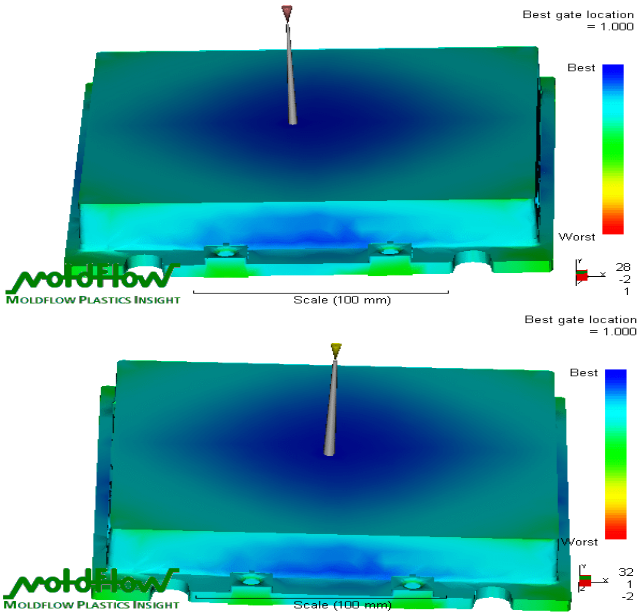


Fig. 2. Best Gate Location

Blue area represents the best gate locations for the part. The result shows that the best gate location can be at the top or at the side of the part.

V. EXPERIMENTS ON MOULD FILLING

A. Fill Time Results

The fill time result shows the progression of the material into the cavity. One of the aims in selecting gate location is to ensure the flow paths in the cavity fill uniformly [6] and filling completed rapid as possible. Figure 3 show the fill time result.

The fill time for the first case is 1.243 seconds and for second case 1.338 seconds

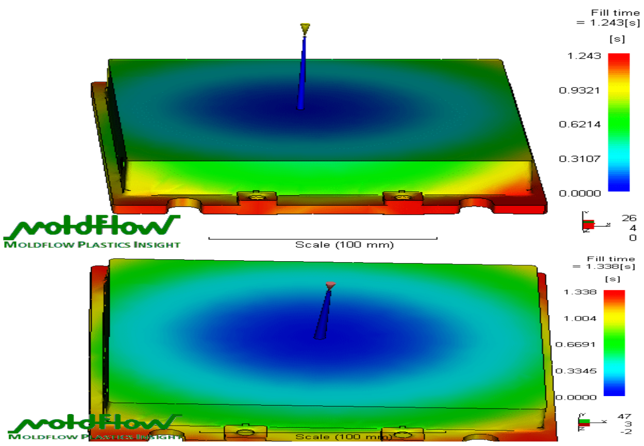


Fig. 3. Fill time results for first case and second case

B. Time to Freeze Results

The time to freeze indicates the time required for the resin polymer to reach the solid state. This will affect the cycle time for the part. Parallel freezing time and fast cooling is desired as these affect the product properties and cycle time. As shown in Figure 4, the time to freeze for the first case is 54.91 seconds while second case recorded 69.05 seconds.

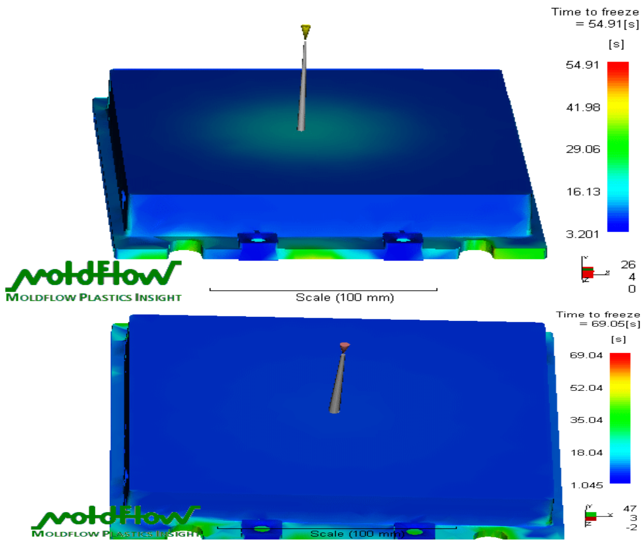


Fig. 4. Time to freeze results first Case and second case

C. Shear Stress Result

Shear stress at wall occurs at the frozen or molten layer interface. This is the location in the cross section where the shear stress will be the highest. The shear stress within the part should be below the material limit specified in the material database. Shear stress should be keep to minimum because

shear stress can cause warping surface, blemishes and reducing the strength of the part. A higher injection pressure is an indicative of an occurrence of higher shear rate and shear stress level [6]. As shown in Figure 5, the maximum shear stress at wall for the first case is 2.859 MPa and second case is 0.796 MPa.

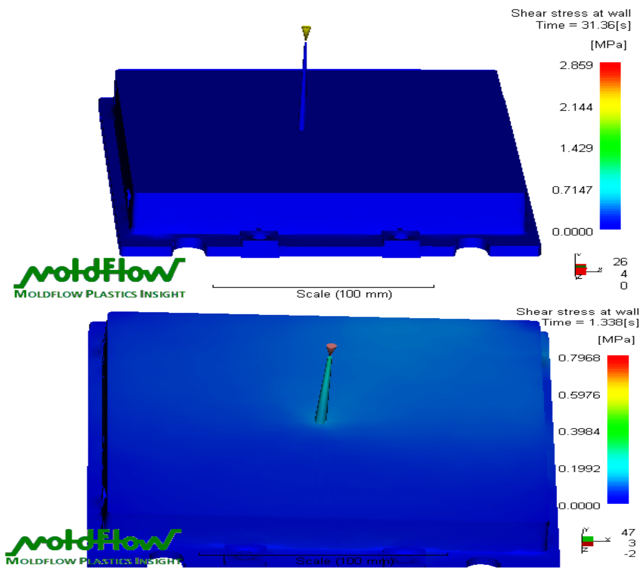


Fig. 5. Shear stress at wall results for first case and second case

D. Air Trap Result

The result will show air traps that might possible to develop in the part during filling. Air traps should be eliminated by using several approaches such as changing the wall thickness, gate locations or injection speed. Figure 6 show the visualization of the air traps that might be develop in the part. Air traps indicate the presence of surface defects such as burn marks, blemishes and short shot [6].

Fig. 6. Air trap results for first case and second case

E. Weld Line Result

Weld lines occurs when two material flow meet together, or a flow front splits and comes back together as happen around a hole. Occasionally weld lines are formed at the interface between the thick and thin section when there is significant race tracking where the material in the thick section is racing around and the thin is lagging. Weld lines basically will cause poor appearance of the part. Figure 7. shows the weld line in case (a) and case (b).

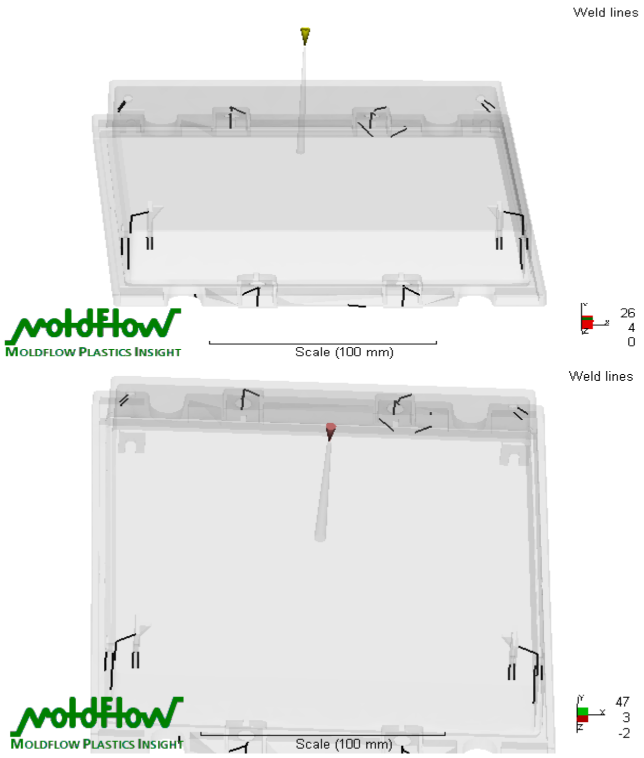
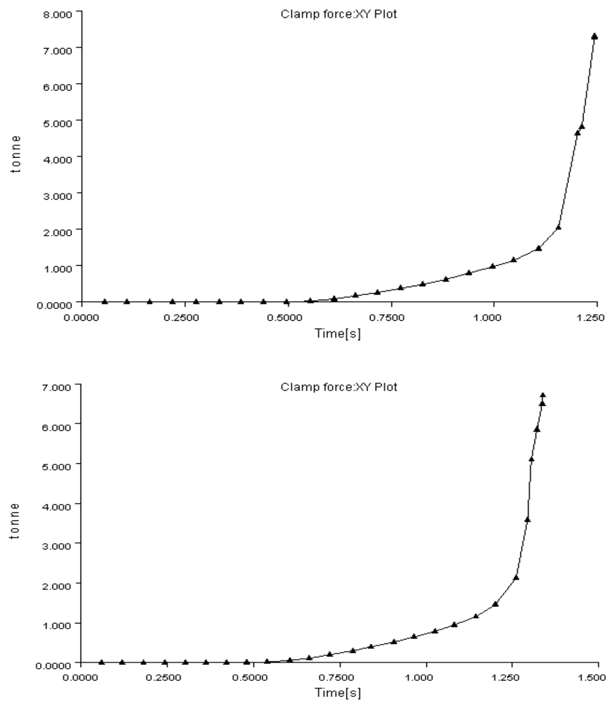


Fig. 7. Weld line results for first case and second case

F. Clamping Force Result

The clamp tonnage is calculated based on the cavity area at the parting line. The clamp force is calculated in each element using the projected area on the XY plane and the pressure in that element. Clamp force can be very sensitive to balanced of

fill and pack pressure. Graph1. show the graph of the clamp force. The maximum clamp force for the first case is 7.48 tonne and second case is 6.8 tonne. The clamp force rate also seen smooth for second case compare to sudden change at first case.



Graph1. Clamping Force for first case and in second case

VI. DISCUSSION

Table 1 shows the results summary for both case to determine the best optimize mould design. In terms of production time which is the time taken for complete fill plus the time to freeze, the first case need the total time of 54.91 seconds, while the second case need the total time of 69.05 seconds. This shows that the second case has the fastest production time. From the results, we can also see that the second case has the high shear stress (2.859 MPa) as compared to the first case. For air traps and weld lines defects, the second case also proved to be the best design as it has low defects than the other. Result for the clamp force is better at second

Table 2. Comparison between two cases

EXPERIMENTS	1ST CASE	2ND CASE
FILL TIME	1.243	1.338
TIME TO FREEZE	54.91	69.05
SHEAR STRESS	2.859	0.796

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AIR TRAPS	High	Low
WELD LINES	High	Low
CLAMPING FORCE	7.48	6.8

VII. CONCLUSION

This paper outlines the result of computer simulation of Moldflow Plastics Insight® (MPI) software in identifying the best gate position for an Ph meter cover. The first computer simulation demonstrates best position of gate. Best location of the gate obtained from the analysis has been selected for manufacturing and in design. The present gate size and location is finalized after little iteration from the point of balanced filling and other factors. In the 1st case we can reduce the fill time, clamping force, air traps etc. As compared to 2nd case which are shown above. Most of the air traps are located on the surface, which can be removed by providing suitable air vents in the mould. Mould filling simulation gave a picture that the second alternative of gating position is the best suite for the part.

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