Middle-East Journal of Scientific Research 24 (S2): 282-288, 2016
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2016.24.S2.182

Flow Analysis Based on Moldflow in Injection Molding Process

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Abstract: This paper is based on the Mold flow software result analysis for the injection molding process which is compared on the results obtained from the software used. Injection molded components are consistently designed to minimize the design and manufacturing information content of the enterprise system [1]. The resulting designs however are extremely complex and frequently exhibit coupling between multiple qualities attributes. Mold flow software is used to analyze plastics flowing status during the formation of the trapezoidal plastic plate. Comparison and analysis is made in for different melt temperatures by MPI software. It fully reveals the outstanding effect of MPI software in the injection system and development of injection mould.

Key words: Bulk temperature · Mold Flow Plastic Insight

INTRODUCTION

There are basically two process involved in this experiment. The first one is the requirement of the basic knowledge of the working of injection molding. Next is the knowledge on how to use mold flow software. First lets see about Mold flow plastic insight (MPI) [2]. This is a software providing analysis of plastic parts and mold. In recent years it has been used in a large number of mold designs, which allows the user to optimize the geometry parts of the plastic materials, select the materials, design the mold and set the processing parameters. It is also helping in forecasting the plate defects that may occur, in order to obtain high-quality products [3]. MPI Software simulates the mold in the filling, flowing, cooling, war paging and other processes to find the problems in mold design and parameter setting. Improving that can greatly reduce the tryout time and increase the efficiency of the injection mold design and reduce the production costs.

There are two steps involved first the numerical simulation and next the injection molding process. Numerical simulation of the injection mold filling process need to consider the parameters in injection molding processes, such as: injection molding material, the melt viscosity, mold temperature, melt temperature, filling pressure, filling time, packing pressure and packing time. MPI software could simulate the process of injection molding by setting the processing parameter. In the processing parameter settings, MPI software will recommend parameters to the user. If the designers want to get the best parameter values, they usually keep the value of other parameters constant, changing only one parameter. By analyzing the plate under different values of the parameter and comparing the different results the best value can be obtained. The numerical simulation software greatly reduces the products' developing time and cost.

MPI software makes it possible to integrate the plastic plates, mold designing and the parameters into the filling process. The analyzing process is shown in chart 1.

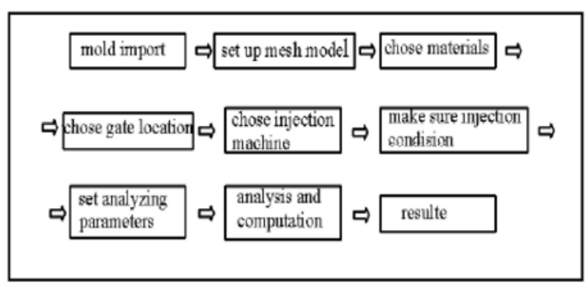

Chart 1: The rheological analysis process

For injection molding process the temperature which suits the material is taken for consideration and that temperature is kept as standard temperature and the experiment is carried out in injection molding machine.

Numerical Simulation: A short trapezoidal plastic plate in simulation is shown in Figure. After importing the plate graphics into MPI software, the mesh model for the

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plate is made first. For such kind of thin plate, MPI grid finite element analysis of surface mesh grid can be used. As shown in Figure 1, in this mesh model, the total number of nodes is 694 and number of elements is 1400. The advantages of using the surface grid are that its shape and appearance is the same as the 3D model and the time of pretreatment is shorter. For the thin-walled entities, MPI surface mesh modules are based on the MPI analyzing technology. It can allow the users to directly analyze the thin walled solid model and that would reduce the several hours or even days of the original modeling work to a few minutes, without the need for medium-sized surface mesh generation and modification [4]. Besides, the surface mesh can be directly further analyzed.

The plastic plate material used is nylon. In the mold filling process, plastic properties of the materials also play a very important role, in particular, the viscosity of the material. Even though the same kinds of materials and the same mold are used, different material viscosities may lead to differences in melt temperature and injection pressure [2]. Furthermore, different melting viscosity can also affect the shear rate and Shear stress in the gate during the filling process. Then a viscosity model is necessary, the following are the commonly used viscosity models: Power law models (Mold flow first order model), Mold flow second order model, Mold flow matrix data, Ellis model, Carrie model, Cross model. In the MPI software model, cross model equation is used for analyzing the viscosity of nylon materials.

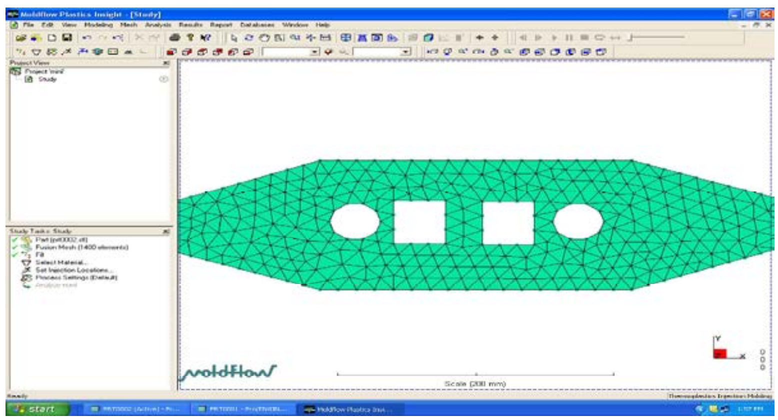

Fig. 1: Mesh model

The plastic plate material used is nylon. In the mold filling process, plastic properties of the materials also play a very important role, in particular, the viscosity of the material. Even though the same kinds of materials and the same mold are used, different material viscosities may lead to differences in melt temperature and injection pressure [5]. Furthermore,

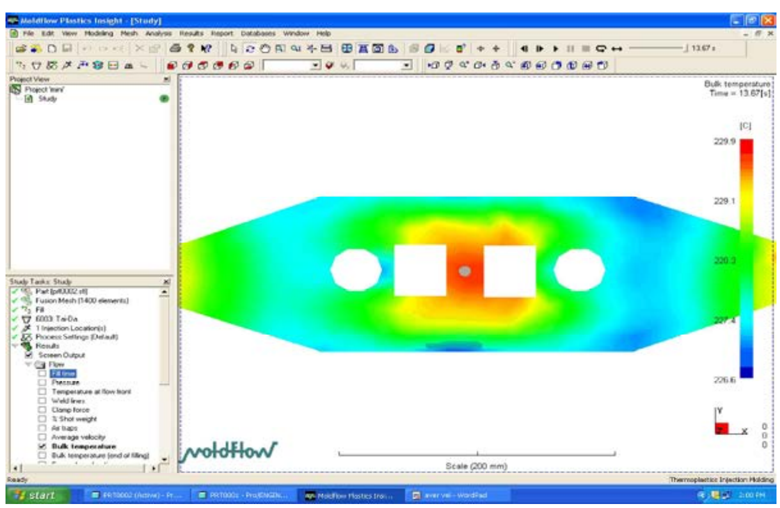

Fig. 2: Bulk temperature

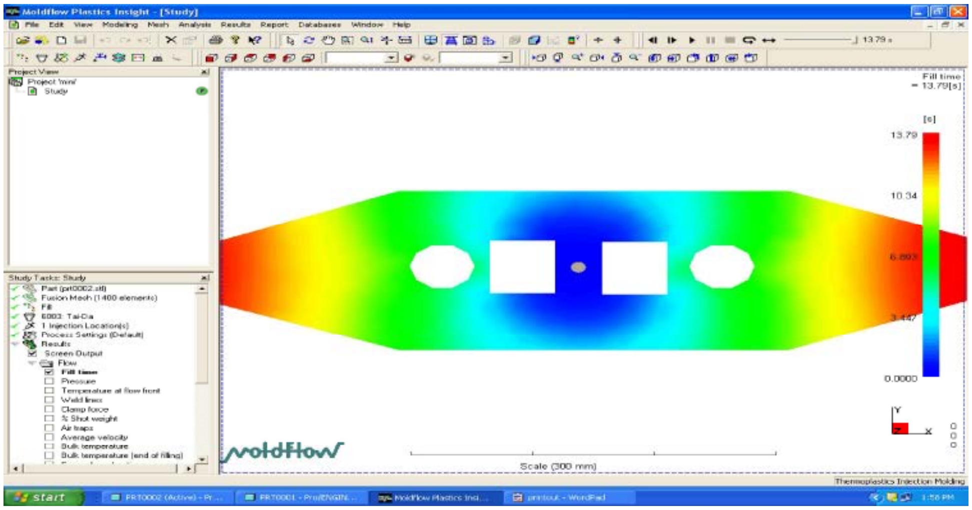

Fig. 3: Fill time

Different melting viscosity can also affect the shear rate and shear stress in the gate during the filling process. Then a viscosity model is necessary, the following are the commonly used viscosity models: Power law models (Mold flow first order model), Mold flow second order model, Mold flow matrix data, Ellis model, Carrie model, Cross model. In the MPI software model, cross model is used for analyzing the viscosity of PVC materials [6].

The Fig. 1 shows the mesh model, based on the mesh model the number of nodes and the number of elements are obtained from the analyzed results. The plastic insight software gives us the details about the bulk temperature Fig. 2 shows the distribution of the temperature flow in the trapezoidal plastic plate, fill time Fig. 3 shows the time required to complete the injection molding process.

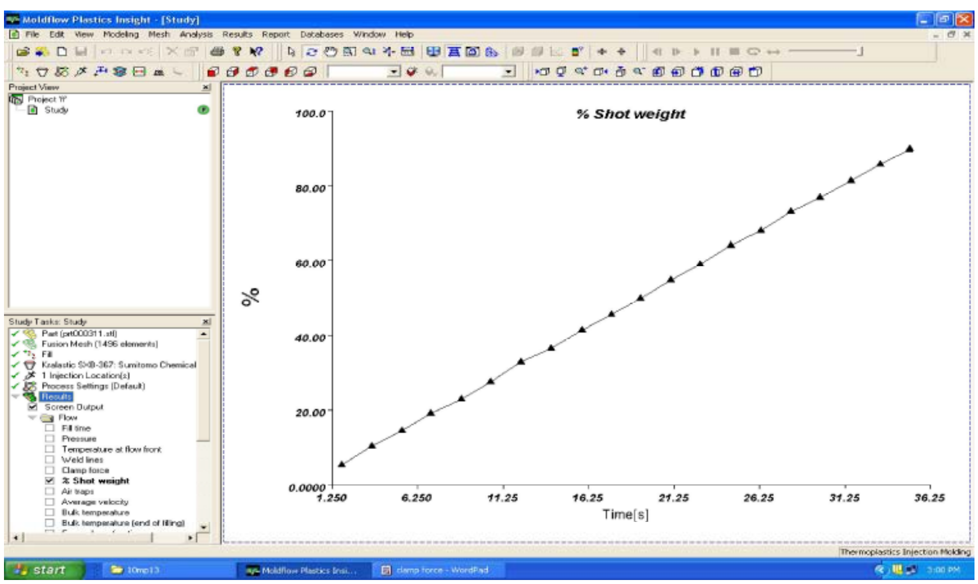

Fig. 4: % Shot weight

Fig 4 shows the percentage shot weight graph. Shot weight is the amount of percentage of completion of the process with respect to the amount of time required for each process.

The Fig. 5 shows the average velocity of the material used. Average velocity flow is the flow from the point of injection till the die has been completely filled [7]. The velocity at each and every part of the material is known in the plastic plate used.

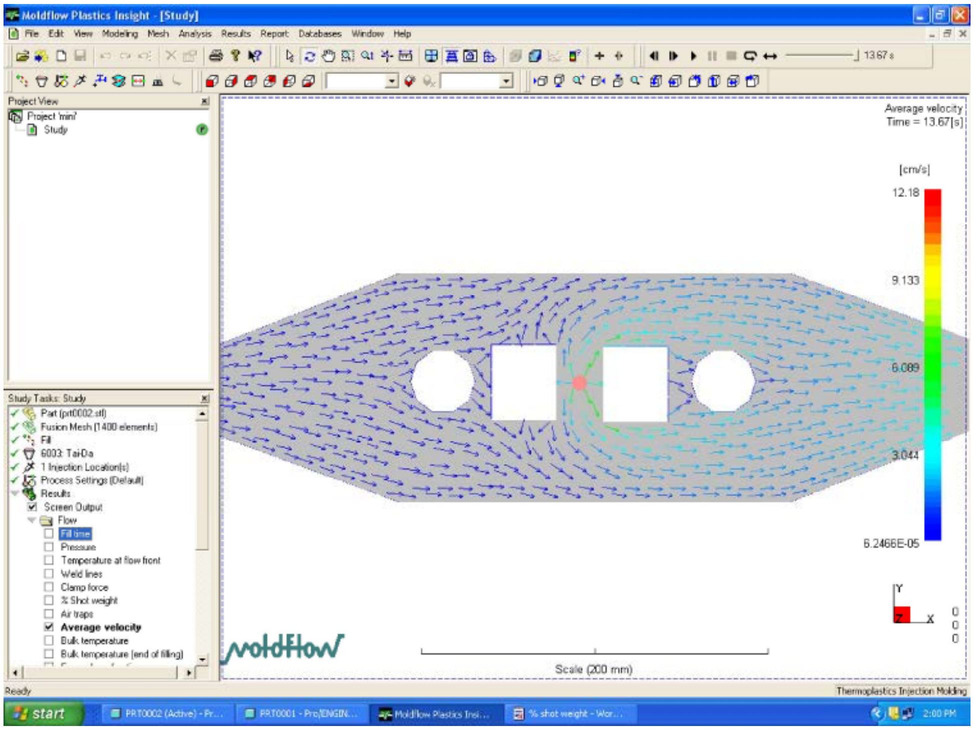

Fig. 5: Average velocity

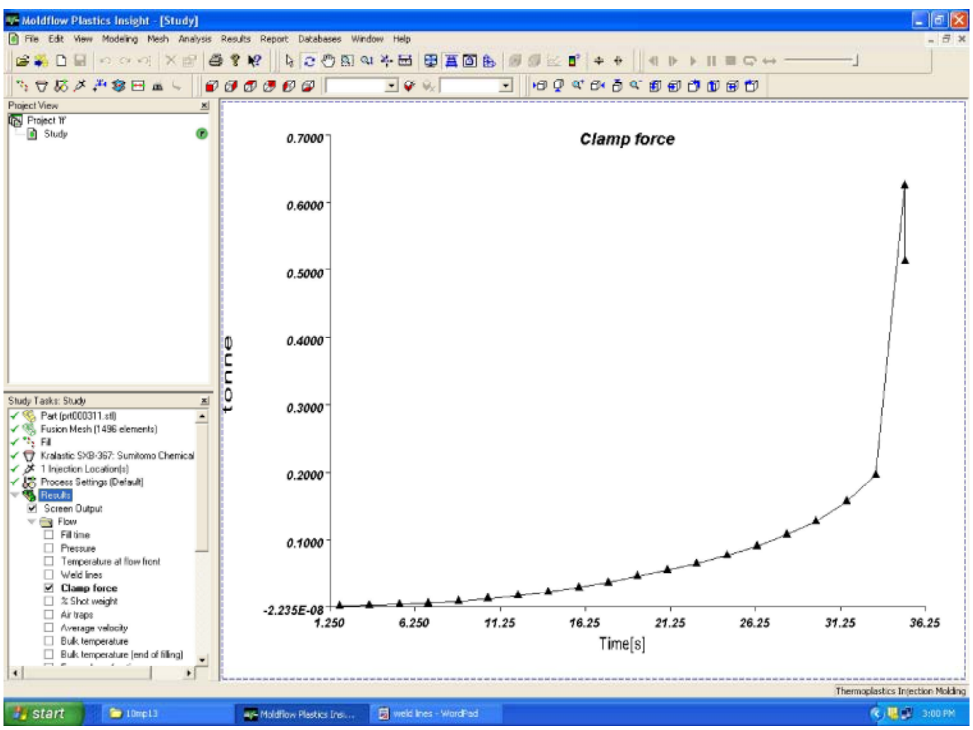

Fig. 6: Clamp force

Fig 6 represents the clamp force graph based on the force applied in tones with respect to the time taken as shown in the graph. Taking tone in the y-axis and time in the x-axis.

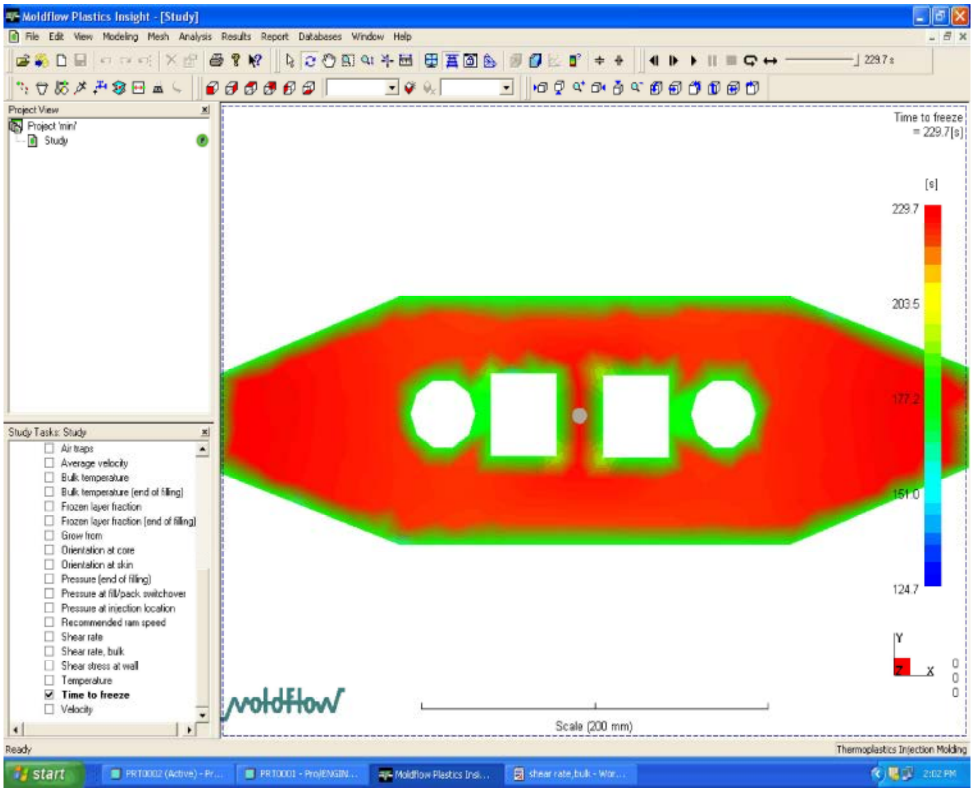

Fig. 7: Time to freeze

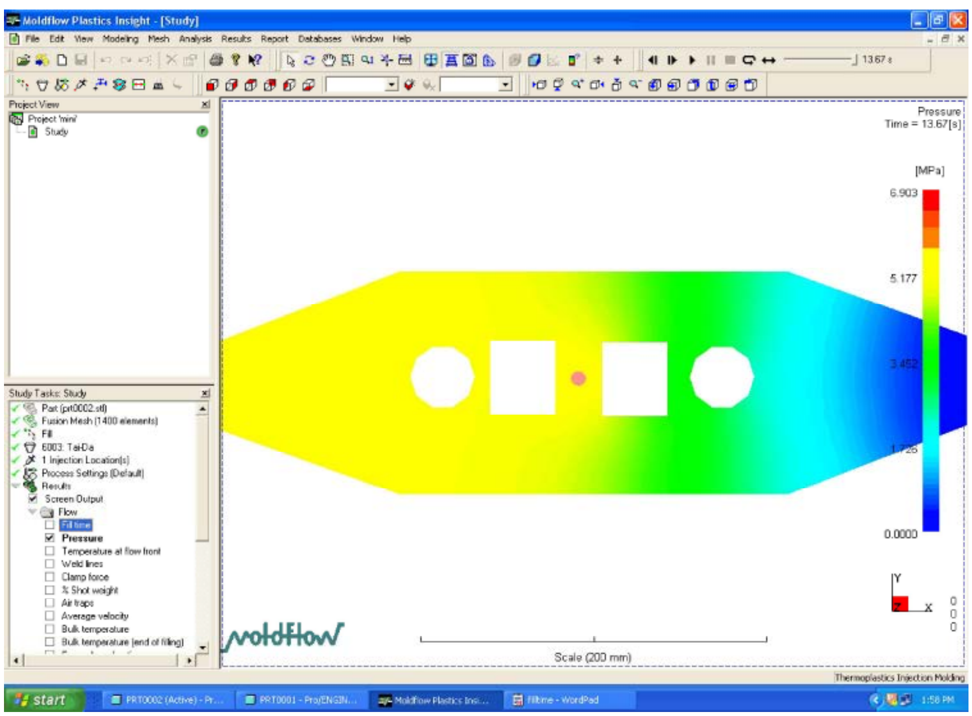

Fig. 8: Pressure

Fig 7 and Fig. 8 represent the freeze time and the pressure at particular areas of the plastic material.

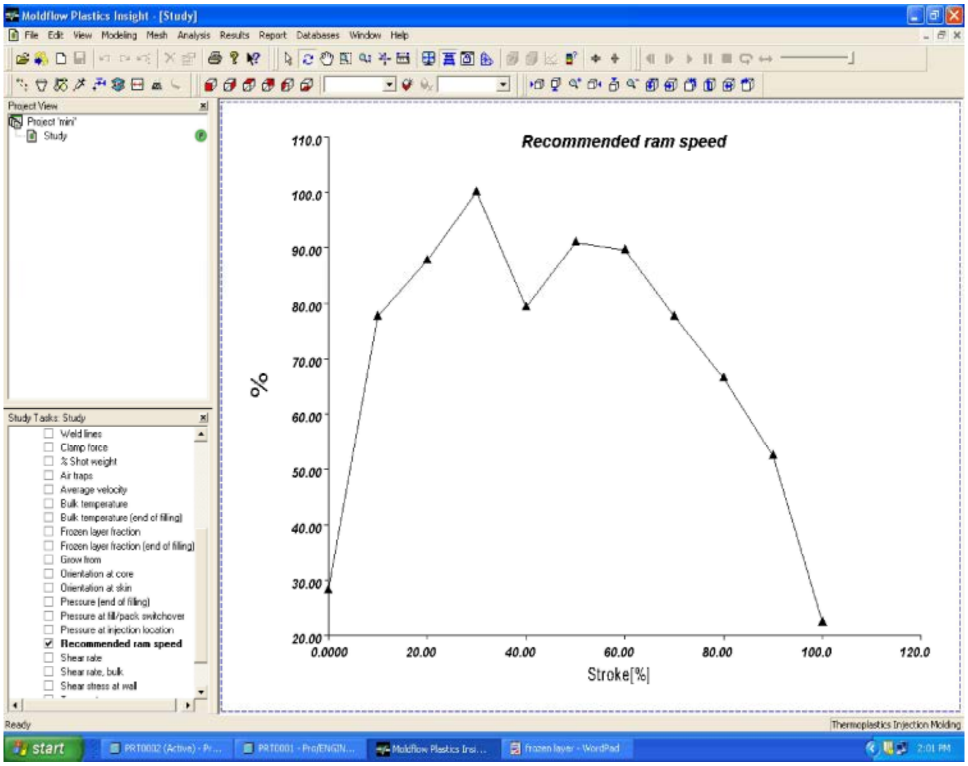

Fig. 9: Ram speed

Fig.9 represents the recommended ram speed based on the percentage flow and the percentage stroke. Ram speed is the speed at which the ram is operated at various times of the process from the time of starting till the stoke of ejection.

Injection Molding Process: The fig shows the injection molding machine which was used for the experiment. The nylon beads are injected from the top and are compressed using a pneumatic piston into the heating chamber. The heating chamber is allowed to heat up to the melting temperature of nylon which is around 220°. The die and the mold are placed below the heating chamber [8]. Heating chamber is where the temperature is increasing with time and the beads begin to melt after a particular temperature. The beads as they start melting they begin to flow out through the nozzle and into the die. The liquefied beads take the shape of the die and cools down quickly to that particular shape [3]. There are few pre-requisites for this experiment to be conducted. They are, the die should be clean, ejector pins must be available and the die should be clamped properly with additional plates if required. Then with the help of the ejector pins the material is taken out from the die and the finishing process is done in that material.

Fig. 10: Injection molding machine

The Fig. 11 shows the die which was used for the process in injection molding the figure in the left represents the top part and the figure in the right is the bottom part. The top part is fixed to the heating chamber where as the bottom part is movable in up and down direction.

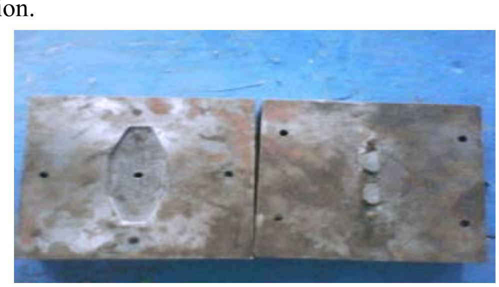

Fig. 11: Model of the Die

Fig. 12 shows the final piece. As the figure shows the output is as per the expectations

Fig. 12: Final Piece

RESULTS AND DISCUSSION

The following shows the details about the results obtained from the mold flow plastic insight software.

Machine Parameters:

Maximum machine clamp force	= 7.0002E+03 tonne
Maximum injection volume	= 2.0000E+04 cm^3
Maximum injection pressure	= 1.0000E+02 MPa
Maximum machine injection rate	= 5.0000E+03 cm^3/s
Machine hydraulic response time	= 1.0000E-02 s

Process Parameters:

Fill time	= 13.5000 s
Cooling time	= 20.0000 s
Packing/holding time	= 10.0000 s
Ambient temperature	= 25.0000 C
Inlet melt temperature	= 230.0000 C
Ideal cavity mold temperature	= 50.0000 C
Ideal core mold temperature	= 50.0000 C

CONCLUSION

Using the MPI software, plans of filling process with different melt temperatures are analyzed. The best melt temperature is achieved and the mold parameters are chosen. A practical filling condition is obtained, under which the bulk temperature of the plate is more balanced, interior stress change is small and plate war page is reduced in the cooling process. Under this temperature, the plate productivity rate is the highest due to the maximum melting flow rate and the minimum injection time. the results show that MPI software helps to improve injection efficiency and quality of products and shorten the manufacturing cycle of new products. With the help of MPI the process is done in the injection molding machine the time and cost are reduced and the efficiency is increased.

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