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The Hot Runner Injection Mould for Water Bottle Caps: Design and Analysis

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Abstract- Injection moulds are divided into two types based on runner design (i.e.) Cold runner moulds and Runner lessmoulds (i.e.) hot runner moulds. In cold runner moulds, for multi-cavity and multi-point injection moulds, there is wastage of material in runner area. Sometimes wastage of material is more than component weight. For avoiding the above problem, the technique used is hot Runner moulds. Hot runner mould is one of the advanced manufacturing methods for multi-cavity type moulds. These types of moulds are commonly used for large production rate. While producing plastic components using normal/standard multi-cavitymould, we are facing theproblems like partial filling, cavities in components, less product quality, injection pressure and temperature drop age and warpage etc... To overcome these problems, hot Runner mould is designed and modeled in PROE 5.0 andtested. Then the thermal analysis is carried out to find out the thermal variations due to the injection pressure of a molten plastic into the cavities of the mold by usingSimulation Technology.

Index Terms- Hot Runner Injection Mold, Finite Element Model,3D numerical method, temperature analysis.

I. INTRODUCTION

Injection molding is a method of forming a plastic product from powdered thermoplastics by feeding the material through the machine component called the hopper to a heated chamber in order to make it soft and force the material into the mold by theuse of the screw. In this whole process, pressure should be constant till the material is hardened and is ready to be removedfrom the mold. This is the most common and preferable way of producing plastic products with any complexity and size.

The runner system accommodates the molten plastic material coming from the barrel and guides it into the mould cavity. Its configuration, dimensions, and connection with the moulded part affect the mould filling process and, therefore,largely the quality of the product. In other words, the runner system dictates part quality and productivity. Runner systems in conventional moulds have the same temperature level as the rest of the mould because they are in the same mould block. The ideal injection moulding system delivers moulded parts of uniform density, and free from all runners, flash, and gate stubs. To achieve this, a hot runner system, in contrast to a cold runner system, is employed. The material in the hot runners is maintained in a molten state and is not ejected with the moulded part. Unlike an ordinary cold runner, the hot runners are heated, so the plastic melt in the hot runners never freeze.

Hot runner systems were first developed and came into sporadic use in the early 60s with generally negative results. They gained popularity in the 80s and 90s as technological advantages allowed improved reliability and the escalation of plastic materials prices made hot runner systems more desirable and cost effective. Hot runners are fairly complicated systems, they have to maintain the plastic material within them heated uniformly, while the rest of the injection mold is being cooled in order to solidify the product quickly. For this reason, they are usually assembled from components pre-manufactured by specialized companies

Injection moulding is a manufacturing process for producing parts by injecting material into a mould. Injection moulding can be performed with a host of materials, including metals, glasses, elastomers, and most commonly thermoplastic and thermosetting polymers. Material for the part is fed into a heated barrel, mixed, and forced into a mould cavity where it cools and hardens to the configuration of the cavity. The manufacturing of thin-wall products is very important for the automotive industry because thinner components allow considerable overall weight savings, beneficial effects on the reduction of fuel consumption and improvement of environmental impact. In addition, the decrease in thickness allows significant cuts in production costs due to less material being used and shorter cycle times. All materials used for automotive applications such as metals, foams, plastics and composites are investigated in order to achiever educations in product thickness. In particular, thin-wall fabrication of plastic products allows the realization of smaller and lighter parts which can withstand day-to-day use while maintaining their aesthetic appearance.

IV. DESIGN OF HOT RUNNER DIE

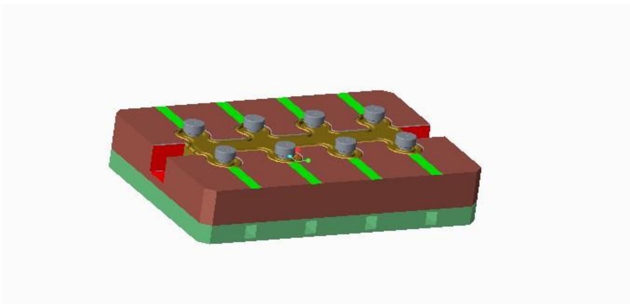

Figure 3:Part design

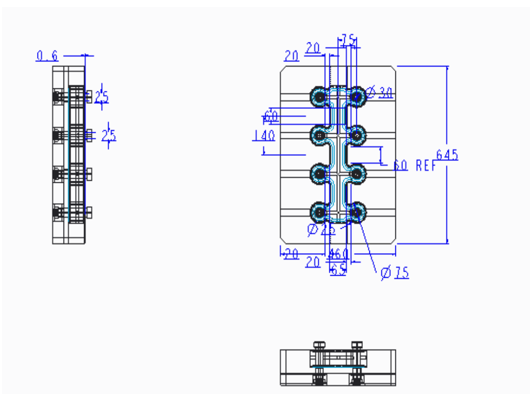

Figure 4: Drafting

V. INTRODUCTION TO ANSYS

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software implements equations that govern the behavior of these elements and solves them all; creating a comprehensive explanation ofhow the system acts as a whole. These results then can be presented in tabulated or graphical forms. This type of analysisis typically used for the design and optimization of a system far too complex to analyse by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

ANSYS is the standard FEA teaching tool within the Mechanical Engineering Department at many colleges. ANSYS is also used in Civil and Electrical Engineering, as well as the Physics and Chemistry departments. ANSYS provides a cost- effective way to explore the performance of products or processes in a virtual environment. This type of product development is termed virtual prototyping. With virtual prototyping techniques, users can iterate various scenarios to optimize the product long before the manufacturing is started. This enables a reduction in the level of risk, and in the cost of ineffective designs. The multifaceted nature of ANSYS also provides a means to ensure that users are able to see the effect of a design on the whole behavior of the product, be it electromagnetic, thermal, mechanical etc.

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VI. THERMAL ANALYSIS OF HOT RUNNER DIE FORORIGINAL MODAL

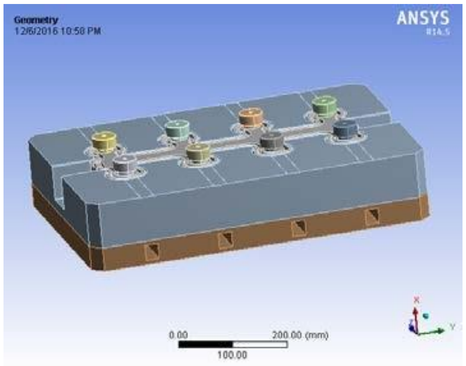

Figure 5: Imported model

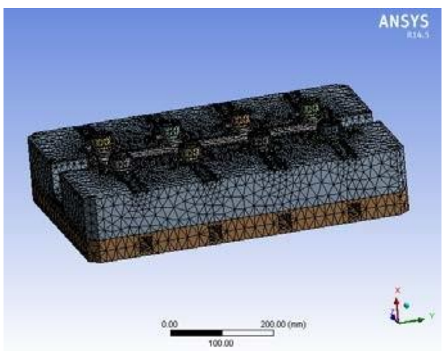

Figure 6: Meshed model

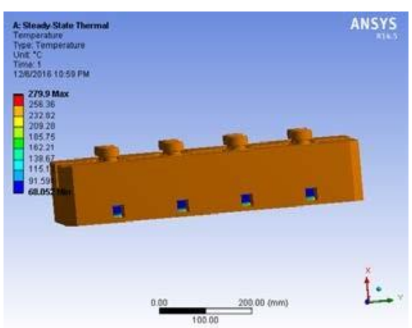

Figure 7: Temperature

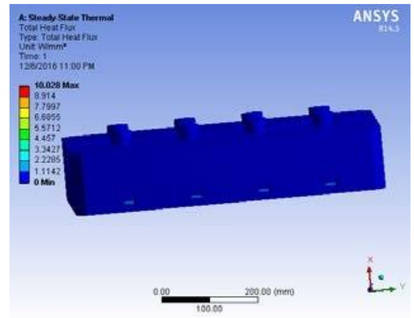

Figure 8: Heat flux

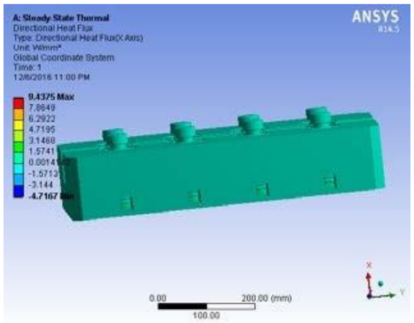

Figure 9:Directional heat flux

VII. THERMAL ANALYSIS OF HOT RUNNER DIE FORMODIFY MODAL (CHANGING THE INSERTS IN THIS MODEL)

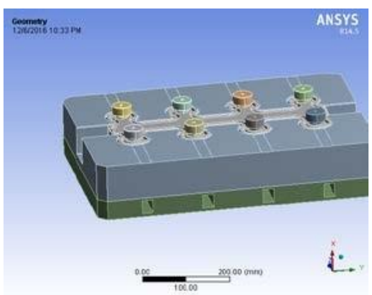

Figure 10: Imported model

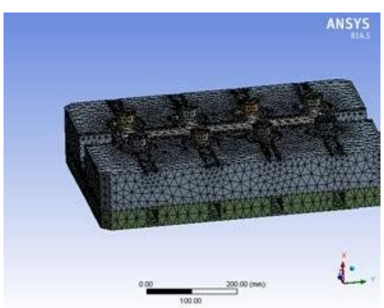

Figure 11: Meshed model

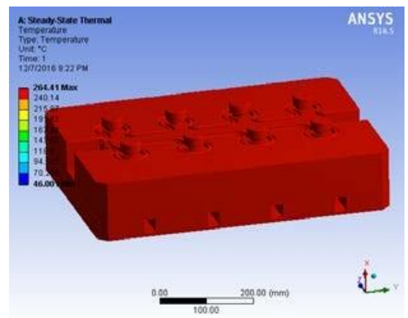

Figure 12: Temperature

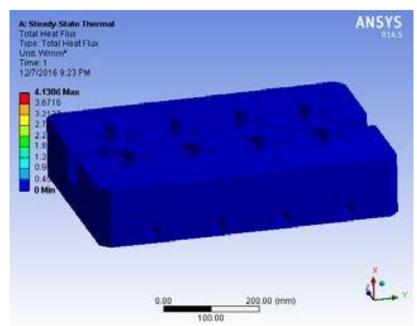

Figure 13: Heat flux

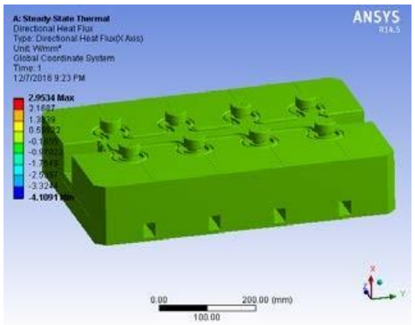

Figure 14: Directional heat flux

VIII. RESULTS

TABLE1. Results for original and modify models

RESULTS	ORIGINALMODAL	MODIFYMODAL
Temperature	68.052	46.001
Heat Flux	10.028	4.1306
Directional Heatflux	9.4375	2.9534

IX. GRAPHS

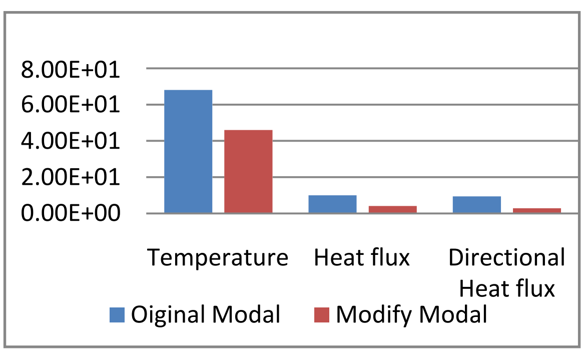

Figure 15: Comparison of Temperature, Heat flux and Directional Heat fluxfor Original model and Modify model

X. CONCLUSION

The runner system accommodates the molten plastic material coming from the barrel and guides it into the mould cavity. Its configuration, dimensions and connection with the molded part affect the mould filling process and, therefore, largely the quality of the product. In other words, the runner system dictates part quality and productivity. In the present work, structural and thermal analysis varied out on original and modified designs of the mould and the results reveals that the deformation, stress, strain and thermal deformations are improved and modified design gives thebest output.

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