Design and Developement of Cooling Pocket In Injection Moulding

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ABSTRACT

Injection moulding is one of the most versatile and important operation for mass production of plastic parts. In this process, cooling system design is very important as it largely determines the cycle time. A good cooling system design can reduce cycle time and achieve dimensional stability of the part. This paper describes a new square sectioned conformal cooling channel system for injection moulding dies. Both simulation and experimental verification have been done with these new cooling channels system. Comparative analysis has been done for an industrial part, a plastic bowel, with conventional cooling channels using the Mold flow simulation software. Experimental verification has been done for a test plastic part with mini injection moulding machine. Comparative results are presented based on temperature distribution on mould surface and cooling time or freezing time of the plastic part. The results provide a uniform temperature distribution with reduced freezing time and hence reduction in cycle time for the plastic part.

Keywords : - *Inverse Problem , Heat Transfer, Injection Moulding, Cooling Design.*

1. INTRODUCTION

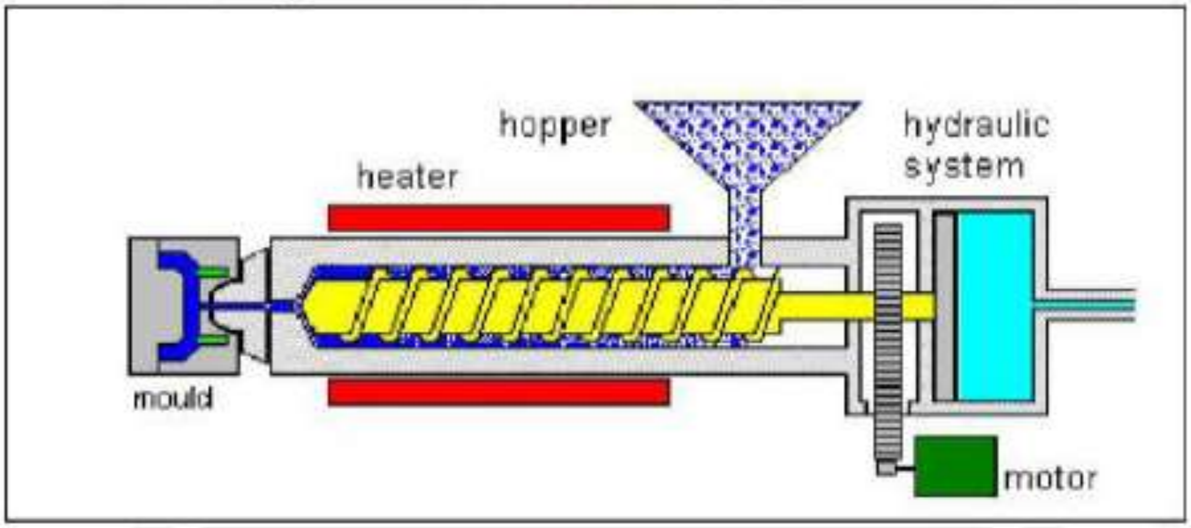
Injection moulding is the most important industrial processes in the production of plastic parts. The basic principle of injection moulding consists of heating and injecting the polymer melt in impression created by core and cavity. The main phases in an injection moulding process are filling, cooling and ejection. The cost-efficiency of the process is dependent on the time spent in the moulding cycle. The cooling phase in injection moulding is the most significant step amongst the three, it determines the production rate. The longer is the time to produce parts the more are the costs. Reducing the cooling time spent on cooling the part before it is ejected increase the production rate, hence reduce costs. Therefore, it is necessary to understand and analyse the heat transfer processes inside a mould efficiently. Injection moulding process begins with the feeding of solid plastic material in the form of granules through the hopper of the heated injection barrel. In the plastication stage, the injection screw rotates at specified RPM and pushes molten material to the screw chamber in front of the screw tip. After sufficient amount of molten material is melted, the plastication stops. During the filling stage, the impression formed by core and cavity halves are filled with the molten polymer. When the cavity is filled, the packing stage in which additional pressure is applied to force molten material into the cavity to compensate for material shrinkage. After this the cooling stage begins which removes the heat from the melt by passing the coolant through the cooling channels.

2. LITERATURE SURVEY

[1].A B M Saifullah, S.H. Masood and Igor Sbarski: This paper describes the new square sectioned conformal cooling channel system for injection moulding dies. Both simulation and experimental verification have been done with these new cooling channels system. Comparative analysis has been done for an industrial part, a plastic bowel, with conventional cooling channels using the Moldflow simulation software. Experimental verification has been done for a test plastic part with mini injection moulding machine. Comparative results are presented based on temperature distribution on mould surface and cooling time or freezing time of the plastic part. The results provide a uniform temperature distribution with reduced freezing time and hence reduction in cycle time for the plastic. [2]. **Abul B. M. Saifullah Syed H. Masood and Igor Sbarski:** This paper describes One of the most important aspects of mould design in injection moulding is the provision of suitable and adequate cooling arrangements. Proper cooling channel design in the mould is an important aspect as it affects cycle time and quality of the injection moulded plastic part. A new cooling channel design with copper tube insert can reduce cycle time by optimal and uniform heat transfer in the mould. In this research work a comprehensive FEA transient thermal-structural analysis has been performed with ANSYS simulation software to understand robustness and longevity of an industrial plastic part mould with these cooling channels and compared with conventional straight cooling channels. Autodesk Mold flow Insight (AMI) also has been used to get essential process parameter values for analysis. Result shows that by inserting copper tube in the cooling channels, a mould can increase cooling efficiency and can last for higher number of cycles before fatigue failure, thus increasing the product rate. [3]. **Mayur R. Barahate, Manish T. Shete:** This paper describes about the Conventional injection mold (CIM) consists of core and cavity and a straight cooling channels machined in a die. According to requirement of high gloss surface appearance, reduced warpage and sink mark a Rapid heating cooling mold (RHCM) is employed in molding. Various methods of heating and cooling the mold are employed in RHCM according to the dynamic temperature control required. In this work, RHCM and Conforming cooling channels are designed for a mold. Drawback of RHCM is that it is difficult to analyze the mould due to critical temperature control. Improper design of the mold results in the defects in the final molded product. Generally the mold is designed based on the mold designers experience in designing. For getting the defect free product trial and error method is applied and the process parameters are adjusted. This leads to loss of production time and increase in the cost. The aim of this study is to incorporate a Rapid heating and cooling method for a 3 Dimensional complex computer peripheral mouse part which is liable to get molding defect like sink mark. Also the transient thermal analysis in ANSYS WORKBENCH is performed to analyze the thermal response of rapid heating and cooling of mold on mold heating and cooling efficiency and cycle time of molding operation. For simulating the injection molding process and to avoid the injection molding defect occurring in molded component Autodesk Mold flow Insight software is useful in study. [4]. **Eva Vojnová :** This paper deal with the possibilities and advantage of conformal cooling of the forms. The goal of this paper is a comparison of the impact of conforming and conventional cooling on the quality of plastic products, the distance of the cooling channels and the technological production possibilities. It was developed by assessing the impact of technical and technological parameters on the quality of the plastic product by comparing the length of the production cycle based on cooling duration or individual types of cooling systems. Presented results determine that the use of conforming cooling in the forms for injection molding of plastic has a positive effect on shortening the production cycle and improving dimensional stability of the product. [5]. **Mahdi Yadegari, Hamed Masoumi, Mohsen Gheisari:** This paper describes the effect of cooling systems as the most important factors in optimization of plastic injection molding. Cooling phase and freezing consume more than 50 per cent of the cycle time. Optimization of cooling system plays a significant role in the quality, efficiency, and the cost effective manufacturing. Due to the fact that the refrigerant fluid is water and plastic fluid is non-Newtonian, equations of this process are especially complicated. In this research the body of a medical tool is used to investigate the importance of shape, type, and the location of cooling channels using the Moldflow software and good results are achieved. Software results are then analyzed using mathematical equations and the final results have verified the software. Findings of this study have been demonstrated that increased length, closeness of cooling channels to the cavity, and adoption of two-way spiral cooling channels not only increase efficiency and reduce the cost of the plastic part, but also optimize its quality in terms of appearance and volume.

3. DESIGN METHODOLOGY

This proposed method has to design and Heating and cooling arrangement, for that component which has been to reduce the manufacturing cycle time. When the component produced on a small size previously this is to produces the large quantities of requirements. The selective components require for cooling operations. The few operations where been done in CNC and rest operations are carried out in tool die. The proposed method has to be design and fabricated the Heating and cooling arrangement for the complete operations in a single machining centre. The Heating and cooling arrangement design has will serve for the economic production for the component.



3.1 Design step and Introduction of Molding die cooling pocket

[1] purpose and advantages of Molding die cooling pocket, [2] important considerations while designing Molding die cooling pocket, [3] know the meaning and principles of location, [4] describe the different types of locations, [5] explain the path and its different type, [6] the requirements of a good path cooling, [7] explain the jigs and their different types, and [8] know about the fixtures.

3.2 Important Considerations While Designing Molding die cooling pocket: -

Designing of Molding die cooling pocket depends upon so many factors. These factors are analyzed to get design inputs for Molding die cooling pocket. The list of such factors is mentioned below (a) Study of work piece and finished component size and geometry. (b) Type and capacity of the machine, its extent of automation. (c) Provision of cooling pocket devices in the machine. (d) Available cooling arrangements in the machine. (e) Available indexing devices, their accuracy. (f) Evaluation of variability in the performance results of the machine. (g) Rigidity and of the machine tool under consideration. (h) Study of ejecting devices, safety devices, etc. (i) Required level of the accuracy in the work and quality to be produced.

3.3 To achieve their expected objectives, Designing Molding die cooling pocket consist of many elements:

1) Frame or body and base which has features for cooling;2) The accuracy and availability of indexing systems or plates;3) The extent of automation, capacity and type of the machine tool where cooling arrangement will be employed;4) Bushes and tool guiding frames cooling pocket b; The availability of locating devices in the machine for blank orientation, and suitable positioning;5) Auxiliary elements;6) The strength of the machine tool under consideration;7)The precision level of the expected product;8)Fastening parts;9)The available safety mechanisms in the machine tool;10) The study of the fluctuation level of the machine tool.

4. STATE OF THE ANALYSIS: -

Design flexibility allows the removal of finishing surface treatments and assembly operations. Mold temperature control system consists of a system of channels and cavities, where suitable fluid flows through, which maintains the temperature of the tempered parts on the required level. The purpose of the temperature control is to reach optimized time of production cycle of injection while maintaining all technological requirements on the production and on the final product. Tempering is cooling or heating of the form eventually parts of it. With the help of tempering the desired temperature is maintained. The form tempering affects shrinkage and changes in shape, surface quality and mechanical features of the molds, as well as filling up the form cavity, and the length of the injection cycle time.The movable and fixed form part is tempered independently in the injection molds. To achieve the most efficient heat abstraction, the tempering channels need to be placed as close as possible to shaped form cavity. Flow section is chosen so large that strength of components is not disrupted. Some plastics are processed at higher temperatures of the form, e.g., PC up to 120 □ C. In this case, the heat losses of the form are greater than it is its heating by the melt and it has to be heated. Before the production start it is necessary to warm up the form to operating temperature to avoid thermal shock to the mold. The goal of tempering is:- To ensure an even temperature throughout the whole surface of the form cavity. - To abstract the heat from the form cavity filled with melt that the whole production cycle has an economic length. Local uneven distribution of form temperature results in increase of dimensional and shaped deviations of molds. However, sometimes different parts of the form are tempered deliberately differently to eliminate shape deformations caused by shrinkage of plastic. The movable and fixed form part is tempered independently in the injection molds. To achieve the most efficient heat abstraction, the tempering channels need to be placed as close as possible to shaped form cavity. Flow section is chosen so large that strength of components is not disrupted. Some plastics are processed at higher temperatures of the form, e.g., PC up to 120 C. In this case, the heat losses of the form are greater than it is its heating by the melt and it has to be heated. Before the production start it is necessary to warm up the form to operating temperature to avoid thermal shock to the mold. The goal of tempering is:- To ensure an even temperature throughout the whole surface of the form cavity.- To abstract the heat from the form cavity filled with melt that the whole production cycle has an economic length.Local uneven distribution of form temperature results in increase of dimensional and shaped deviations of molds. However, sometimes different parts of the form are tempered deliberately differently to eliminate shape deformations caused by shrinkage of plastic.

Thermoplastic	Melt temperature	Mold temperature
ABS	190 - 250	50 - 85
PA 6	230 - 290	40 - 120
PC	280 - 320	85 - 120
PE - HD	180 - 270	20 - 60
PE - LD	180 - 270	20 - 60
PMMA	200 - 250	50 - 80
POM	180 - 220	50 - 120
PP	170 - 280	20 - 100
PS	180 - 260	55 - 80

5. CONCLUSIONS

In this project we have presented a moldflow software and calculations show that spiral channels are very effective in reducing cycle time and more than 50 percent of the time can be reduced using such channels; results of shape factors also prove this fact. Other advantages of spiral channels include: Longer cooling channels as compared with linear ones; Being spiral covers a huge part of the product; Nearness of cooling channel to the cavity because of the spiral shape; and Reduced thermal loss due to the conformity of spiral shape of the channel to the plastic part. Based on the above-mentioned advantages, plastic injection mold designers are recommended to use cooling systems with spiral channels in order to reduce cycle time and increase efficiency.

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