Design and Development of Cooling Pocket for Injection Moulding Die

Review Paper

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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.**

***Index Terms*: Moulding, rapid heating, cooling mould, cooling pocket, cycle time.**

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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.

2. RAPID HEATING AND COOLING MOULD (RHCM)

Rapid heat cycle moulding (RHCM) is a new injection moulding technology, which improves surface quality of the plastic parts without increasing the cycle time of process. In the RHCM, the mould cavity surface is heated by various types of heating methods to a high mould temperature before melt injection, generally higher than the glass transition temperature (Tg) of the polymer, then kept at the high temperature during filling and packing stages, and finally the mould is cooled down rapidly to solidify the polymer melt in cavity for ejecting the part

In RHCM only the outer surface of the plastic part is required to have a high gloss appearance therefore only one side of the mould i.e cavity side is heated and cooled rapidly while the core side is just cooled with the normal coolant like water or oil.

3. ADVANTAGES OF RHCM

Due to the high mold temperature during filling, the molten plastic has good flow ability and can be easily transformed into the geometry of the cavity. The surface of injected plastic parts has extra-high gloss if the surface of mold cavity is glossy. The inherent injection molding problems which occur in CIM are solved by RHCM technology. The mold surface temperature is very crucial in the plastic injection molding. If the mold surface temperature is high then surface quality of the part will be better, but the cooling time will increase and thus the cycle time will increase. If the mold surface temperature is reduced the cooling time will also reduce, but in exchange the surface quality of part has to be compromised.

4. TYPES OF MOLD HEATING METHODS

The rapid mold heating methods include resistance heating, high-frequency proximity heating, gas-assisted heating, induction heating, infrared heating, and convection heating using hot fluids such as oil, water and steam. The existing mold heating techniques is divided into two categories

Exterior Heating
Internal Heating.

5 .COOLING METHOD IN RHCM

In rapid mold cooling methods, the conventional method by circulating water in mold cooling channels is employed. To increase the cooling efficiency, the optimized layout of cooling lines and the coolants with low temperatures and large flow rates are used.

The conformal cooling is proved to be essential in rapidly cooling the mold. To shorten molding cycle, mold temperature need to be kept much lower than the frozen temperature of the polymer melt. As a result, hot polymer will freeze much early as soon as it contacts the mold wall, which results in a premature solidification which brings a many problems

Such as flow mark, jetting mark, weld mark, short shot and floating fibers. The most effective method to eliminate these problems is to raise the mold temperature during filling. However, this will in turn increase the molding cycle time and hence decrease productivity. For rapid mold cooling, the conventional method of mold cooling is employed. However, the coolant temperature is much lower than in CIM. For rapid mold heating there are various mold heating techniques. Following section lists some of the heating methods which are used in mold heating.

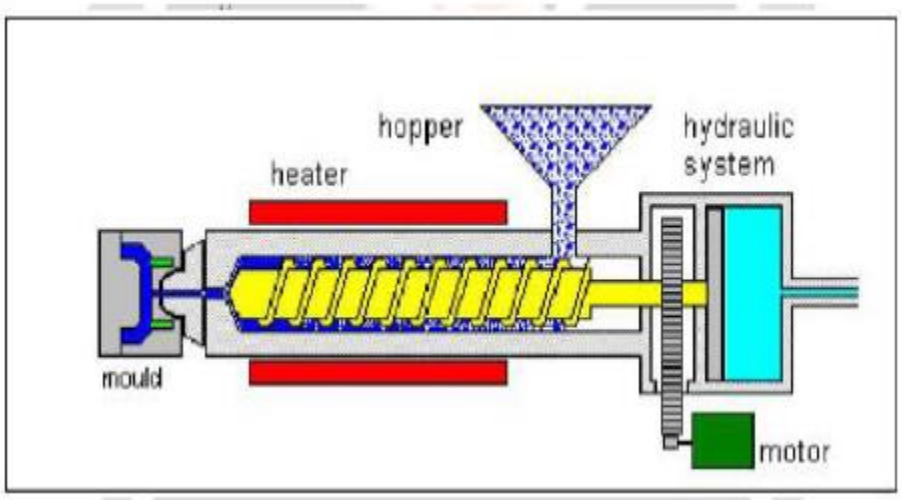

Figure 01: Basic Arrangement of moulding Die

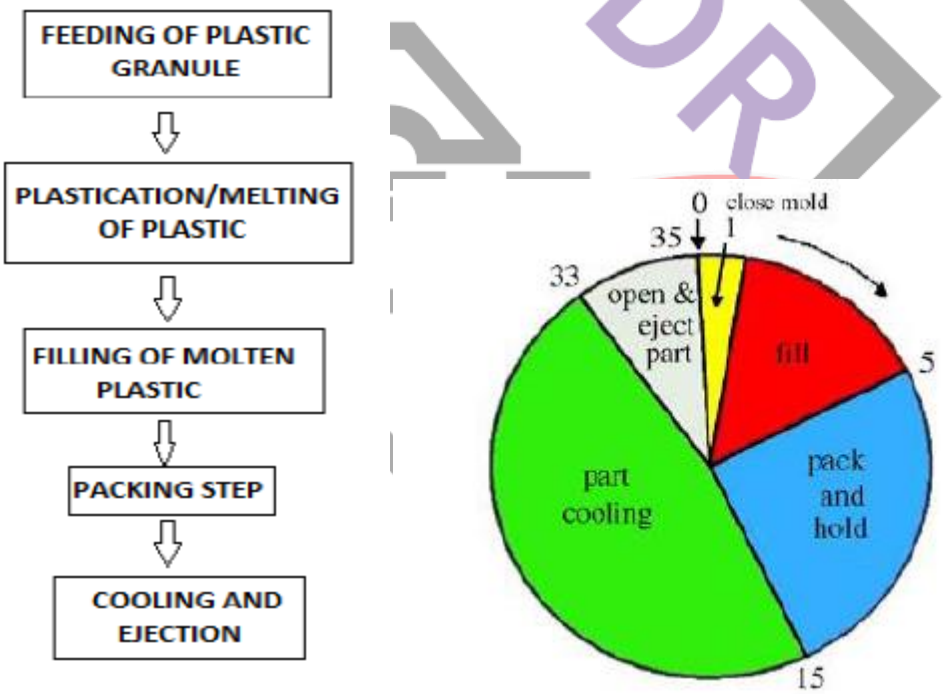

Figure 02: Process variation

6. IMPORTANT CONSIDERATIONS WHILE HEATING AND COOLING ARRANGEMENT

Designing of Heating and cooling arrangement depends upon so many factors. These factors are analyzed to get design inputs for Heating and cooling arrangement. 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 locating devices in the machine.
(d) Available clamping 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.

7. PROBLEM STATEMENT

1) Previous techniques are more time consuming.
2) More efforts & skills are required arrangement of heating setting
3) It may cause errors due to improper skills or increase cycle time
4) Chances of slippage are more while higher applied force

8. NECESSITY OF WORK

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 dia The proposed method has to be design and fabricated the Heating and cooling arrangement for the complete operations in a single machining center. The Heating and cooling arrangement design has will serve for the economic production for the component.

9. OBJECTIVE OF WORK

1. Analytical design of "Heating and cooling arrangement".
2. Modelling and Simulation of "Heating and cooling arrangement".
3. Preparation of Prototype sample of "Heating and cooling arrangement".
4. Experimental workout of "Heating and cooling arrangement".
5. Study of comparative result of "Multi-Purpose Jigs and Fixture".

10. ACKNOWLEDGMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

I am highly indebted to Guide Prof Mandhare M for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

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