Cooling Analysis and Development of Test rig to evaluate the performance for Injection mould cooling applications using ANSYS

M.E.DHIVYA, V.R.SIVA KUMAR, U.SATHISH KUMAR,S.A.RAMESH

***Abstract*—Injection molding and die casting are the basic casting process which are cooled with conventional cooling method.cooling of mouldis essential in order to obtain the good quality of moulded parts. Conventional water jacket method is not suitable for obtaining good results and posses many disadvantages. Hence a technique which can overcome all the disadvantages and become optimum emerged. The main aim of this proposed work is to improve cooling by the application of heat pipe.hence heat pipes are used in moulding process to cool the mould.In this project , experiment are performed and observations are taken with copper rod, heat pipe and with out heat pipe. Heat pipe plays an very important role in such situations, and shows effective results,At the conclusion, the effect of these limits on the cooling power of heat pipe is high.**

***Key words*-Test rig, heat pipe, copper rod, injection mould.**

I. INTRODUCTION

Injection moulding is a widely used manufacturing process in the production of plastic parts. The basic principle of injection molding is that a solid polymer is a molten and injected into a cavity inside a mould which is then cooled and the part is ejected from machine [1]. Therefore the main phases in injection moulding are filling, cooling and ejection. The cost effectiveness of the process mainly dependent on the time spent on the molding process in which the cooling phase is the most significant step. Time spent on the cooling cycle determines rate at which the parts are produced [2]. A reduction in Time spent on cooling the part would drastically increase the production rate as well reduced costs.The application of heat pipes in conventionalwaterjacket methods in mould cooling, it is observed and can be stated that the liquid cooling with heat pipe system is more efficient and effective than liquid cooling with water jacket cooling method. Thus heat pipes are proved to be the basic need in conventional water jacket methods in mould cooling processes for optimum performance.[3]

The ope ration of a heat pipe is easily understood by using a cylindrical geometry, as shown. However, heat pipes can be of any size or shape. The components of a heat pipe are a sealed container pipe wall and end caps, a wick structure, and a small amount of working fluid which is in equilibrium with its own vapor. Different types of working fluids such as water, acetone, methanol, ammonia or sodium can be used in heat pipes based on the required operating temperature [4]. The length of a heat pipe is divided into three parts: the evaporator section, adiabatic transport section and condenser section. A heat pipe may have multiple heat sources or sinks with or without adiabatic sections depending on specific applications and design[4]. Heat applied externally to the evaporator section is conducted through the pipe wall and wick structure, where it vaporizes the working fluid. The resulting vapor pressure drives the vapor through the adiabatic section to the condenser, where the vapor condenses, releasing its latent heat of vaporization to the provided heat sink. The capillary pressure created by the menisci in the wick pumps the condensed fluid back to the evaporator section. Therefore, the heat pipe can continuously transport the latent heat

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of vaporization from the evaporator to the condenser section[5]. This process will continue as long as there is a sufficient capillary pressure to drive the condensate back to the evaporator.

*II.*EXPERIMENTAL SET UP

COMPONENTS:

Injection mould

- Heat pipe
- Data logger
- Copper rod
- Wattmeter
- Dc power supply
- Heater

HEATPIPE:

A heat pipe is a closed evaporator-condenser system consisting of a sealed, hollow tube whose inside walls are lined with a capillary structure or wick. Thermodynamic working fluid, with substantial vapor pressure at the desired operating temperature, saturates the pores of the wick in a state of equilibrium between liquid and vapor. When heat is applied to the heat pipe, the liquid in the wick heats and evaporates. As the evaporating fluid fills the heat pipe hollow center, it diffuses throughout its length. Condensation of the vapor occurs wherever the temperature is even slightly below that of the evaporation area. As it condenses, the vapor gives up the heat it acquired during evaporation. This effective high thermal conductance helps maintain near constant temperatures along the entire length of the pipe.

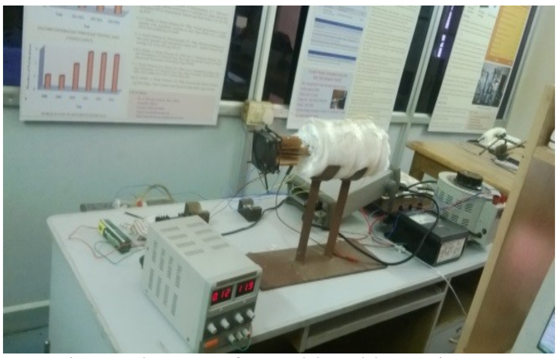
DATA LOGGER:

Data loggers are implicitly stand-alone devices, while typical data acquisition system must remain tethered to a computer to acquire data. This stand-alone aspect of data loggers implies on-board memory that is used to store acquired data. Sometimes this memory is very large to accommodate many days, or even months, of unattended recording. This memory may be battery-backed static access memory or flash memory. Earlier data loggers used magnetic tape, punched paper tape. COPPER ROD:

Copper has been in use at least 10,000 years, but more than 96% of all copper ever mined and smelted has been extracted since 1900, and more than half was extracted in only the last 24 years. As with many natural resources, the total amount of copper on Earth is vast around 10^{14} tons just in the top kilometer of Earth's crust, or about 5 million years' worth at the current rate of extraction. However, only a tiny fraction of these reserves is economically viable, given present-day prices and technologies.

HEATER:

The sensor for the temperature control is also an important factor and should be placed between the working surface of the part and the heaters. The temperature of the part approximately 1/2" away from the heaters is used in selecting maximum allowable Watt density from the graph. Control of power is an important consideration in high Watt density applications. On-off control is frequently utilized, but it can cause wide excursions in the temperature of the heater and working parts. Thrusted power controls are valuable in extending the life of high Watt density heaters, since they effectively eliminate on-off cycling. There are a variety of temperature controllers and sensors one can use depending on the application.



Experimental setup of mould and heat pipe

III.DESIGN ANALYSIS AND SIMULATION RESULTS

Injection molding is one of the most versatile and Important operation for mass production of plastic parts. In this Process,

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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.Heat pipes are enclosed, passive two phase heat transfer devices. They make use of the highly efficient thermal transport process of evaporation and condensation to maximize the thermal conductance between a heat source and a heat sink. They are proven to be very effective, low cost and reliable heat transfer devices for applications in many thermal management and heat recovery systems. In this project the total heat transfer of heat pipes in different orientations with different flow rate to mould cavity has been investigat.

IV.IMPLEMENTATIONTECHNIQUE

Mould was created by stainless steel with covered wire heater the voltage is given by gradually. Now days mould was cooling by water jacket or open atmospheric air but now implement quickly observed high temperature heat transfer rate. The heat pipe is used remove heat at small time. The heat pipehave condenser section the water flow in the condenser the temperature will reduced suddenly 50^0c to 20^0c.

V.RESULT AND DISCUSSION

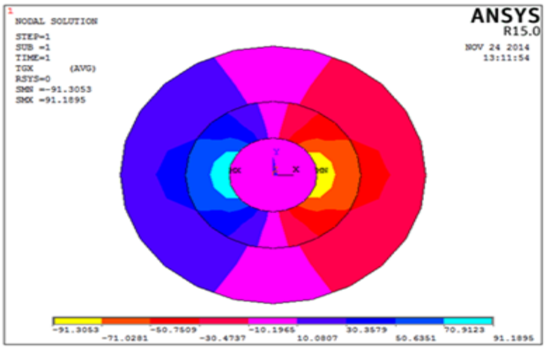

Fig.4.1 Simulation of copper rod

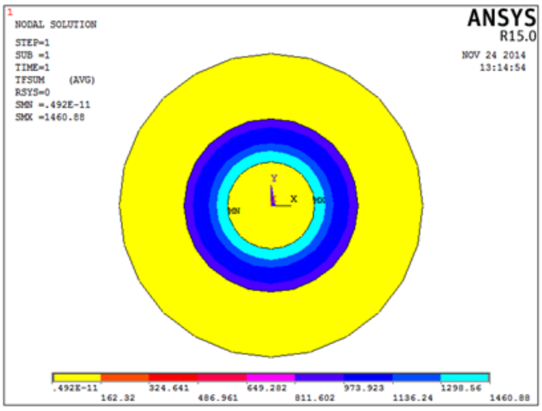

Fig.4.2 Afterstimulation of without heatpipe after

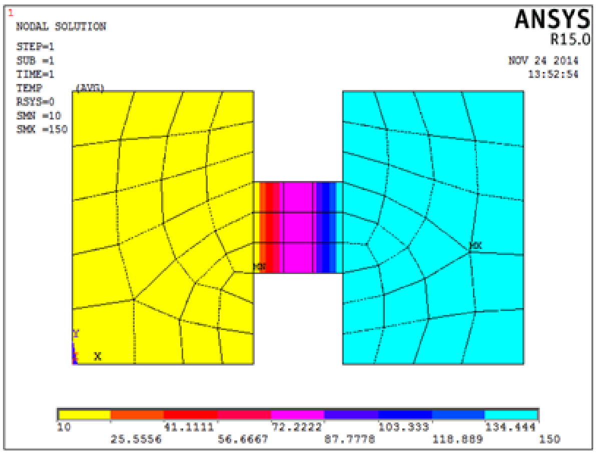

Fig.4.3.Simulation of heat pipe

VI.CONCLUSION

The cooling process is one of the most important sub processes in injection molding because it normally accounts for Approximately half of the total cycle time and affects directly the Shrinkage, bending and warp age of the molded plastic product. Therefore, designing a good cooling channel system in the mould is Crucial since it influences the production rate and quality. Experimental test is conducted to evaluate performance of heat pipes in different orientations. By changing the heat pipe material, dimensions of heat pipe better heat transfer rate can be achieved.

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