THERMAL AND STRUCTURAL ANALYSIS OF AN INJECTION MOULD CAVITY COOLING CHANNELS

Ambati Sri Venkatesh[1] | Mannem Veera Venkata Kondala Rao[2] | Geddati Mothi Naga Prudhvi[2] | Namadi Deepak[2] | Arja Naga Surendra Babu[2] | Prof T.Ravi Kumar[2]

[1](Dept of Mechanical, D.M.S.S.V.H College of Engineering, Macilipatnam, A.P-521001, ambativenkatesh310@gmail.com)

[2](Dept of Mechanical, D.M.S.S.V.H College of Engineering, Macilipatnam, A.P-521001)

Abstract— *Plastic components are taking important role in human life both in form of consumer and industrial goods aspect. Manufacturing of plastic components can be done in so many ways among those manufacturing method, Injection moulding is leading one. In this present project a cavity part (conical cup) of injection mould assembly is considered for analysis. In the first case a cavity half section with three holes is developed in by using PRO-E Wildfire 5.0 software. And thermal, structural analysis is done which is comes under ANSYS 11.0 analysis. In the second case a cavity half section with six holes is developed by using PRO-E Wildfire 5.0 and thermal, structural analysis is done. In the third case a cavity half section with twelve holes is developed by using PRO-E Wildfire 5.0 and thermal, structural analysis is done.*

Keywords— Injection Mould; PRO-E; FEA; Thermal Analysis; Structural Analysis

1. INTRODUCTION

In injection moulding process, the cooling channel performance is one of the most crucial factors because it has significant effect on both production rate and the quality of the plastic part. In order to reduce the cycle time, and control the uniform distribution of temperature, it is necessary to create different cooling channels, which conform to the shape of the mould cavity and core. This project presents a simulation study of different types of cooling channels in an injection moulded plastic part and compares the performance in terms of temperature profile and stresses distribution, to determine which configuration is more appropriate to provide uniform cooling with minimum cycle time.

2. INJECTION PROCESS

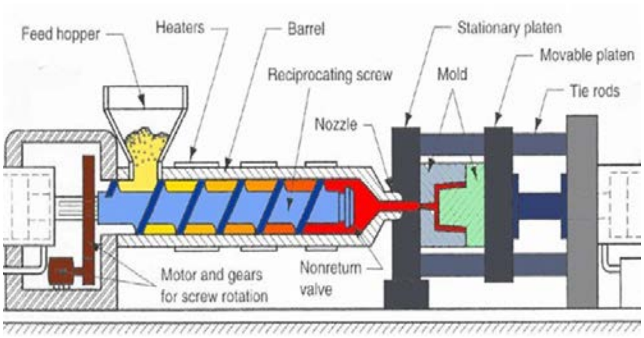

Fig 1.1 Small injection moulded showing hopper, nozzle and die area

With injection moulding, granular plastic is fed by gravity from a hopper into a heated barrel. As the granules are slowly moved forward by a screw-type plunger, the plastic is forced into a heated chamber, where it is melted. As the plunger advances, the melted plastic is forced through a nozzle that rests against the mould, allowing it to enter the mould cavity through agate and runner system. The mould remains cold so the plastic solidifies almost as soon as the mould is filled. Modeling is done using Pro-E Wildfire 5.0.

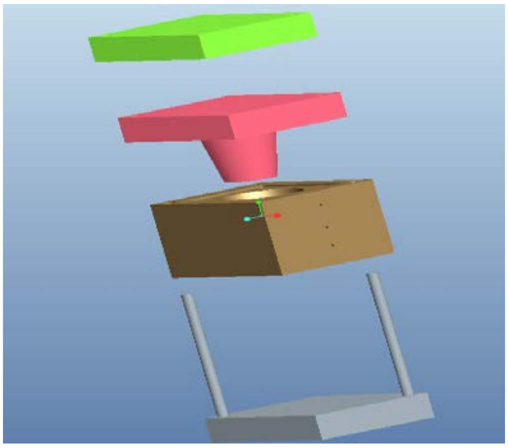

Fig1.2 explode view of final assembly.

3. MATERIAL PROPERTIES

SS-Stainless Steel
Thermal conductivity = 1.44 btu/hr.
Young's modulus = 30e6 psi
Poisson's ratio = 0.3
Material = Stainless steel
The inlet wall temperature = 450 ^{0}F
Ambient temperature = 85 ^{0}F
The internal water temperature = 70 ^{0}F
Die Dimensions:
Cavity = 6*6*4.5 inches.
Core = 6*6*1.5 inches.
Cavity back plate = 6*6*1.5 inches.
Core top plate = 6*6*1.5 inches.
Supporting rods = Ø 4.5 Height 7.5 inches.
Cup = Ø3.25 , Ø2.3 , Height 3.0 inches.

4. THERMAL & STRUCTURAL ANAYSIS

We have done thermal and structural analysis in ANSYS 11.0. In case 1 we have considered required model with three holes and we have done thermal analysis, then we have given input that thermal result for structural analysis. Similarly we have done for six holes and twelve holes.

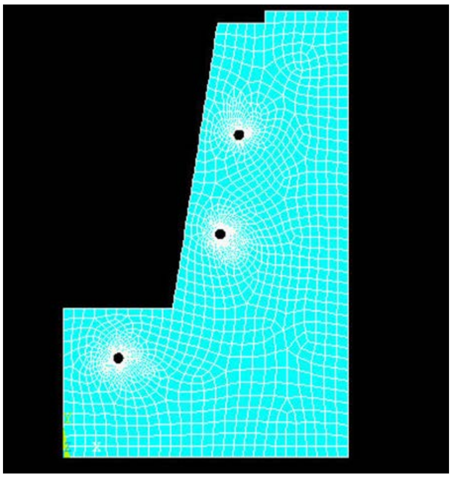

Fig 1.3 meshed model with three holes

5. RESULTS AND DISCUSSION

Case-1: Following figure shows results of temperature distribution and von-Mises stress with three holes.

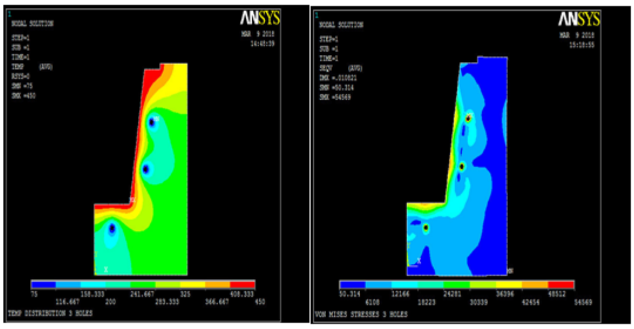

Fig 2.1 Temperature and von-mises stress distribution with three holes.

Case-2: Following figure shows results of temperature distribution and von-Mises stress with six holes.

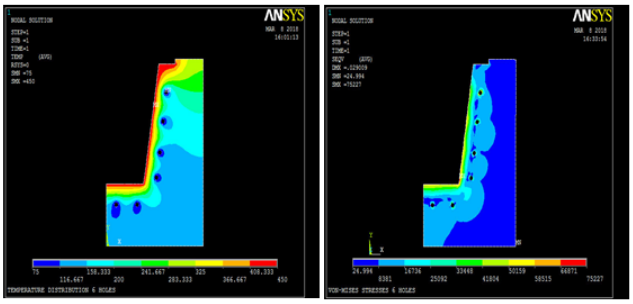

Fig 2.2 Temperature and von-mises stress distribution with six holes.

Case-3: Following figure shows results of temperature distribution and von-Mises stress with twelve holes.

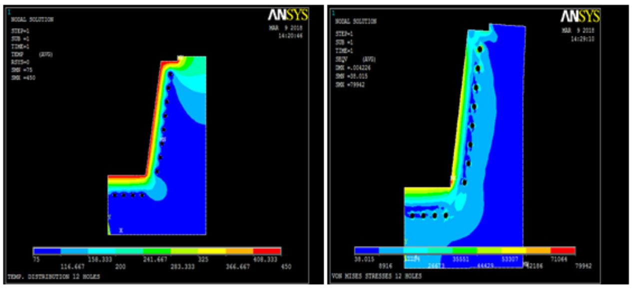

Fig 2.3 Temperature and von-mises stress distribution with twelve holes

Cases	No. of. holes	Max. Temperature (^{0}F)	Von-mises stress(psi)
1	3	450	54569
2	6	450	75227
3	12	450	79942

6. CONCLUSION

Now-a-days moulds play an important role in manufacturing plastic components. Injection moulding is one of the manufacturing processes to produce a vast variety of plastic components from combs to aerospace parts. In this project the focus is on improving heat flow rate from the mould cavity and reducing the induced stresses in it. For the maximum heat flow rate, cooling channels are provided. If the number of holes are provided in the cavity for more cooling, the section becomes weak and it has more induced stress. From the discussions, it can be concluded that case 1 has lowest induced stress which is 54569 psi and better temperature 450^{0}F

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