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THERMAL ANALYSIS OF CONFORMAL COOLING CHANNEL IN PLASTIC MOLDING MACHINE USING MULTI CAVITY MOULD

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ABSTRACT

As the volume of production and the quality of the parts produced depend on the injection moulding process, it is critical that each component's cycle time be as short as possible. This can be accomplished only by maintaining a consistent temperature within the moulded part, which assists in heat dissipation. What we need is a cooling channel design that "conforms" to the mould cavities. This research examines various cooling channel layouts using an analytical lens. Temperature uniformity, time to reach ejection temperature, and warp age are all factors that should be considered while choosing the appropriate cooling channel design..

Keywords:Conformal cooling channel, plastic material, multi cavity, Moulding, SOLIDWORKS Plastics.

1. Introduction:

The plastics industry relies heavily on injection moulding, which is a huge worldwide company that accounts for around 32% of all plastic. Extrusion, which consumes around 36 wt percent [1], is next followed. As much as two-thirds of the moulding cycle is spent cooling, therefore cutting cooling time will increase output while lowering costs. When cooling time is reduced, components may shrink and deform severely [4]. As a result, a cooling approach is necessary to minimise cycle time while retaining component quality. In order to maximise heat transmission in an injection moulding process, it is critical to understand and optimise the cooling channel design. They used a geometric modelling method to design the cooling circuit as it approached the conformal cooling channel for a speedier cooling phase. For four different cooling methods, the researchers measured the ejection temperature attainment time, part ejection temperature attainment time (freezing time), shrinkage, and temperature variance.

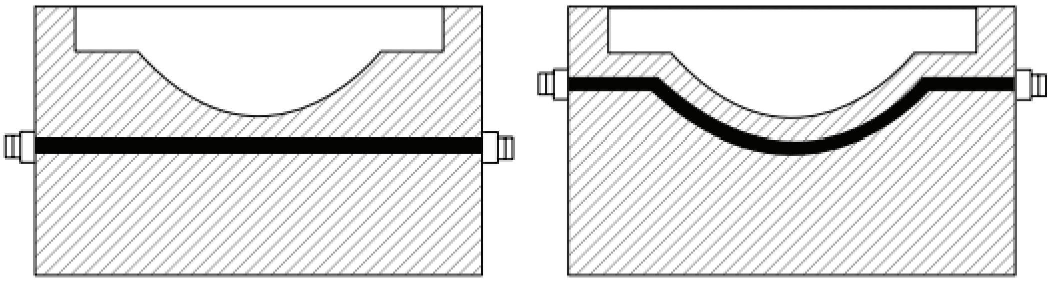

Figure1:Conventional Cooling channel and Conformal Cooling Channel

In this study, four unique cooling channels were analyzed for their discharge temperatures, freezing times, shrinkage, and temperature variance.

2. LiteratureReview

Mazur et al. [23] further verified through both numerical simulation and physical experiments that lower cooling temperature and better temperature uniformity could be achieved in conformal cooling comparing with baffle cooling. About the different designs of conformal cooling.

Khan et al. [24] performed a comparative study on the series conformal cooling channel, parallel conformal cooling channel, and the conformal cooling channels with improver cooling lines, wherein the last option led to the most uniform temperature distribution of the part. The cross-section shape of the channels obviously affects the cooling effect.

Kamarudin et al. [28] added sub grooves to the square cross-section. It was found that the application of sub-grooves increased the contact area leading to enhanced thermal convection effect and disturbed the coolant flow to make it turbulent. Better heat transfer rate and cooling effect were observed than the milled grooved square shape. It was also discovered that the improper design of cross-section shape and cooling channel locations

Wang et al. [5] projected a Voronoi graph-based conformal cooling channel system that compact the cooling time by 26% compared with the straight-line water channels. However, the flow rate and temperature circulation inside the cooling circuit are highly non-uniform, leading to a degraded performance of cooling uniformity and unnecessarily increased pumping power requirement. At the same time, it is technically non-trivial and expensive to manufacture the cooling circuit with such complex channel connectivity

3. ProposedWork

The current research investigates the effect of conventional and conformal cooling channel on plastic injection molding machine. We also know that design of a cooling channel play an important role in plastic molding process. Here in our study we work on different profile of conformal cooling channel like, circular shape cooling channel and polygon shape channel and see their result on cycle time, cooling time and other parameter for designing SOLIDWORKS is used and for simulation SOILDWORK Plastic is used.

4. Methodology

The simulation is done in the SOLIDWORKS plastic. The model is developed as shown in figure 2 below. The modeldeveloped In SOLIDWORKSdesignmodelerisimportedformeshing.

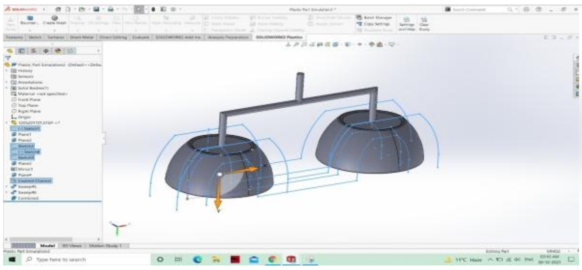

Figure2:CADmodelofcircular shape cooling channel

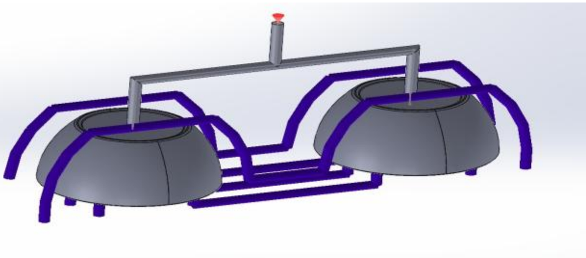

Figure3:shaped model of circular cooling channel

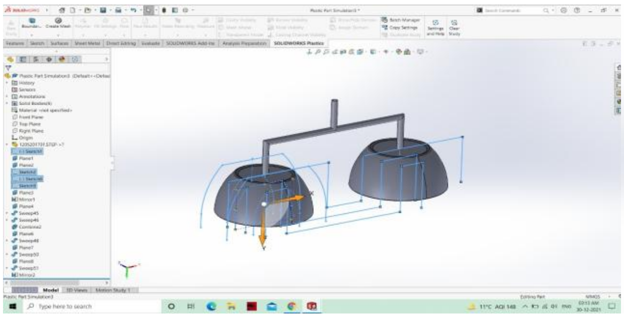

Figure: CAD Model of polygon profile cooling channel

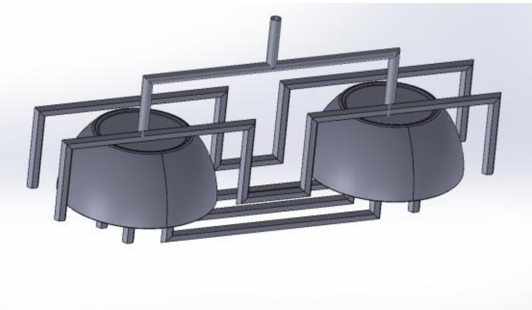

Figure 6: Shaped model of polygon shape cooling channel

Multi cavity plastic injection molding is used for simulation. Both circular and polygon geometry are imported in a SOLIDWORK S Plastics for simulation. ABS material is used injection molding machine. As a result of mesh 2953274 Elements and 620214 nodes are generated in circular profile and 5679507 elements and 1094336 nodes are generated in polygon profile.

5. ResultsandDiscussion

Theresultsof SOLIDWORK Plasticsimulationaregenerated.Thecycle time andcooling timegeneratedonplastic molding processis generatedas showninfigure6andfigure7below.

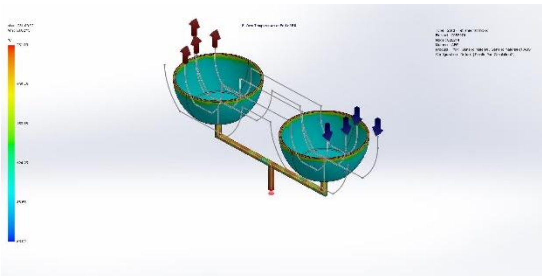

Figure7: Temperature at the end of fill

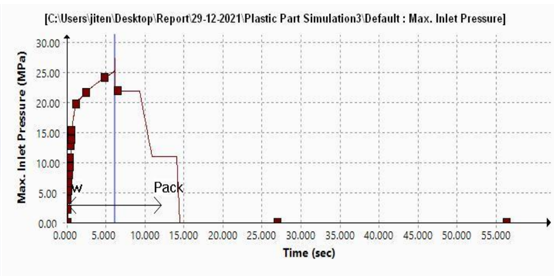

Figure8:Pressure distribution over a time

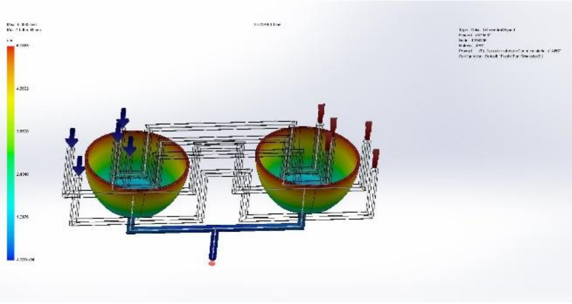

Figure 8: Filling time in polygon profile

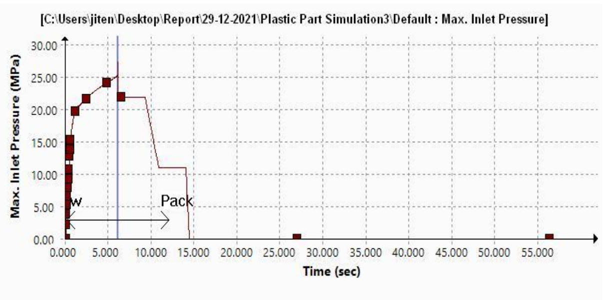

Figure 9: Pressure distribution over a time

The simulation results are shows in table below as result of this is clear that circular profile has low cycle time and cooling time also shear stress and bulk temperature has also less as compare to polygon profile.

Table1:Flow result in circular profile cooling channel

X-dir. Clamping Force	7.4350 Tonne
Y-dir. Clamping Force	15.6194 Tonne
Z-dir. Clamping Force	11.6592 Tonne
Required injection pressure	26.7620 Mpa
Max. real temperature	231.2447 °C
Max. bulk temperature	231.2403 °C
Max. shear stress	1.4210 Mpa
Max. shear rate	1044.1000 1/sec
CPU Time	74252.59 sec
Cycle Time	45.37 sec
|- 1. Filling Time	6.08 sec
|- 2. Cooling Time	34.29 sec
|- 3. Mold Open Time	5.00 sec

Variation of temperature, cooling time, cycle time and shear stress value shows that circular profile has better result than polygon profile.

Table2:Flow result in polygon profile cooling channel

X-dir. Clamping Force	7.3482 Tonne
Y-dir. Clamping Force	15.4322 Tonne
Z-dir. Clamping Force	11.5305 Tonne
Required injection pressure	27.3621 Mpa
Max. real temperature	231.1693 °C
Max. bulk temperature	231.1470 °C
Max. shear stress	1.4269 Mpa
Max. shear rate	1920.2570 1/sec
CPU Time	80453.63 sec
Cycle Time	60.17 sec
|- 1. Filling Time	6.09 sec
|- 2. Cooling Time	49.09 sec
|- 3. Mold Open Time	5.00 sec

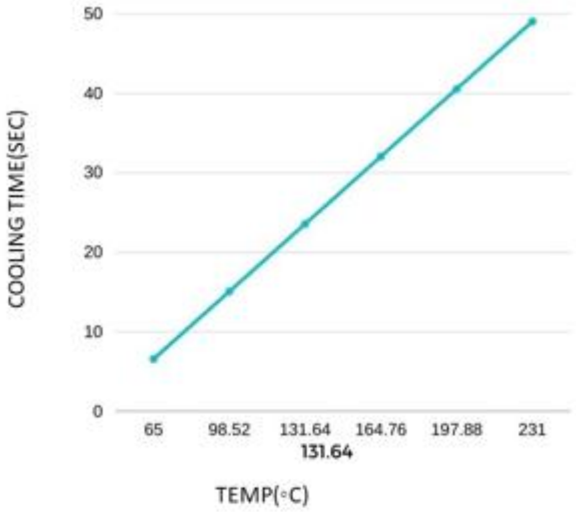

Figure9:Cooling Time vs. temperature graph

Here we shows, time vs temperature graph for ABS material. It is clear to see the graph that if the value of temp of material less time of cooling is also less and if the temperature is high cooling time is also high.

6. Conclusion

From the start of filling through portion freezing, these simulation results show how much time it takes to attain the desired temperatures, as well as how much volumetric shrinkage occurs at ejection and how much temperature variation there is. According to the data, a circular conformal cooling channel takes 34.29 seconds to reach the ejection point, whereas a polygon-shaped conformal cooling channel requires 49.09 seconds to reach the same destination.

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