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Study on the Temperature Distribution of the Mold Cavity With The Air Heating Method

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ABSTRACT : *Paper: "Research on the temperature distribution of the mold cavity after heating with hot air from outside the mold" is the addition of a heating method by hot air. The process of heating with hot air is quick, the structure is simple. Very convenient for manufacturing operations, easy to automate.Research and design cover shape (in terms of size, number of inlets, outlet ... from simulation results with different specifications), from there based on the standard cover shape to design suitable covers for the cavity surfaces have different convex R radius.The results of the thesis will be the basis to handle actual errors in injection molding caused by the loss of heat and pressure in the motion of the plastic flow. And that is also the theoretical basis for further studies for the future development of the mold industry in Vietnam.*
KEYWORDS: *Injection molding; Cover heating; mold heating; hot air.*

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I. INTRODUCTION

Today, the phenomenon of plastic flow losing heat in the process of flowing into the mold is important in the injection process. If during the plastic filling of the mold, the mold temperature can be maintained at a value higher than the phase transition temperature of the plastic material, the quality of the plastic product is also increased. And there are many heating methods for molds as induction heating [1, 2], heater heating [3, 4], proximity heating [5], air heating [6 – 8]. In recently years, the air heating method shows many advantages in mold temperature control.

Especially, the hot air heating method is currently one of the most effective methods and is being studied by many countries. So, this research will design the cover and then simulate on the convex mold surfaces to study the temperature distribution of the cavity after heating by hot air from outside the mold is very necessary. In addition, during experiments and simulations, we will conclude which factors affect the heating results in terms of temperature and the distribution of the mold cavity surface.

II. SIMULATION METHODS

ANSYS CFX is the most popular and commonly used fluid dynamics analysis module that can help to reliably and accurately simulate different types of fluid flows.

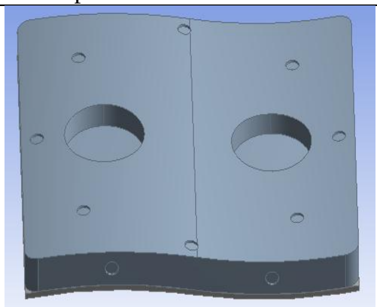
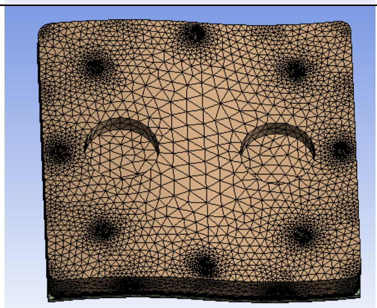
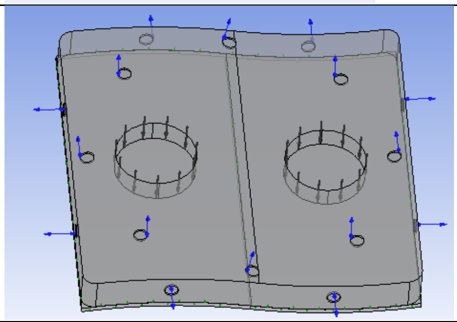
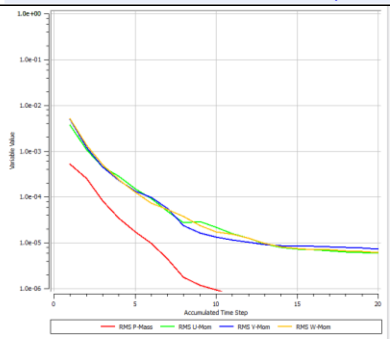
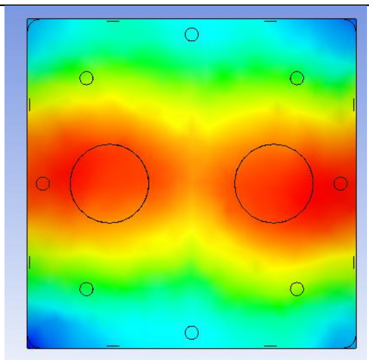
Content	Description	Parameter
1. Geometry		- Inlet - Outlet - Stamp - Stamp air
2. Mesh		- Inflation + Geometry: 2 Bodies + Boundary: Multiple Entities + Maximum Thickness: 1mm
3. Setup		- Air (U, V, W=0, P=0, T=30°C) + Inlet (Normal Speed: 10m/s, Static temperature: 400°C) + Outlet (Opening temperature: 30°C) - Stamp (Material: stell, temperature: 30°C) - Output (Time interval: 1s)
4. Solution		- Start run
5. Results		- Stamp side: + Model: Variable + Variable: Temperature + Range: Local - Default Legend View 1 + Title mode: Variable + Precision: 1 - Fixed

Figure 1: Process in ANSYS software simulation

III. RESULTS AND DISCUSSION

Research on the temperature distribution of the mold cavity after heating with hot air from outside the mold with gas inlet air temperature of 400°C, heating time 20s, and steel cavity surface by simulation

Mold cavity with convex surface

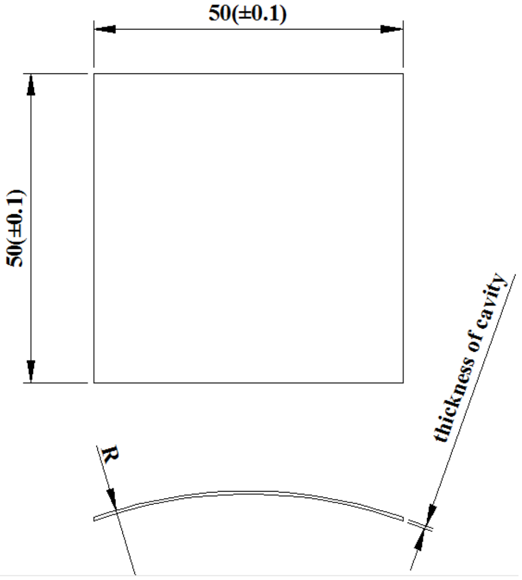
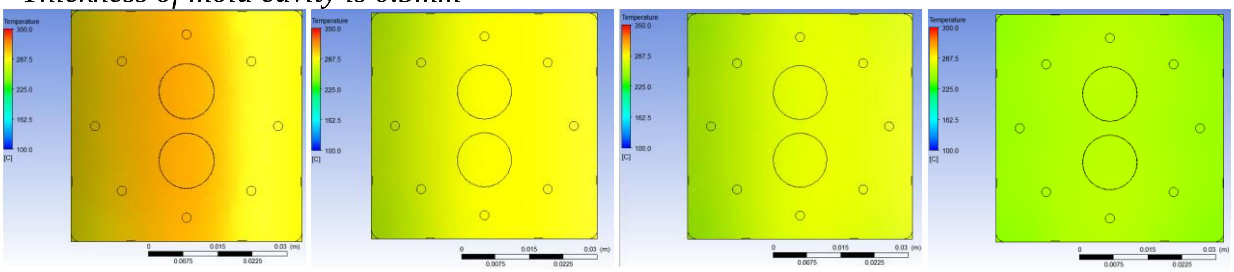


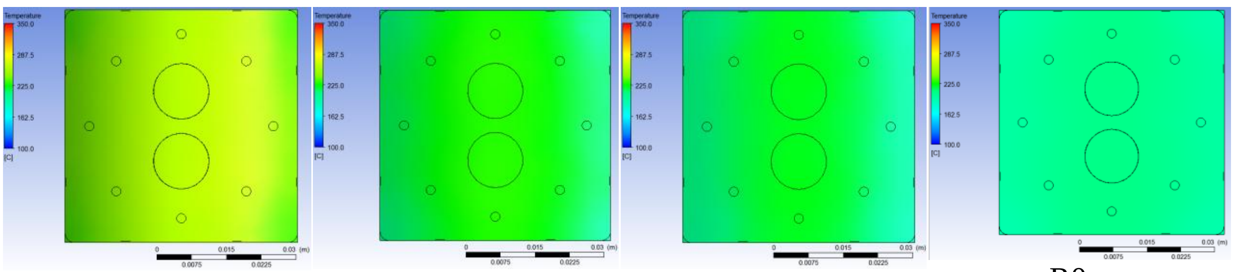
Figure 2: Mold cavity with convex surface

- *Thickness of mold cavity is 0.5mm*



R50 R75 R90 R0

- *Thickness of mold cavity is 0.75mm*



R50 R75 R90 R0

- Thickness of mold cavity is 1.0mm

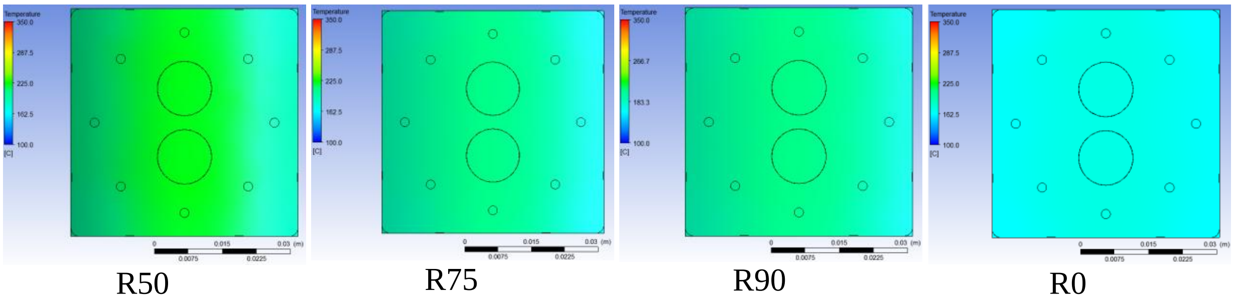


Figure 3: Mold temperature distribution after 20s heating time by simulation mold cavity with convex surface

- For the mold cavity with convex surface:
  + Distribution of temperature in each heating plate is relatively uniform.
  + The temperature difference in each heating plate is from 13°C to 27.6°C.
  + Temperatures tend to decrease gradually from heating plates R50 to R75 to R90 to R0.
- Simulate line temperature as **Figure 4**:

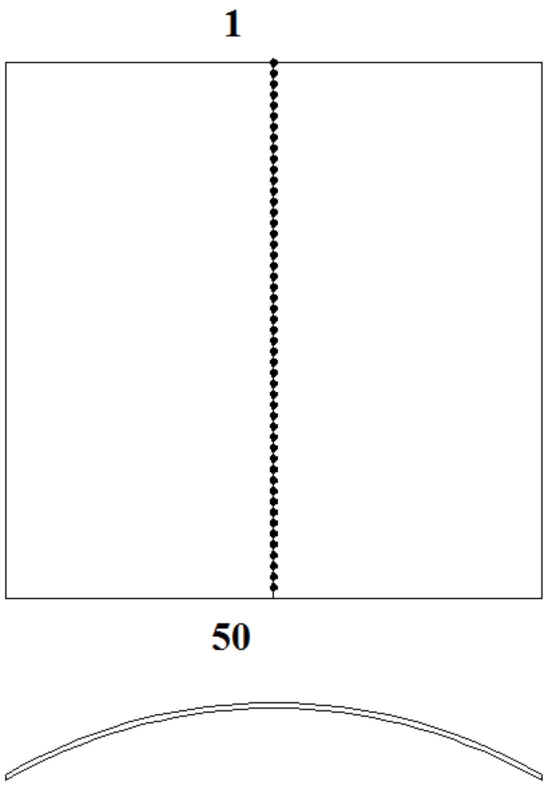


Figure 4: Location simulation results by Line

- Results on chart: Comparing the surface temperature at the surface, the result was collected as in Figure 5 to 8. This result show that:
  + The temperature decreases gradually from the surface of the heating plate R50 to R75 to R90 to R0.
  + In the same curved surface thinner heating plate absorbs more heat, and thicker plate absorbs lower heat.

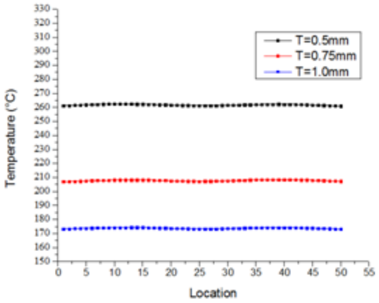


Figure 5: Mold cavity with convex surface R0

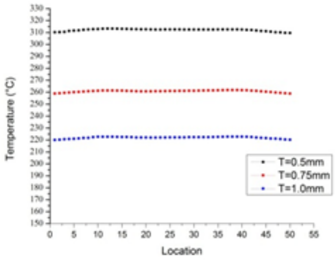


Figure 6: Mold cavity with convex surface R50

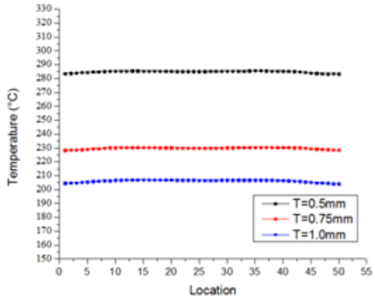


Figure 7: Mold cavity with convex surface R75

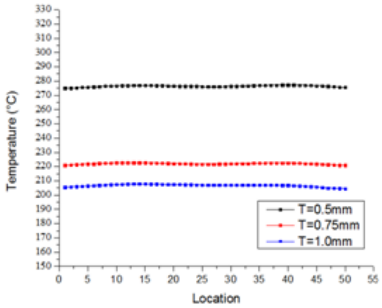


Figure 8: Mold cavity with convex surface R90.

IV. CONCLUSION

- During the simulation to find out the optimal cover type, the size is 54mmx54mmx15mm, 2 inlets, 16 air outlets, the gas volume height is 5mm and the radius of the cover is equal to the radius of the heating plate.
- Investigate the hot air heating simulation on different convex and concave surfaces:
+ Distribution of temperature in each heating plate is relatively uniform.
+ In the same curved surface thinner heating plate absorbs more heat, and thicker plate absorbs lower heat
+ Based on the results, using covers will improve the quality of plastic products compared to not using covers. 0974751388

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