Cooling study of baffles integration in the molding industry

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Introduction: For molding processes, efficient and homogeneous heating and cooling are required. The 3iTech® inductive technology developed by RocTool enables all the above by ensuring both good temperature homogeneity and short heating time. Most of the time, to fulfill these requirements when considering cooling large 3D shaped part, water cooling networks are integrated through complex geometries and baffles configuration is often used. If the heat transfer coefficient (htc) is well known for simple geometries, specific studies are required to estimate the htc in such configurations.

In the present study, a CFD turbulent model aimed at characterizing the htc in a succession of baffles illustrated in the Figure 1 has been developed in collaboration with SIMTEC.

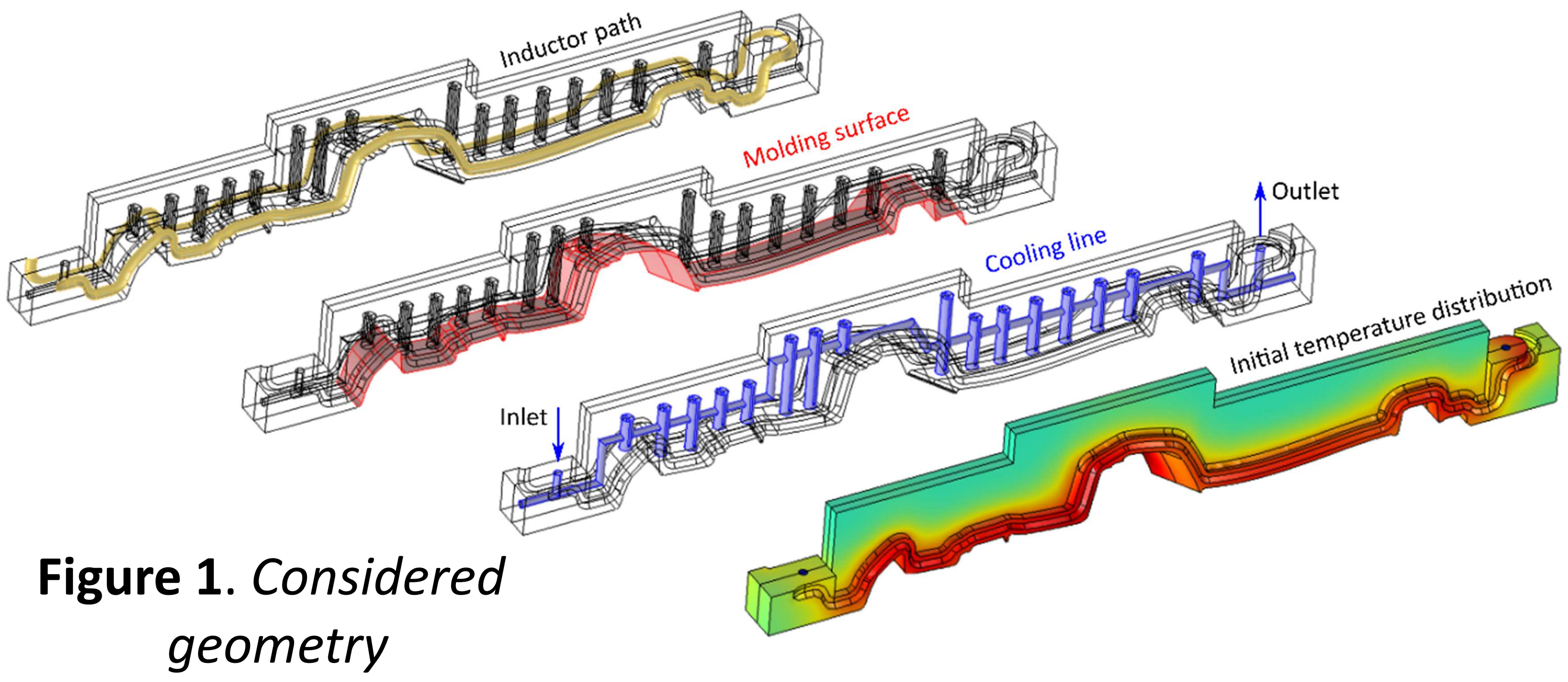
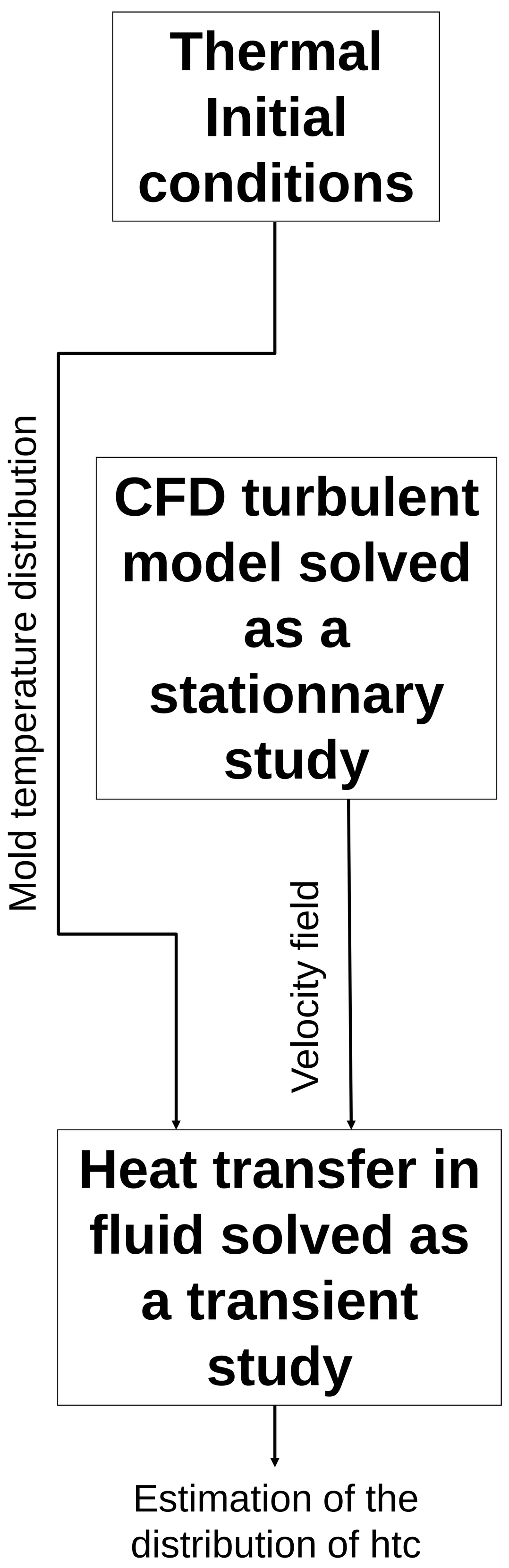


Figure 1. *Considered geometry*

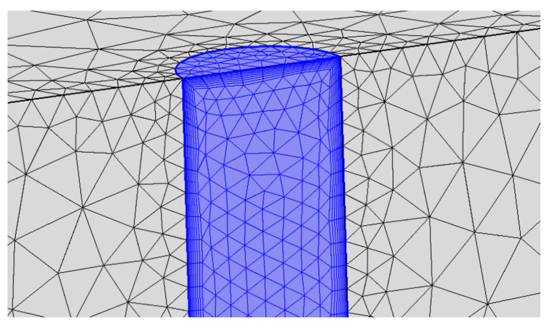
Computational Methods: To solve the problem at stake, both the flow equation and the thermal equation in fluid and in solid are considered.



To simulate the thermal distribution induced by the 3iTech® heating, the AC/DC model and the thermal transfer in solids model are coupled.

The *Low-Reynolds number k-epsilon* model which does not take into account any wall function and solves the velocity of the flow in the whole domain is particularly well suited for accurate heat exchange estimations. As shown in Figure 2, the use of specific boundary layers depending upon the Reynolds number and Prandtl number to refine the viscous layer and the buffer layer is required to ensure the accuracy of the results.

Solved as a time dependent study, the module is used to evaluate the impact of the turbulent water flow on the temperature distribution of the flow and of the mold according to the time.



Estimated Reynolds number: 28 000
Estimated buffer layer: 300µm
Estimated viscous sublayer: 110µm
DOF: 3 800 000

Figure 2. *Meshing considerations for turbulent CFD*

Results: The velocity field and the thermal distribution are respectively illustrated in the Figures 3 and 4.

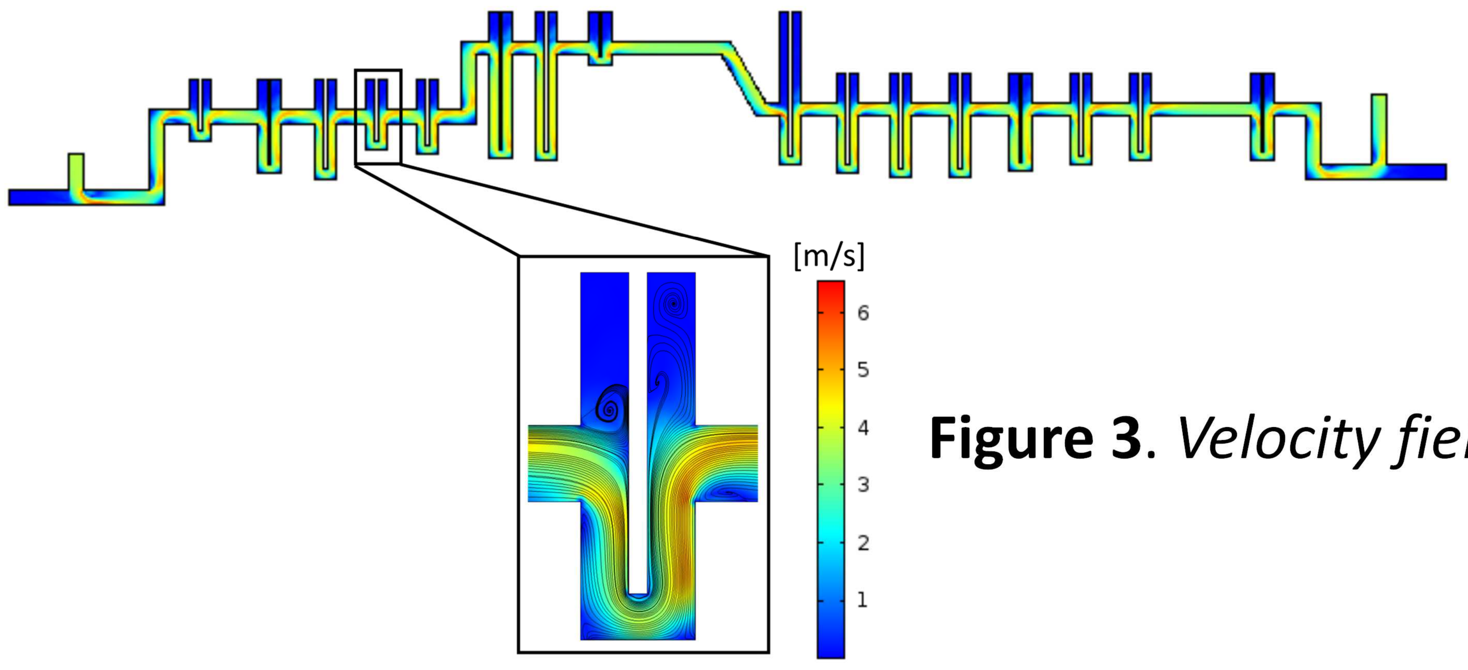


Figure 3. *Velocity field*

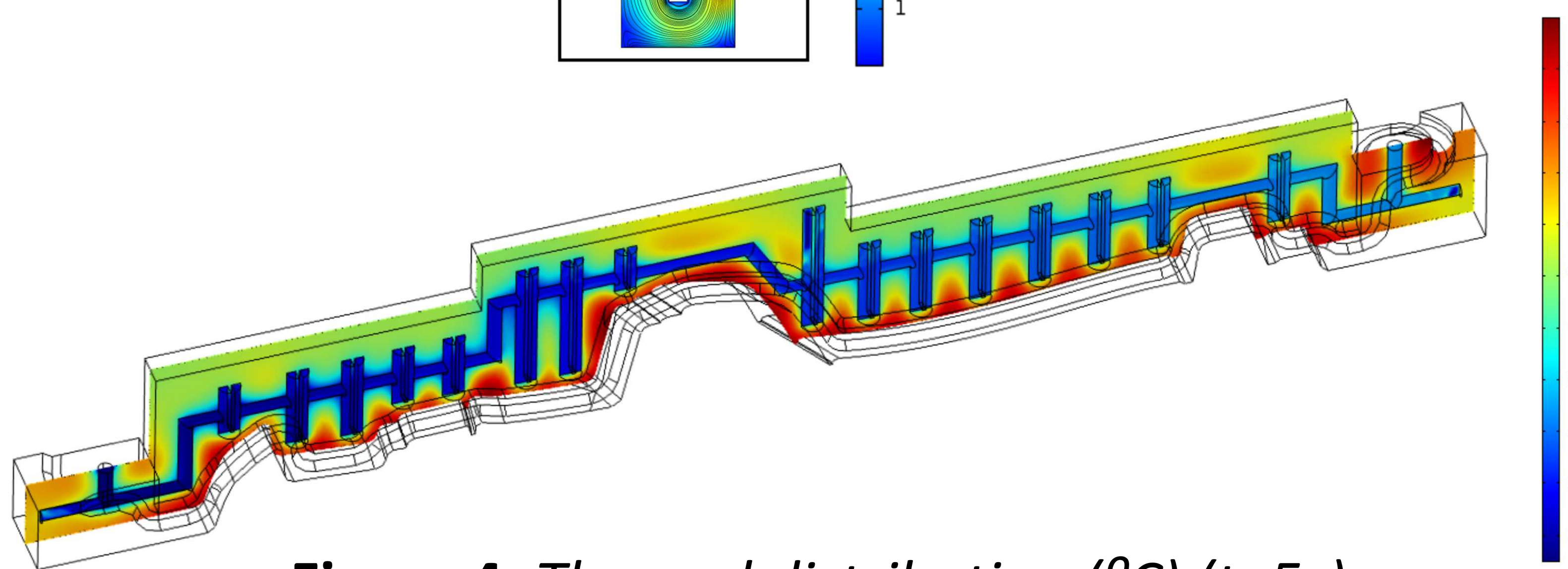


Figure 4. *Thermal distribution (^{o}C) (t=5s)*

The heat transfer coefficient estimated along the cooling line is illustrated in the Figure 5.

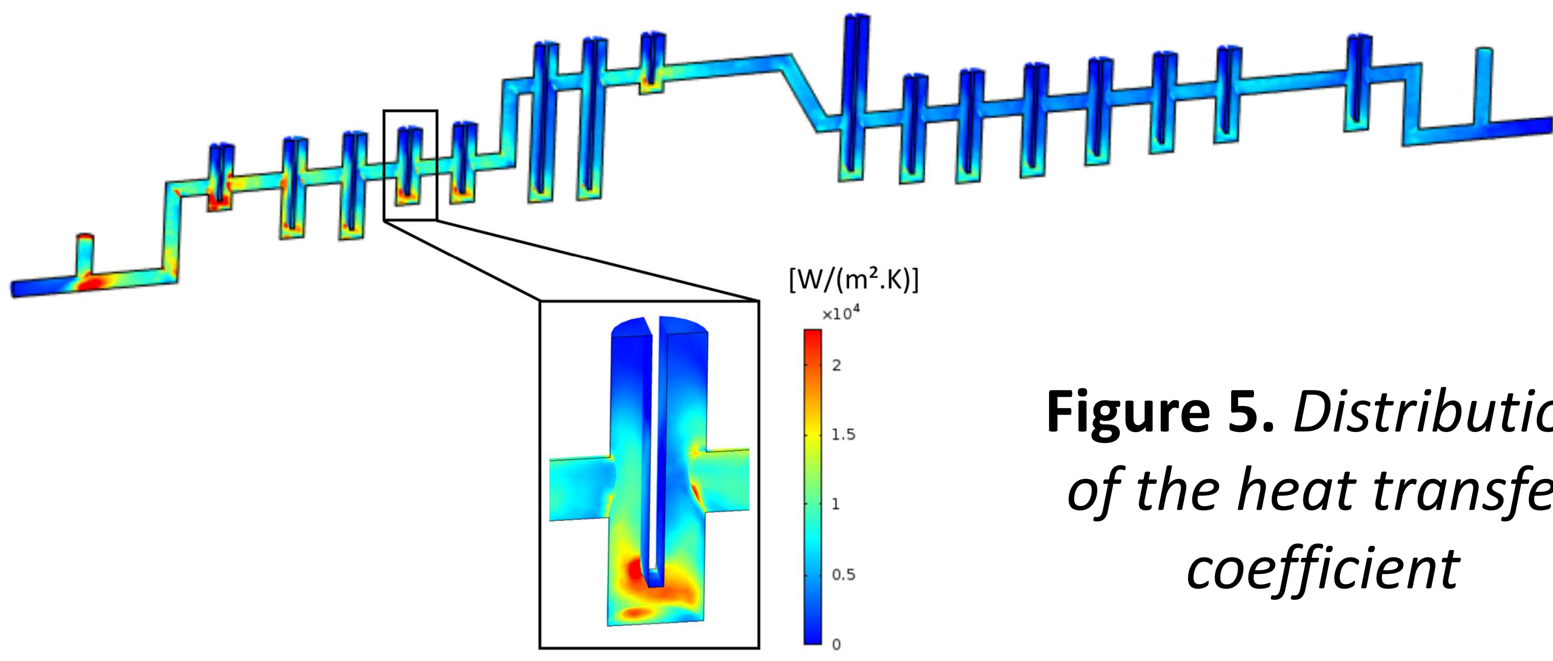


Figure 5. *Distribution of the heat transfer coefficient*

Conclusions: Use of Comsol Multiphysics enables accurate estimation of the heat transfer coefficient in a complex geometry. This has led to reach a suitable cooling integration related to the intrinsic constraints of the molding industry.

References:

- Launder, B. E. and Sharma, B. I. (1974), "Application of the Energy-Dissipation Model of Turbulence to the Calculation of Flow Near a Spinning Disc", Letters in Heat and Mass Transfer, Vol. 1, No. 2, pp. 131-138.
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