

Postdoctoral fellow CETHIL (18 months)

Design and experimental characterization of an innovative cooling system for injection molds

OUMOUSS project, funded by the AURA Region

Context:

The thermal control of injection molds for metallic or polymer materials is an important challenge, since the temperature uniformity of the molded piece determine the quality of the final product. Furthermore, a decrease of the mold heating-up stage and of the molding cycle duration are required, to reduce costs and scrapping. The actual cooling techniques are based, amongst others, on water circulation as close as possible to the molding surface (figure 1). The use of a high water mass flow rate enables a very efficient cooling, but causes corrosion and fouling problems.

The objective of the OUMOUSS project is to develop an alternative cooling system, leading to suppress the water circuit or to remove it at the mold periphery. This system is based on the insertion of metallic foams, coupled to heat pipes and/or to phase change material (PCM), into the mold structure. Owing to the resulting weight reduction, this honeycomb structure allows the reduction of the mold thermal inertia. It may also act as a thermal dissipater towards a cooling medium circulating inside the foam. The role of the PCM is then to smooth the temperature peaks involved by the metallic mass reduction. A heat pipe is a tight enclosure containing a two-phase fluid, which evaporates at the contact of a heat source and condenses at the contact of the heat sink. The fluid is circulated under the action of capillary or gravity forces, in a passive way. Thus, heat pipes could act as high conductive materials, able to transfer the heat very efficiently between the heat source (molding surface) and the heat sink (cooling medium), to improve the fin effect of the foam, or to uniformize the temperature of the molding surface. For polymer molding applications, the use of air as the cooling medium instead of water may be considered, what would involve a technological breakthrough.

The role of the research team “Energy and Heat Transfer in Industrial System” of the CETHIL is to theoretically analyze the required thermal functions of the molding process, in order to define the optimum cooling systems answering to the specifications of both polymer and metal molding applications. The interest of inserting metallic foams, heat pipes, and PCM inside the mold is examined, as well as the most relevant location of these elements. Furthermore, experimental test benches are developed to characterize thermal parameters which are difficult to predict by modeling. These tasks take place in a close collaboration with the partners of the projects, especially the research group “Reactive Media and Heat Transfer” of the CETHIL, the Industrial Technical Center for Plastics and Composites (IPC), the Industrial Technical Center for Foundry (CTIF) and industrial companies like SANDEN, ARKK Shapers, Innomolds.

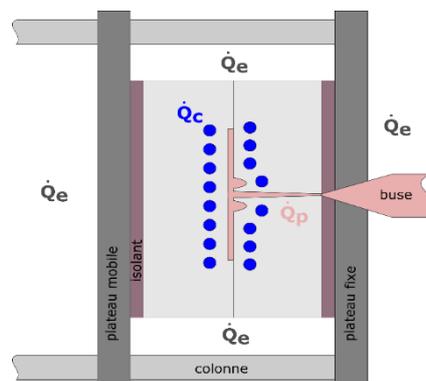




Figure 1: Schematic of a molding tool for polymers

Job description

The global objective of the postdoctoral work is to take in charge the various tasks of the project. A first experimental mock-up, in which a piece of aluminum foam equipped with embedded cylindrical heat pipes is submitted to representative operating conditions, is currently under manufacturing. The effect of various parameters - heat pipe dimensions, type of working fluid, of cooling medium, presence or not of PCM inside the foam ... - will be analyzed from the experimental results. The thermal parameters required to simulate the thermal behavior of the complete mold equipped with the new cooling system will also be deduced from these results. The insertion of heat pipes inside the foam made with the real material, a steel of very high hardness, is a technological issue to which the CTIF should give an answer during the project.

The selection of the working fluid of the heat pipe depends of the operating temperature of the application, on its thermal performance, and on the chemical compatibility with the steel. An incompatibility would lead to non-condensable gases generation inside the heat pipes, which would progressively hinder its correct operation. As the compatibility data are scarce in the literature, a second test bench will be developed, to study the chemical compatibility of various working fluids with the steel constituting the mold.

The final design of the cooling system will result from the best trade-off between technological feasibility, thermal performance and mechanical strength. Due to the originality of the work, publications in scientific international journals and conferences are expected.

Profile

The candidates should have a PhD and have a strong experience on two-phase heat transfer phenomena. Good experimental skills are also preferred.

Expected start date

Between January 2019 and June 2020

Contacts

Valérie Sartre : valerie.sartre@insa-lyon.fr ; +33 (0)4 72 43 81 66

Stéphane Lips : stephane.lips@insa-lyon.fr ; +33 (0)4 72 43 63 85

Frédéric Lefèvre : frederic.lefevre@insa-lyon.fr ; +33 (0)4 72 43 87 00

CETHIL – INSA Lyon – 9 rue de la physique – 69621 Villeurbanne