EXPERIMENTAL ASSESSMENT OF A NUMERICAL MODELLING CODE DEVELOPED FOR THE PROFILE EXTRUSION COOLING STAGE

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One of the critical stages in the extrusion of thermoplastic profiles is the cooling of the profile, which is usually undertaken in a metallic calibrator. In order to assure the highest possible productivity, the profile thermal energy must be removed as fast as possible. However, due to the typical low diffusivity of thermoplastic materials, the cooling stage is relatively long and the temperature gradients along the profile thickness are high, promoting the development of thermal residual stresses, which should be minimized. Consequently, designing an optimum calibration system that ensures fast and low level of thermal residual stresses is always a difficult task, especially when dealing with complex geometry profiles.

In this work, we firstly report the experimental assessment of a previously developed numerical modelling code [1], which is able to model the thermal interchanges that take place at the profile extrusion calibration stage, and was developed in the framework of the OpenFOAM® [2] computational library. This task is undertaken with an industrial case study: a cooling system, composed by three calibrators in series, used in the production of a swimming pool cover profile. The experimental data of the temperature evolution along the calibration length was found to be similar to the numerical predictions, with a maximum relative error of circa 8.6% near the inlet of the second calibrator unit, which allowed the numerical code validation.

Upon the experimental assessment the numerical code was used to support the redesign of the calibration system. This study led to an alternative calibration system design, which has a simpler constructive solution and a better performance than the original one, considered in the validation of the numerical code.

As main conclusions, the results reported in this work prove the accuracy of the numerical code developed to compute the temperature distribution in the cooling/calibration extrusion stage, and its suitability to support the design of these systems.

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References

[1] Habla, F., Fernandes, C., Maier, M., Densky, L., Ferrás, L.L., Rajkumar, A., Carneiro, O.S., Hinrichsen, O. and Nóbrega, J.M., 2016. Development and validation of a model for the temperature distribution in the extrusion calibration stage. Applied Thermal Engineering, 100, pp.538-552.

[2] foam-extend. Open Source CFD Toolbox, 2013. URL https://sourceforge.net/projects/foam-extend/