On the constitutive modelling and friction laws used for the numerical simulation of Friction Stir Welding process

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ABSTRACT

This work deals with the FE-based simulation of Friction Stir Welding (FSW) processes. FSW is a solid-state joining technique used in many practical applications where the quality of the resultant joint is of essential importance. This feature decreases the harmful effects of high heat input, including distortion, and avoids solidification defects.

A non-consumable tool, rotating at a constant speed, is inserted into the line between the two plates to be welded. The heat is produced by the friction between the tool shoulder and the work-pieces and the mechanical mixing/stirring process.

In the present paper, a coupled thermo-mechanical analysis using Arbitrary Lagrangian Eulerian (ALE) framework is carried out to accurately predict the temperature histories and material flow around the pin tool. Different constitutive and friction models are presented and discussed and their impact on the final heat generated in the work-piece is studied.

On one side, the material behaviour is characterized by a family of thermo-viscoplastic constitutive laws which consider the material as an incompressible viscous non-Newtonian fluid such as Norton-Hoff, Sheppard-Wright, Bingham or Carreau models.

On the other side, the friction law allows for modeling the frictional contact interface between the pin shoulder and the metal sheet which have a relative sliding movement. Several friction models such as Tresca, Coulomb or Norton laws are used in this work. The final heat generated is studied.

The sensitivity to the constitutive model as well as the frictional law selected is investigated and the final result is compared with the experimental evidence.