Computational Techniques to Study Material Damage in High Temperature Metal Forming Processes

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ABSTRACT

In forming processes material damage is a key factor of study. Many times the material damage is a limiting factor since its presence is an issue, but other times its appearance is a necessary factor for the forming stage (cutting processes, chip formation ...). The presented work is focused on a specific manufacturing process of seamless steel tubes which includes three basic steps: vertical piercing press, piercer-elongator and hot Pilger mill. This process transforms a blank or ingot into a final seamless steel tube with specific dimensions and characteristics depending on market requirements. In this forming process is necessary the presence of material damage to enable the breakage of the ingot bottom. However the presence of damage in the tooling (cracks on the tool surface because of thermo-mechanical fatigue phenomenon) and in the final tube is undesirable.

The objective of this paper is to present computational simulation techniques that allow to increase the knowledge of the thermo-mechanical variables evolution and to predict the deformed shapes evolution during the forming stages. In this way the process can be optimized and the presence of problems can be anticipated. Besides, this paper includes specifically, simulation techniques that allow to approach the study of the material damage during the breakage of the ingot bottom, including in the study factors such as material heterogeneity, non-uniform temperature distribution or the presence of defects (filling gaps or shrinkage cavities).

For this work, it has been done several series of coupled thermo-mechanical FE simulations of the three conforming steps using ABAQUS/Explicit solver.