Innovations in Forging Technology

Simulation et implementation of the near-isothermal forging

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Stéphane Magron, Project Engineer expert in forging processes at Cetim since 2018. He has a Master in Material/Process Engineering from Ecole des Mines de Nancy supplemented by a specialization at Ecole Supérieure de Forge et de Fonderie. Stéphane has a 15 years industrial experience of hot forging processes. He has worked for major groups specialized in stamping, die-forging and open-die-forging in various sectors including Aeronautics, Nuclear, Defense, Oil & Gas and Public-works, and has hold different positions such as at engineering/methods, R&D and quality. As part of his work at Cetim, he supported many industrials in defining and implementing innovation projects around Forging.

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Abstract

Temperature of forging tools is one of the main characteristics of the forging conditions which could be affect parts health in case of deviation. These conditions are considered optimal when the temperature of the tools remains stable and closer to the slug one throughout the transformation operation.

Isothermal forging remains today one of the best ways to improve productivity or to develop innovative products for the forging industry. However, this technology is today technically and economically reserved for specific applications due to very severe constraints associated with the heating equipment, the atmosphere and the operator’s environment.

The objective of the study was to develop a new approach, economically industrial, targeting a temperature level just below the set point for hot forging, in order to achieve near-isothermal conditions. Despite a multi-sectorial interest, Aeronautical applications with sensitives metallurgical properties (such as nickel and titanium-based alloys) are the most concerned by this technology.

The first phase of the study consisted in identifying and characterizing heating solutions, insulations materials, and tools solutions able to be implemented in near-isothermal conditions.
Concerning heating, solutions by conduction, radiation or induction are identified.

For insulation solutions, materials such as ceramics and refractory steels have been selected and characterized.
Finally, hot characterization of tool grades such as nickel bases and carbides were carried out.

The second phase of the study focused on the design of a demonstrator able to reach a temperature of 900°C to evaluate heating and maintaining capacity of tools, but also to qualify embedded solutions pre-retained in the previous phase. The demonstrator has been validated by numerical thermal simulation which also allowed to qualify working environment.The purpose of the last phase was to adjust the simulation model based on the comparison between experimental data and first numerical thermal simulation results. The results allowed to define a methodological approach by finite element and allowed industrials to size their tools.