Austempering heat treatment of ductile iron: Computational simulation and experimental validation

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Abstract

The three-step austempering heat treatment of ductile iron parts in this paper is simulated by employing a coupled thermo-mechanical-metallurgical model. The thermo-mechanical formulation is solved in the macroscale using the finite element method to predict the evolution of temperatures and deformations in the whole part. The metallurgical model deals with phase transformations that occur during the heat treatment, which are analyzed in the microscale. For each phase transformation the microstructure features such as type, distribution, and shape and size of phases are considered employing representative volume elements. The performance of the proposed model is tested by simulating experimental heat treatments reported in the literature. By means of comparison with experimental results, the model proved to be able to predict correctly the evolutions of temperature and dimensional changes, the minimum austenitization and austempering times, and the final phase fractions. It is concluded that this model could be a useful computational tool in the design of austempered ductile iron parts as well as the austempering heat treatment process.

Keywords: Austempered Ductile Iron (ADI)||Finite element analysis||Experimental validation||Heat treatment simulation||Thermo-mechanical-metallurgical model
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