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Mathematical Model of Thermal and Microstructural Evolution during Austempering of Ductile Iron

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Abstract

Austempering of ductile iron is a heat treating process designed to improve the mechanical properties of ductile iron: Increasing its strength and wear resistance while maintaining the tenacity and ductility associated with the untreated condition. This task is achieved by rapidly cooling the part from the austenitizing temperature to the austempering temperature and holding it during a specific time. Austempering promotes the formation of an ausferrite matrix, i.e., a mixture of bainitic ferrite and retained austenite, along with graphite nodules. In order to achieve the required microstructural control, a detailed knowledge of the phase transformation evolution coupled with a heat transfer analysis is

required. Thus a thermostructural model has been developed to simulate the phase transformations during austempering of a ductile iron cylindrical probe. The thermal and microstructural submodels were coupled within the Abaqus software. The predictions were validated by austempering ductile iron probes from an austenitizing temperature of 920°C to an austempering temperature of 300°C in a molten salt bath and comparing predictions versus experimental data. It was concluded that the model is suitable to predict the thermal behavior and the final microstructure of the austempered ductile iron.

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