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# A combined experimental–numerical approach to assess the effects of quenching transfer time on the microstructure and mechanical properties of a Ti-6Al-4V alloy

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Nowadays, titanium (Ti) alloys play a pivotal role in aerospace and energy production sectors due to their specific mechanical properties. To date, the design of forged components in Ti alloys has been based on the experience of operators and engineers, and on the use of industrial tests to optimise production processes. However, the high production costs of these components and their possible anisotropy have led to the development of numerical models to assist engineers in designing the entire production cycle, thus reducing the number of industrial tests.

This work aimed to develop a combined experimental and numerical approach for the study and prediction of the effects of transferring time to the quenching bath on the microstructure and mechanical properties of a real industrial component made of the Ti-6Al-4V alloy. First, the thermal properties of the alloy were validated by comparing numerical and experimental results, the latter obtained at both laboratory and industrial scales, and by adjusting the input simulation data to fit the experimental measurements. The validated model was used to conduct multiple heat treatment simulations of the industrial component with varying transfer times to the quenching bath. For each simulation, time-temperature curves were obtained at different depths from the surface of the component. The calculated data were then discussed and compared with the experimental results from the same heat treatment routes performed at a laboratory scale on representative Ti-6Al-4V samples. On these samples, the subsequent metallographic and mechanical analyses enabled to establish quantitative relationships between the transfer times and the microstructural and mechanical properties of the material. The results were reasonably consistent with data obtained from the real component, confirming the validity of the proposed predictive method.

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