# Digital Heat Treatment Optimization For API 6A-Compliant Petrochemical Valves

J. Kadkhodapour[1], D. Perkowski [1], K. Hornig[1]

[1]Andritz Metals Germany

## Abstract

Petrochemical valves operating at wellheads must satisfy the stringent microstructural and hardness limits of API 6A, particularly when exposed to sour-service conditions. Achieving a tempered-martensitic structure with hardness 207-237 Brinnel Hardness in low-alloy steels such as AISI 4130 demands precise control of quench and temper parameters. Conventional development relies on multiple furnace trials and destructive tests—an approach that is slow, expensive, and prone to overlooking risk factors such as residual stress or delayed hydrogen cracking.
At Andritz we have embedded the entire heat-treatment design workflow in COMSOL Multiphysics®, uniting the Heat Transfer, Phase Transformation, and Structural Mechanics capabilities into a single predictive environment. Our session will showcase how this COMSOL-native model shortens development cycles and strengthens customer confidence:
1. 3-D Thermal Model: Accurate furnace heating and Water-quench cooling, with temperature-dependent material data imported via the COMSOL Material Library.
2. Metallurgical Transformation Module: Coupled CCT kinetics predict austenite decomposition and martensite start/finish temperatures in real time.
3. Hardness Prediction: Microstructure-based hardness is computed and validated against the API 6A criterion.
A single COMSOL run now replaces multiple shop-floor experiments, delivering first-time-right process windows and eliminating costly rework. Just as importantly, the simulation outputs—temperature curves, phase maps, and stress fields—serve as visual evidence during technical audits, enhancing transparency with valve OEMs and end-users.

## Figures used in the abstract

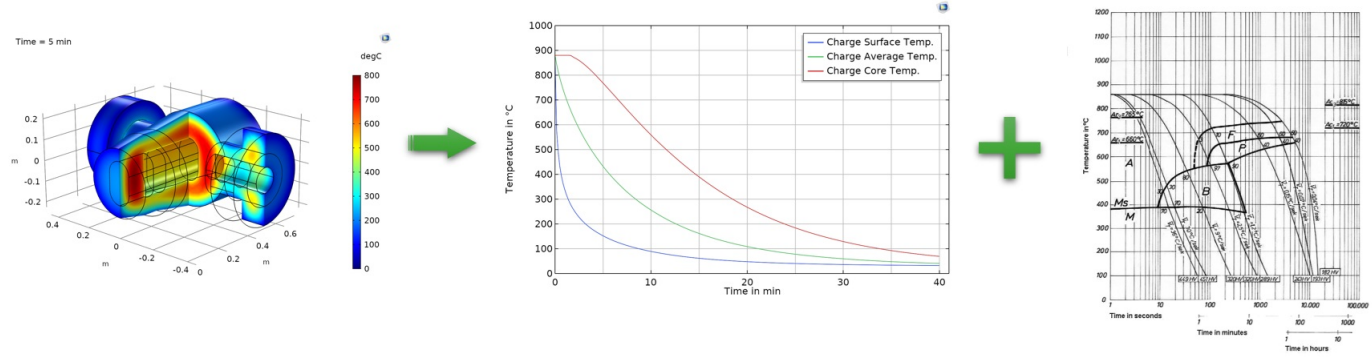


**Figure 1**