Modelling and numerical simulation of the quenching heat treatment. Application to the industrial quenching of automotive spindles.

Author: C. Coroas[1,2]
Supervisor: E. Martín[2,3]

[1] *Departamento de Matemática Aplicada II, E. de Ing. de Telecomunicación, Universidad de Vigo, Vigo, Spain.*

[2] *Departamento de Ingeniería Mecánica, Máquinas y Motores Térmicos y Fluidos, E. de Ing. Industrial, Universidad de Vigo, Vigo, Spain.*

[3] *Instituto Tecnológico de Matemática Industrial ITMATI, Campus Vida, Santiago de Compostela, Spain.*

Abstract

The quenching heat treatment consists in the immersion of a steel piece, previously heated above the austenization temperature. The fast cooling underwent by the pieces induces microstructure transformations (from austenite to martensite) that provides the piece with specific mechanical properties (high hardness) at the end of the process.

The numerical simulation to solve the cooling process and the final crystallographic structure involves several problems associated with the strong interaction between a fluid-dynamic model on a two-phase fluid (due to the presence of liquid and vapor because of the high temperatures), a thermal model and a metallurgical model.

To solve these problems, the heat flow on the surface of the spindle is characterised using correlations adapted to the curve of Nukiyama's experiments (based on the literature). It allows to describe (up to a certain degree of accuracy) the cooling process without solving a complex fluid-dynamic multiphasic model. The objective of this study is to obtain conclusive results about the cooling process and the final crystallographic structure, in order to optimize the industrial process of steel quenched spindles used on the automotive industry.

Keywords: Numerical simulation, heat treatment, quenching, microstructure prediction.