Determination of Heat Transfer Coefficient In Heat Treatment Processes Using Computational Fluid Dynamics Simulation

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Abstract

Heat treatment is the most common method to modify the mechanical properties in steel automotive workpieces, through heating and cooling processes. Depending of the heat treatment or stage we can have different values of heat transfer coefficient (HTC). For the thermometallurgical calculations, the most important boundary condition is the HTC, which can be obtained by a trial-and-error approach, inverse mathematical techniques, or computational fluid dynamics.

In this paper the application of computational fluid dynamics (CFD) in the calculation of the HTC values for natural convection phenomena was used. These measurements were obtained in austenitizing stage, annealing, normalizing and quenching processes, the specimen was a structural steel channel beam. The simulation was developed in Ansys Fluent. The incompressible-ideal gas model was used for the buoyancy effect generated by the internal heat source in the flow field. The two-equation k-ω based SST (Shear Stress Transport) turbulence model was used to mould the turbulent stresses in the Reynolds-Average Navier-Stokes equations (RANS).

The results demonstrated that CFD simulation is a powerful tool to calculate HTC in transitory states. The feasibility and precision of CFD calculations in each external fluid condition was demonstrated. A good correlation between the gotten results and similar previous works in the literature was confirmed.

Keywords
HTC, CFD, Natural convection, Heat treatment Processes, Cooling curve.

Biographies

Barbosa J. is a Mechanical Engineer from the Universidad Nacional de Colombia (2012). He completed a Master of Science in Automotive Engineering at the Universidad Autonoma de Nuevo Leon (2019). He started in 2017 as an intern at DRIVEN/CLAUT Innovation Center and currently works as a CAE analyst engineer and researcher. He has participated in different projects in the area of design, reverse engineering and simulation CAE, with more than 5000 hours of training in CAD modeling software, such as computational fluid dynamics (CFD) simulation. His interests are in the automotive area focused on design and product engineering, thermo fluid and fluid dynamics process.

Aranda A. is process Computer Aided Engineering (CAE) leader at Driven/CLAUT Innovation Center since 2018. He has played different roles: finite element analyst specifically in mechanical-structural, welding and heat treatment simulations; leader of research and development projects in the thermo-metallurgical-mechanical area; Instructor in engineering topics and CAE software. He earned a Master´s degree in Automotive Engineering (2018) and a Bachelor´s degree in Mechanical Engineering (2015) from the Universidad Autónoma de Nuevo León. His interests of study are topology optimization, lightweight materials, materials selection and metallurgy.