# An Integrated Numerical-Experimental Approach for Heat Transfer Analysis of Industrial Furnaces

Giuseppe Petrone[1], Andrea Adorisio[2], Stefano Adorisio[2], Marco Calderisi[3], Antonio Cecchi[3], Marco Scionti[1], Fabrizia Turchi[3]

[1]BE CAE & Test, Catania, Italy
[2]Gadda Industrie, Ivrea, Italy
[3]Laboratori Archa, Pisa, Italy

## Abstract

This paper deals with an integrated numerical and experimental analysis work aiming at the investigation of the thermal distribution inside an industrial furnace built for metal materials treatments. The main goal of the research is to find the geometrical and/or functional parameters responsible for a not homogenous thermal distribution inside the internal volume of the furnace. During the experimental measurements, 16 thermal probes were located inside the furnace chamber to monitor and record spot temperature values during a given heating process. Numerical FEM-based models were built in COMSOL Multiphysics environment to solve turbulent fluid flow and transport-diffusion/radiating heat transfer during the furnace operation. A multivariate analysis was also developed by applying multivariate linear regression and autoregressive models to build-up a predictive tool able to assess temperature state at several operational conditions of the furnace, from experimental temperature acquisitions and/or FEM-based results. A study of the recorded temperature variance of has been also carried out in order to understand the potential source of inhomogeneity due to burners operative conditions. Experimental time evolutions of temperature were firstly exploited to successfully validate numerical and analytical models. Then, several analyses were performed to evaluate the influence of many design parameters (burners location, thermal properties of insulating materials, surface thermal emissivity) on the thermal distribution inside the furnace.