Simulation of the Thermal Equipment Associated with a Paint-shop Oven of a Vehicle Assembly Plant with a Special Focus on the VOC Incinerator

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The automotive industry is characterized by complex and energy-intensive processes, which consume a significant amount of electricity and fuels. Therefore, improving the energy efficiency and promoting the use of renewable energies in this industry is of the highest importance. Among the different sectors, typically, in vehicle assembly plants, paint-shops are the most energy intensive consumers, requiring large amounts of fuels to dry and condition the air in the painting lines and to oxidize the Volatile Organic Compounds (VOC) that are generated in the industrial process.

Bearing in mind that the simulation of the piping and process equipment associated with a paint-shop oven helps to analyse the effectiveness of possible energy efficiency measures and the use of renewable fuels, a model that simulates the network of thermal equipment of a real industrial paint line was developed. Most of the equipment is simulated by solving the transient integral mass, momentum and energy conservation equations in OpenModelica. However, the VOC thermal incinerator is modeled with a surrogate model developed with the help of Computational Fluid Dynamics simulations performed in ANSYS/Fluent for different operating conditions.

In this work the results of the OpenModelica and the ANSYS/Fluent models are compared with measurements obtained in an industrial environment. Additionally, not only different operating conditions are analysed, but also, the partial substitution of fossil fuels by renewable fuels is investigated.