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Simulation-driven comparison and investment prioritization of gas-fired and electric radiant tubes in galvanizing furnaces.

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The operation of strip/coil galvanizing furnaces is significantly influenced by the choice of heating technology, which affects thermal uniformity, energy consumption, service life, maintenance costs, and CO2 emissions. Traditionally, gas-fired radiant tubes have been widely employed. However, the transition to electric heating solutions presents potential advantages in terms of thermal homogeneity, energy efficiency, durability, and reduced carbon footprint. A key challenge in this transition lies in evaluating the comparative performance of these two technologies under real operating conditions to support strategic plant investments.
This comparative study applies Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA) simulations to develop a representative virtual model of a galvanizing furnace equipped with both traditional gas-fired U-shaped radiant tubes and electric heating elements. The model captures combustion phenomena for the gas system, heat transfer mechanisms across the furnace, and the local thermal deformations and induced stresses affecting tube longevity. The impact of each heating technology on the homogeneity of thermal distribution on the coil and on the radiant tubes, overall power consumption, CO2 emissions, and expected critical regions affecting tubes service life are analysed. Additionally, maintenance costs associated with the two solutions are assessed.
The model is used to compare the current operational practices with alternative configurations, identifying key trade-offs between energy efficiency, temperature uniformity, CO2 emissions, and long-term maintenance requirements. By integrating these insights, the study provides a quantitative basis for prioritizing plant investments, optimizing furnace operation, and facilitating the transition toward more sustainable and cost-effective heating solutions in galvanizing processes.

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