

The Greening of Gas Burner Design

Simulation assists in developing efficient and environmentally friendly recuperative burners used in heat-treating applications.

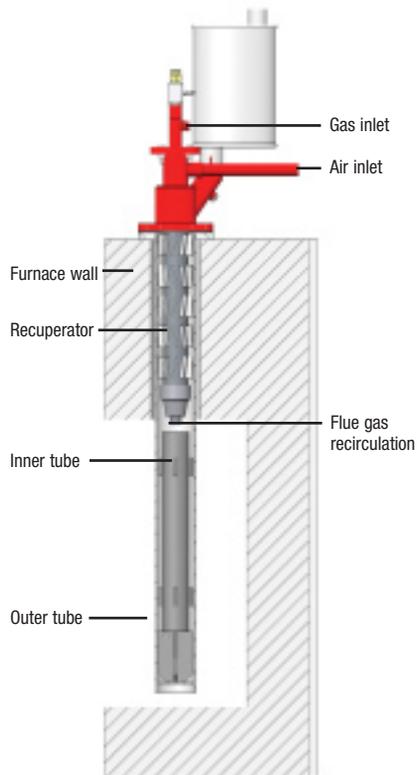
By Örjan Danielsson and Marcus Andersson
Kanthal AB, Hallstahammar, Sweden

Companies that depend on gas burners for heat-treating materials are challenged with adapting to tougher nitrous oxides (NOx) and carbon dioxide (CO₂) emissions rules and legislation, along with maintaining high efficiency. To address this, Kanthal AB uses a simulation-driven design process to develop innovative products such as the ECOTHAL® single-ended recuperative (SER) burner, the latest addition to the Kanthal family of heating solutions.

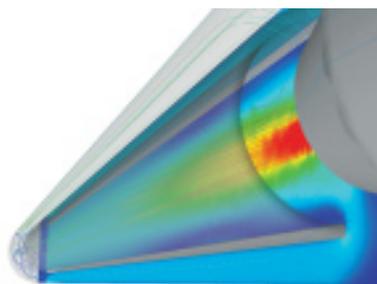
The key to success in delivering a low-emission, high-efficiency gas burner lies in well-defined combustion. Delivering too much air reduces heat output and increases the amount of harmful NOx produced, whereas too

little air results in incomplete combustion that causes unburned residue in the form of carbon monoxide (CO) and hydrocarbons. In the ECOTHAL SER burner, fresh air and fuel are combusted in an inner tube within a burner assembly while exiting exhaust gases are recovered, passed back through an outer tube that surrounds the inner tube and used to heat the incoming fresh air in a recuperator region upstream of the combustion area. Kanthal used computational fluid dynamics (CFD) to model and optimize flow behavior, gas mixture control and combustion efficiency. CFD simulations using software from ANSYS, Inc., together with physical testing, resulted in an SER burner that had an efficiency of approximately 80 percent — 10 to 20 percent higher than conventional SER burners — while still keeping NOx levels below 50 ppm (or 20 mg/MJ).

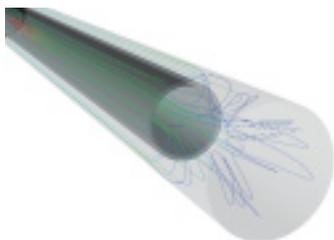
To help ensure that Kanthal provides accurate recommendations regarding procedures for maintaining proper performance, the company uses ANSYS Mechanical software to model creep. Kanthal's burner systems often are mounted horizontally, and creep, or deflection, of the tubes can affect flow characteristics and operation within the burner. The deflection rate typically is measured through physical testing in which a sample tube is placed in a furnace and the deflection is measured at specified intervals. This is a very time-consuming test that can take up to 3,000 hours, or 125 days. On the other hand, when modeling creep, existing test data is used to provide the coefficients for the creep equation that is used in the simulation inputs, and the testing process is simulated in less than a day.



Geometry of a single-ended recuperative burner, in which fresh air and fuel are combusted in an inner tube within a burner assembly while exiting exhaust gases are recovered, passed back through an outer tube that surrounds the inner tube and used to heat the incoming fresh air in a recuperator region



Contours of velocity and streamlines predicted by ANSYS CFX, viewed looking into the inner tube from its inlet area



Streamlines indicate exhaust gases that are exiting the inner tube and recovered back through the outer tube of Kanthal's SER burner.

The SER burner from ECOTHAL is the first in a family of five burners. The second burner in the series was designed entirely using CFD in combination with traditional computer-aided design (CAD) software. The ability to go directly from a 3-D CAD model to meshing and simulation within the ANSYS Workbench platform, and then to pass design changes back to the CAD program, greatly improved the speed of product development for Kanthal. By using simulation in conjunction with CAD tools, expensive and time-consuming laboratory testing was kept at a minimum, and development time was reduced by several months. ■

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