Innovative Energy-Efficient High-Temperature Gas-Fired Furnace

Heating mantle research yields increased heat transfer rates, energy savings, and reduced environmental pollutants

Benefits

- Potential to save 5.8 billion Btu per year compared to one electric mantle and 9.7 billion Btu per year compared to one conventional gas mantle
- Increases heat transfer rates over those offered by conventional technologies in the 1,800 to 2,400°F temperature range
- Potentially reduces emissions up to 75 percent
- Lowers operating costs on a per-year basis compared to conventional gas-fired and electric furnaces, resulting in a differential payback of 1.2 years

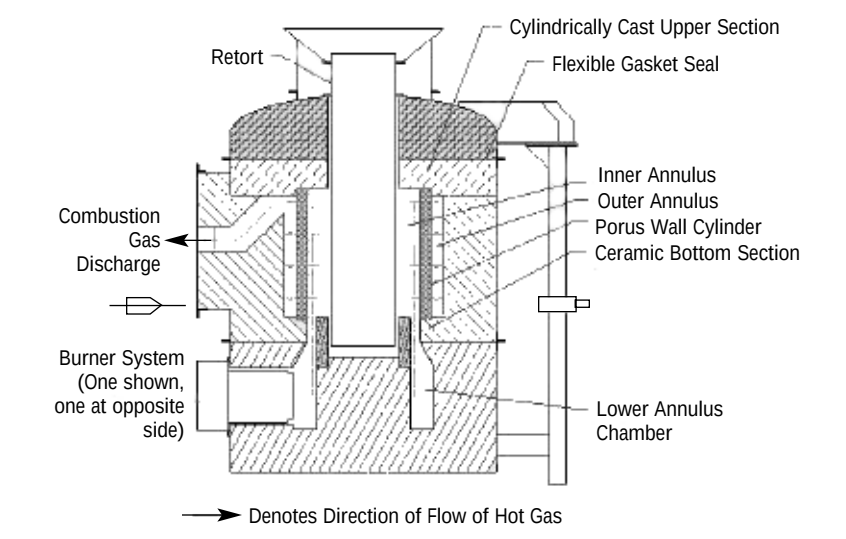
Applications

This new technology will have immediate applications in the heat-treating, metal-processing, and chemical-processing industries. The porous wall radiation barrier heating mantle could be retrofitted into existing gas-fired and electric-heating mantles to provide an even more energy-efficient process. Initial plans call for the complete manufacture of a porous wall radiation barrier furnace.

Retort furnaces, which consist of a heating-mantle jacket surrounding a retort vessel, are widely used to generate high temperatures for the metal-processing, chemical-processing, and heat-treating industries. In addition, a growing number of commercial processes use these furnaces in the temperature range of 1,600 to 2,350°F. However, low heat-transfer rates and poor energy efficiency with current gas-fired heating mantles have limited the number of successful commercial applications to date, while increasing the use of electrically heated mantles in these processing industries.

A new porous wall radiation barrier (PWRB) heating mantle represents a breakthrough in heating mantles that significantly increases heat-transfer rates over both the existing gas-fired heating mantle and the electrically heated mantle. In this advanced design, combustion gas flows through a porous wall surrounding the retort, transferring heat by conduction and convection to the porous wall, which then radiates heat back to the retort. This unique development results in a heat-transfer rate in the 1,800 to 2,400°F range that is 2 to 4 times greater than electric and conventional gas-fired mantles.

Porous Wall Radiation Barrier (PWRB) Heating Mantle



The new PWRB heating mantle offers increased heat-transfer rates, increased energy savings, and a significant reduction in emissions.

Project Description

Goal: Design, construct, and test a commercial-scale prototype furnace to evaluate construction materials and methods, as well as heat-transfer characteristics.

The porous wall radiation barrier heating mantle (PRWB) and furnace are based on the concept that porous material is more effective in augmenting heat transfer to a metal surface than conventional gas-fired and electric mantles and furnaces.

This technology has the potential to increase heat transfer rates, reducing annual energy costs by $36,456 per unit versus existing gas-fired mantles and $21,672 per unit versus electric mantles. In addition, emissions could be reduced by up to 75 percent.

The simplicity of the porous wall radiation barrier heating mantle's geometric design offers the possibility of producing a lighter, lower capital-cost furnace. The incremental capital cost of a PWRB heating mantle for 24" diameter by 60" high retort is $26,450 higher than a comparable electric heating mantle. However, the incremental heating costs decline by $21,672 per year, resulting in a differential payback period of only 1.2 years.

Procedyne Corporation is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Engineer a commercial prototype system based on lab-scale prototype performance.
- Fabricate and test the new prototype, then transfer and install it at industry partner's facility.
- Monitor performance of the prototype system for 2,000 to 4,000 hours of operation.
- Modify system to achieve targeted performance results.
- Develop engineering standards and drawings suitable to support subsequent production.

Economics and Commercial Potential

The metal-processing, heat-treating, and chemical-processing industries are receptive to new technologies that offer cost saving advantages. The considerable decrease in energy consumption due to higher heat transfer rates and reduction of environmental pollutant emissions make this technology an attractive alternative for these processing industries.

In processing industries with significant energy costs, industry representatives have stated that increasing prices of natural gas have forced companies to search for more energy efficient, less costly processes. Any new technology, such as the PWRB heating mantle, that offers the benefits of reduced energy consumption and costs will prove valuable to companies within the industry. If thorough industry testing supports the grantee's projections with regard to higher heat transfer rates, reduced energy costs, and environmental benefits, this technology should be well received by industry.

COMBUSTION

The Combustion Program works closely with the industrial combustion community in pursuing research and development (R&D) that can achieve the goals and performance targets set forth by the industry in two landmark documents: ***The Industrial Combustion Vision*** *and* ***The Industrial Combustion Technology Roadmap****. The program promotes the research and development of advanced, highly efficient combustion systems that will help U.S. industry to remain competitive in the future.*

OIT Combustion Program Leader: Bob Gemmer (202) 586-5885.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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