Combustion Gas Heat Exchanger

Battelle Number(s): 14038-E

Patent(s) Issued

Available for licensing in all fields

SUMMARY

Two very challenging problems facing the U.S. and the world are energy security and global climate change, largely due to our dependence on fossil fuels. Researchers at Pacific Northwest National Laboratory have developed cost effective technologies that are capable of substantial energy savings through improved energy efficiency. Microchannel heat exchanger technology is capable of improving the efficiency of natural gas appliances, including residential furnaces and hot water heaters. The technology is also useful for other applications involving combustion processes, such as fuel cell systems that utilize steam reforming to generate hydrogen.

In many applications where fuel is combusted, high temperature heat is generated and then transferred to another media, such as air or water. Energy losses in this process include the unused heat content of the exhaust gas. Exhaust gas losses are reduced by improving heat exchange to extract more energy from the combustion gas. To squeeze the most amount of energy from the exhaust, a heat exchanger is used to preheat the incoming combustion air (or fuel) with the exhaust. Eventually, water condenses from the exhaust gas as it cools, which is usually corrosive, so components that come into contact with the water must be corrosion resistant. These are called ‘condensing’ systems (i.e. condensing furnaces, condensing boilers, etc.), which are a primary application for this technology.

Microchannel heat exchangers, such as the Combustion Gas Heat Exchanger, are smaller in size and have proven more effective than conventional clamshell and tubular heat exchangers currently used in condensing furnaces.

The Lab prototype device is a stainless steel air recuperator designed and tested in a fuel cell demonstration system. It has a design duty of 3.5 kW, exhibits very low pressure drop, and operates with more than 90% heat exchange effectiveness. The device weighs 14 times less than conventional offerings and is almost 30 times smaller than a commercial heat exchanger having similar duty yet lower effectiveness. Researchers estimate that the device is close to the size needed for a 75,000 Btu/hr residential furnace. Process based manufacturing cost estimates project $350/device produced at 20,000 units/year.

The small size and effective heat transfer in microchannel heat exchanger and microreactors have similarly shown advantages in fuel reformers for fuel cells. A system containing of a steam reforming microreactor and a vaporizing microchannel heat exchanger, both heated from a combustion gas stream and designed for very low pressure drop, enabled rapid start of a fuel reforming system. A demonstration system was heated from ambient temperature to an operating temperature over 700Â°C in 5...
seconds and reached full operating capacity in under 30 seconds.

ADVANTAGES

- Stainless steel construction protects against corrosion
- Device is smaller, lighter, and offers high efficiencies for gas appliances

STATE OF DEVELOPMENT & AVAILABILITY

- Multiple devices of similar design have been fabricated and tested on various fuel cell and thermal systems. All working prototypes have been fabricated using photochemical machining (PCM) and high temperature diffusion brazing. Early process development has been done with alternative fabrication methods, including shim stamping, brazing, and laser welding. Process based cost models have been developed and used to generate cost-volume curves for cost of goods sold as well as sensitivity analyses. Large volume manufacturing is not currently established in the world for producing microchannel devices in quantities of thousands per year which would be needed to support a market like residential appliances. Consequently, there is an opportunity for new manufacturing to support this emerging technology if viable high-volume markets are identified.

PATENTS & INTELLECTUAL PROPERTY

- 8,231,697

TECHNOLOGY PORTFOLIO(S)

- Microtechnology

POTENTIAL INDUSTRY APPLICATION(S)

- Consumer Products
- Energy & Utilities

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