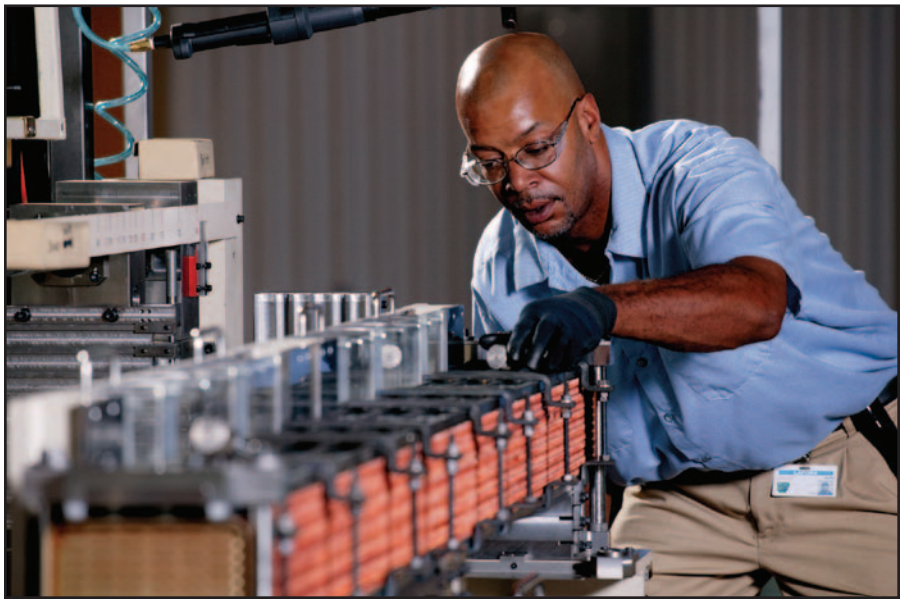
Cool Technology To Help Meet Emissions Targets

CuproBraze process for brazed copper/brass heat transfer components can help deliver cooling performance needed for reduced emissions

By Bo Svensson



Denso's plant in the U.S.A. marked the world's first mass-production application of the CuproBraze process for the manufacture of radiators for off-highway vehicles and started production of car air conditioners.

Current emissions reduction targets for diesel engines are governed by legislation in Europe, Japan, the U.S.A. and many other countries worldwide. The new laws are calling for dramatic reduction in oxides of nitrogen (NO_x) from heavy-duty engines used in on- and off-road vehicles and equipment.

Most modern diesel engines are turbocharged in order to achieve the highest performance and meet emissions regulations. An important part of turbocharged engine systems is the charge-air cooler (CAC). Located between the turbocharger and the engine air inlet manifold, the CAC reduces the air inlet temperature, which rises as the result of the turbocharger compressing the air. As the CAC does its job, typically cooling the air from around 200°C to about 45°C, the air inlet density is increased, which further improves engine efficiency.

As part of their efforts to reduce emissions, many engine manufacturers have adopted exhaust gas recirculation (EGR), in which part of the exhaust gas is mixed with inlet air before going into the intake manifold. This process leads to a reduced air ratio in the combustion chamber, which reduces NO_x, but can lead to higher particulate emissions. To avoid that situation, boost pressure from the turbocharger is increased to achieve the same fuel/air mixture that existed before the introduction of the exhaust gases.

The higher boost pressures lead to higher CAC temperatures — some in the industry expect inlet temperatures to reach 300°C or higher — and a requirement for a better CAC performance, along with an enhanced ability to withstand thermal and mechanical loads. Existing CAC technology uses aluminum alloys, which many believe are near their limit in their ability to accommodate the increased temperatures and thermal stress levels. To continue to use aluminum-based CACs, it may be necessary to include a pre-cooler, which can add both performance losses and cost implications.

To meet these technical, operating and cost challenges, a new manufacturing technology called CuproBraze has been developed. The CuproBraze process is designed to produce mechanically robust, reliable brazed copper/brass charge-air coolers, radiators and other heat transfer components with performance and cost advantages over aluminum radiators, particularly when dealing with the higher temperatures required by new diesel engine technology.

Luvata Sweden AB, former Outukumpu Copper Strip AB, is the company behind CuproBraze technology. Luvata supplies the conventional metal

The International Copper Association Ltd. (ICA) is the leading organization for the promotion of the use of copper worldwide. The association's 29 members represent about 80% of the world's refined copper output and its six associate members are among the world's largest copper and copper alloy fabricators. ICA is responsible for guiding policy, strategy and funding of international initiatives and promotional activities. With headquarters in New York City, ICA operates in 28 worldwide locations through a network of regional offices and copper development associations.

strip for soldered copper/brass products as well as the special copper and brass alloys for the CuproBraze process. The International Copper Association Ltd. (ICA) has also played an important role in the development and expansion of the CuproBraze process.

CuproBraze CACs are already dominating the Russian market, with truck manufacturers like URAL, KAMAZ and bus manufacturer LIAZ in the forefront. In the U.S.A., Denso has been making radiators using the CuproBraze technology for off-highway vehicles at its facility in Arkansas since November 2004.

In all, a total of 15 factories worldwide have commercial CuproBraze production in place and another 10 companies have decided on adoption of the process.

One such company is Finland's Suomen Jäähdytintehdas Oy (SJT), which inaugurated its new CuproBraze production line at its factory in Suolahti, near Jyväskylä, Finland, in March. SJT is a low-volume producer of various types of heat exchangers for heavy-duty trucks and off-road vehicles, such as construction and agricultural equipment.

The company is known for its production of customized manufacturing of products for specific applications. SJT is convinced that being one of the first suppliers of CuproBraze products will further enhance its reputation as a high-quality, service-oriented company.

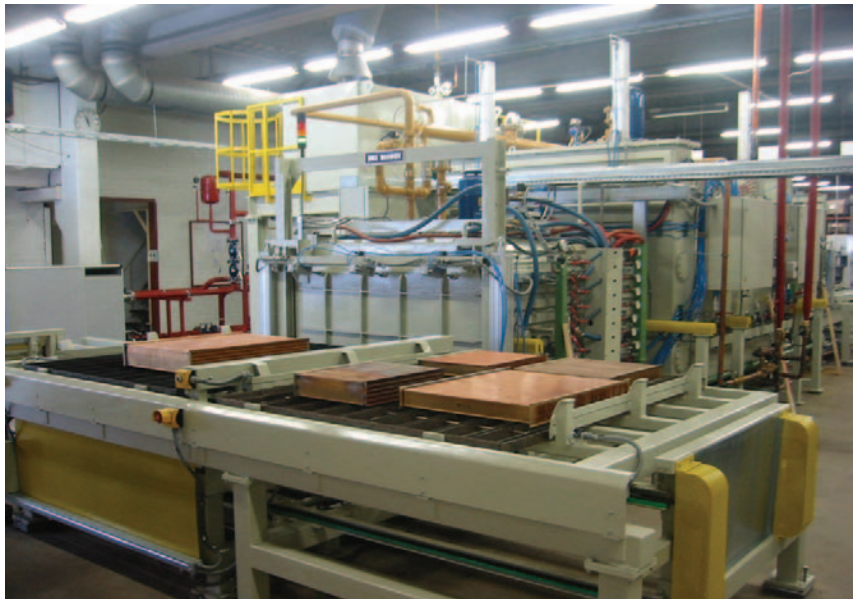
A sister company to SJT, Suomen Jäähdytinosa Oy (SJO) is located in the same industrial property as SJT and manufactures heat exchanger cores, hereby leaving SJT to focus on design, assembly, marketing and sales of complete heat exchangers.

"We have closely followed the development of the CuproBraze process and the markets reception of the technology before taking the decision to make the investment in the new equipment which we have today commissioned," said Hannu Vetikko, managing director of SJT. "Discussions with our customers revealed that they were strongly interested in CuproBraze and were more or less demanding it for their future production."

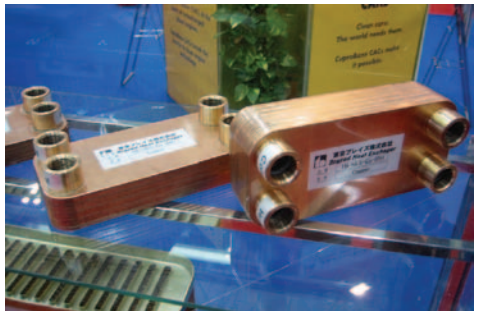
The durability of the CuproBraze exchangers was proven in a broad series of corrosion tests and many of the tests were carried out at Helsinki University of Technology.

"We also considered aluminum, and made an extensive study comparing aluminum brazing with CuproBraze," said Vetikko. "We noticed that aluminum charge-air coolers would have problems at elevated operating temperatures. So at the moment, we see no alternative to CuproBraze and have moved forward with the establishment of the CuproBraze production line which is today commissioned."

For some time, SJT has been working closely with the CuproBraze Brazing Center in Västerås, Sweden, and has made numerous prototype coolers. "CuproBraze is already proven to be a cost-effective manufacturing technology, which has been successfully transferred to the factory floor for small volume, midsize and high volume production," said Staffan Anger, president of Luvata Sweden AB. "As a simple, straightforward process, CuproBraze allows for considerable flexibility in brazing cycles and furnace design."



Charge-air coolers ready to be fed into the Seco/Warwick three-chamber brazing furnace. The midsize volume-production furnace is semi-continuous, allowing easy loading and unloading from both front and rear, which can significantly reduce process times and increase capacity.



Smaller, brazed heat exchangers manufactured according to the CuproBraze system by Tokyo Braze, Japan, and a charge-air cooler built using the CuproBraze process by TRad in Japan.

SJT joins a growing number of radiator manufacturers in Europe, Asia and North America which are finding profit today making CuproBraze products. One of SJT's main customers is the neighboring tractor manufacturer Valtra, which produced an annual 10 500 tractors in its Suolahti factory and another 8500 in its Brazilian facilities.

"We can hardly wait for the series production of charge-air coolers and radiators to start up," said Tero Kangas, materials manager of Valtra. "During some time we have had the opportunity to work closely with SJT and Luvata Sweden AB and have tested the CuproBraze products. No doubt, it is the technology that will be able to meet with the higher demands of future engine designs."

SJO will initially make liquid-to-air heat exchangers for engine coolant or water radiators. Also, air-to-air charge-air coolers for diesel engines will be on the program and later on, oil coolers will be produced.

The CuproBraze production line consists of a number of special machines. A tube mill from Mill Masters is part of the line, along with a fin mill from Livernois Engineering and a fin tip brazing applicator from Schöler. The tube mill contains a high-frequency welding station to convert brass strip into flat tubes that are used in radiators and charge air coolers. A header slurry paste applicator from Schöler is the final link in the production line before the Seco/Warwick semi-continuous midsized volume production brazing furnace.

The furnace is semi-continuous, allowing easy loading and unloading from both front and rear, which will significantly reduce process times and increase capacity. The furnace can braze parts of various sizes and geometries with a maximum core size of 140 cm x 130 cm. In order to preserve the environment, the furnace is equipped with an afterburner unit, which removes unwanted chemical emissions from the exhaust.

"Suitable furnaces for copper-brass brazing are widely available and cost much less than aluminum brazing furnaces," said Anger. "Production can be done in batch, semi-continuous or continuous furnaces depending on part size and production volume."

The SJT staff has been thoroughly trained pending the installation and commissioning of the production equipment. "A combination of manual assembly methods and semi-automated assembly equipment will be used by SJT," said Vetikko, "and it fits well in with our experience and staff." ◆