CuproBraze®

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EXECUTIVE*Report*

New Designs of Charge Air Coolers Increase Performance and Durability

Part II: Laboratory Testing Aids in Design Improvements

Editors Note: A brief overview of the standard tests performed at the Brazing Center was presented in Part I, which can be found in the previous issue of the *CuproBraze Executive Report* (i.e., Issue No. 41). We continue our review of the activities at the Brazing Center with a discussion of how testing can be used in the development of superior charge air cooler designs.

To say that the Västerås Brazing Center is a hotbed of activity is an understatement. Presently, eleven manufacturers around the globe are making radiators, charge-air coolers and other products on their own dedicated *Cu*proBraze lines; and twelve more have decided to open *Cu*proBraze production facilities. The *Cu*proBraze Alliance recently announced that eighty more companies are evaluating *Cu*proBraze heat exchangers.

For many parts manufacturers and OEMs, the decision to produce *Cu*proBraze heat exchangers begins with a trip to Västerås and, subsequently, they avail themselves of the Brazing Center to verify specifications before committing to full-scale production. As a result, the Brazing Center is a breeding ground for new heat exchanger designs.

As described in Part I, the testing of heat exchangers for performance and durability is a critical function of the Brazing Center. Durability testing is especially important in the development of CACs made of brazed copper-brass. Until very recently, nearly all CACs were made from aluminum. In the last few years, however, thanks in a large part to the work performed at the Brazing Center, a large number of practical copper-brass CAC designs have been developed.

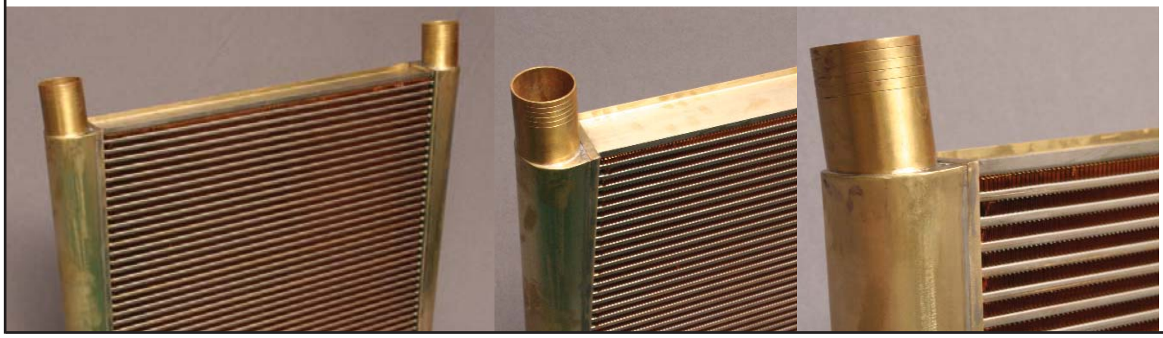
Informed CAC Design

According to Bengt Gustafsson, Technical Manager for the Brazing Team at the Brazing Center, many tests could be performed to simulate various aspects of service. CACs could be subjected to a variety of static and dynamic forces, including pressure pulses inside the CAC, bending forces on the inlet and outlet tubes, vibrations from the vehicle frame, and various conditions of thermal stresses.

Bengt and his group have determined several factors that influence both the burst pressure and the pressure cycling lifetimes. Based on testing experiences, he offers these tips to designers of brazed copper-brass CACs.

- Control over the fin height is important. In a CAC, the sandwich construction of the tubes and fins does not allow for variations in fin height. Exact part dimensions are required to form good brazed joints between the fins and tubes.
- If wide headers and thin gauge tanks are used then these parts will deform at relatively low pressures; therefore, he advises, "Headers should be as narrow as possible to limit stresses in the tube to header joint and in the header close to the joint."
- If thin gauge brass tanks are used, they should be well designed for internal pressure, to minimize stresses in the header. "Well rounded shapes are necessary," he cautions.

A benchmark CAC design was developed by the Brazing Center. (See Figures.) This CAC has also been subject to wind tunnel testing to determine its performance, including its cooling efficiency and air pres-



A new prototypical CAC design was developed at the Brazing Center using design principles derived from testing.

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is the leading organization for the promotion of the use of copper worldwide. The Association's twenty-nine members represent about 80 percent 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.

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sure drops on the charge-air side (internal pressure drop) and the cooling-air side (external air-pressure drop).

Design for Manufacturing

The *Cu*proBraze process is essentially the same for radiators and CACs, except for two important differences: the fin heights must be more tightly controlled, as mentioned previously; and CACs typically have internal fins, whereas radiators do not.

According to Bengt, full brazing contact between the fin tips and the tube walls can be facilitated by the design. "There are at least two ways to go. One is to use fins with a relatively large tip radius that can flex during core compression and then flex back during the brazing," he explains. "Another way to go is to use a relatively rigid inner fin that withstands the compression pressure during core assembly and does not deform when heated during the brazing cycle. This latter approach appears to work well and has the important additional benefit of improving pressure resistance."

Also, brazing foil can be used instead of brazing paste for the internal fins. "Because the foil is thinner than the paste, the pre-brazing core dimension is less and the core shrinks less during brazing," he explains. The foil has no organic binder to evaporate, so there are no fumes that could adversely affect the internal brazing. The even supply of brazing filler material assures uniform brazing.

The Power to Choose

The Västerås Brazing Center has cooperated with many prospective manufacturers on preliminary research and development of *Cu*proBraze CACs. The result is a benchmark CAC design. Besides mechanical testing of burst pressures and pressure cycling lifetimes,

A *Cu*proBraze CAC-radiator package is installed into a truck at URAL truck assembly plant.

it has also performed corrosion testing and wind tunnel tests.

As the industry gains experience with *Cu*proBraze, most manufacturers will seek a competitive edge through proprietary designs. According to Bengt, the six factors governing CAC design are the heat transfer specification; the type of environment, or vehicle type; strength and durability specifications; the weight of finished product; manufacturing considerations; and the projected overall cost.

"The Brazing Center is ready to assist in the early stages of design and manufacturing," says Bengt. "However, once a company develops its own production capabilities, it tends to become more independent, driving its own designs. SHAAZ is a good example. It works with its OEM customers to develop new designs and it performs its own testing, although we collaborate on some projects."

Bengt speculates that, although heat-exchanger manufacturers will always want to know about new technologies, they eventually will perform their own testing of proprietary products, since the superior test results give them an advantage in the marketplace.

"The purpose of the Brazing Center is technology transfer," says Bengt. "There is no intention of establishing a design firm or testing laboratory here in Västerås. At this stage, at least until the industry matures, it's better if diverse designs are available." ■

A *Cu*proBraze CAC and *Cu*proBraze radiator can be packaged in one unit. This package was designed by SHAAZ for URAL trucks.

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