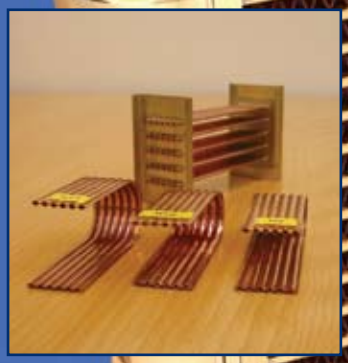
EXECUTIVE Report



CuproBraze Proves Versatile in the Design of Heat Exchangers

Key Advances Include "One-Shot" Brazing and New Tube Designs

CuproBraze has long been considered a versatile and flexible materials system. Typically, heat exchanger cores of different sizes and designs are processed on the same production line, unlike other processes such as brazed aluminum. For the latter, because of the difficulty of establishing the correct processing parameters, high volume production lines dedicated to identical products are the rule.

For the CuproBraze process, flexible manufacturing is the rule. The underlying reason why the CuproBraze process is suitable for flexible manufacturing is that it allows for more latitude or leeway in temperature cycling than other processes. In other words, the temperature cycle that melts the brazing material can be varied significantly without damaging the bulk metals. This simple fact has important consequences for the production environment as well as design.

CuproBraze technology is proving versatile in design. As the number of CuproBraze manufacturers increases, application engineering and design engineering are flourishing. Products are being designed for ease of manufacture. In addition, the superior strength of the joints formed by the CuproBraze process is enabling original designs for heat exchangers.

This *Executive Report* briefly describes the "one-shot brazing" of CuproBraze charge air coolers and new "multiport" CuproBraze tube designs. These two advances in design are presented as examples of the renaissance in heat exchanger design that is taking place as the virtues of CuproBraze technology become better appreciated by heat exchanger manufacturers and OEMs.

One-Shot Brazing

There have been many successes in the refinement of brazing processes for the manufacture of CuproBraze products. The process has proved quite flexible for the manufacture of many shapes and sizes CuproBraze products. Brazing as part science and part art has been covered in previous issues of the *ICA CuproBraze Executive Report* [1] as well as the technical literature [2].

The ultimate reference on CuproBraze brazing is the "CuproBraze Brazing Handbook," which includes 37 figures and tables in 15 chapters and 110 pages [3]. It covers such topics as materials and properties; application of brazing filler materials; fabrication and assembly of components; brazing of cores in a furnace; key factors for good results; and troubleshooting.

Members of the CuproBraze Alliance are becoming adept at developing brazing processes. As proof, consider the development of the "one-shot" brazing process. One of the biggest challenges is to braze different types of joints simultaneously, during one pass through the furnace. One-shot brazing is possible with a process such as CuproBraze, because the CuproBraze process provides enough process latitude to braze different geometries simultaneously.

One-shot brazing requires familiarity with the properties of the filler materials and adherence to geometric tolerances in the assembly of the components. One-shot radiators and charge air coolers are "designed for manufacturing." Once the exact tolerances and brazing application methods are determined and the furnace temperature cycle established, the process

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For information about the *Cu*proBraze process or ICA's *Cu*proBraze consulting services, please contact the International Copper Association at: cuprobraze@copper.org.
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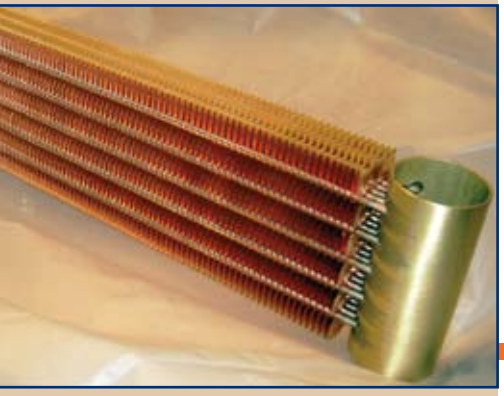
References

1. See ICA *CuproBraze Executive Report* Numbers 19, 23, 34 and 39 for more about brazing. See Numbers 41, 42 and 46 for more about testing of brazed joints. Available in the Literature section of www.cuprobraze.com.
2. An updated list of technical papers about the *Cu*proBraze brazing process is available in the Literature section of www.cuprobraze.com.
3. "*Cu*proBraze Brazing Handbook," Ninth Edition (Updated July 2009) can be downloaded free from the Literature section of www.cuprobraze.com with registration.
4. *Luvata Automotive Newsletter* Number 51, "Partnering with Finnradiator results in successful 'one shot' brazing." Available at www.luvata.com/Automotive-Newsletter.
5. See ICA *CuproBraze Executive Report* Number 54, "Vintage Air Commences Production of Brazed Copper-Brass Components for Durable, Compact Designs" for more about one-shot brazing by Vintage Air. Available in the Literature section of www.cuprobraze.com.



can be implemented in a production environment with high yields.

One-shot brazing tends to improve overall manufacturing quality because it requires tighter tolerances of dimensions. In one-shot brazing processes, furnace temperatures are gradually increased and parts are heated evenly. Strains due to differential temperatures are less than those present in welding processes. The greatly improved dimensional stability makes it easier to install heat exchangers into vehicles because of the accurate alignment of oppositely-facing fixing points.

The labor saving advantages of one-shot brazing are significant. One-shot brazing eliminates the need for skilled welders at the post-brazing production stage. One of the first companies to use the one-shot brazing method in volume production is Finnradiator, a member of the *Cu*proBraze Alliance. It currently uses one-shot brazing for the manufacture of charge-air coolers for several models of Valtra tractors. The company reports a savings in total labor time of about 25 percent when the one-shot method is factored in at the design stage [4].

Several other companies have developed one-shot brazing methods for medium volume production runs. For example, Vintage Air brazes heating units with a one-shot process [5]. Many other companies have tested one-shot brazing of prototypes in laboratory-scale production runs.

Multiple-Port Tube Design

Small diameter or flat tubes are used in heat exchanger designs to increase the contact between the fluid and the inner walls of the tube. The surface-to-volume ratio affects the efficiency of the heat exchanger. Thin-walled tubes are also desirable both in terms of materials savings and heat conductivity.

Yet, the assembly of many individual small tubes can be problematic for assembly. Brass cannot be extruded into multiport tubes so an alternative method for the fabrication of multiport tubes has been under research.

An important motivation for the development of multiport tubes has been the need for pressure resistance, which is important in A/C applications. Round cross-sections of multiport tubes are especially resistant to pressure. Different cross-sectional geometries (e.g., variations of port diameter, wall thickness and distance between ports) are possible using multiport tubes and are simply a matter of tooling.

Prototype designs have now been revealed for multiport tube assemblies fabricated from two matching *Cu*proBraze brass strips. Strips are formed with alternating troughs and flat sections and rolled locally together. Even though no brazing paste is applied between the two strips, the joints are strong enough to withstand the normal core assembly procedure. During the ordinary brazing furnace cycle the strip joints obtain their final strength by diffusion. Brazing paste is applied in a usual manner for the tube-to-fin joints, tube-to-header joints and so on.

In this manner, tough, reliable, multiport tube components can be readily fabricated for use in the production of novel heat exchanger products.

Design Renaissance

*Cu*proBraze is proving itself more flexible and versatile than could be envisioned when the process was first developed more than a decade ago. Although the groundwork was laid when the basic technology was developed, a renaissance of heat exchanger design is taking shape today. This renaissance is driven by the availability of a completely new materials system and the ingenuity of *Cu*proBraze brazing experts and design engineers.

It is envisioned that multiport tubes will be components of heat exchanger cores that will be brazed simultaneously with other fittings. The shape of this new generation of *Cu*proBraze heat exchangers is a topic of great excitement in the heat-exchanger design community. The designs, cooling fluids and end-uses of the next generations of heat exchangers are still a work in progress but one thing is for certain: A renaissance in heat exchanger design is underway and *Cu*proBraze technology is at the center of it. ■

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