EXECUTIVE Report

Manufacturers Discover Brazing Is Better for Joining Copper to Brass

Brazed Copper-Brass Joints Boost Performance of Heat Exchangers

Companies Recently Adding *Cu*proBraze Production Capability

RADAC
Dayton, Kentucky
www.radac.com

Radicon
Bangkok, Thailand
www.radicon.co.th

SHAAZ
Shadrinsk, Russia
www.shaaz.ru

SJT
Suolahti, Finland
www.finnradiator.com

Young Touchstone
Jackson, Tennessee
www.youngtouchstone.com

A continuous-belt furnace is used for high-volume production of brazed copper-brass heat exchanger cores. (Photograph courtesy of SHAAZ.)

Manufacturers worldwide are discovering that brazing is a superior process for joining copper fins to brass tubes. As a result, they are building new production facilities, large and small, and taking advantage of new brazing techniques.

In particular, Russia and China are focusing on the automotive industry to modernize their manufacturing infrastructure. Switching from first-generation technologies such as soft soldering directly to third-generation technologies such as copper-brass brazing allows them to pass over second-generation technologies such as aluminum brazing.

SHAAZ opened a high-volume production facility last year in Shadrinsk, Russia, and is already brazing copper-brass radiators and charge air coolers for Russian over-the-road trucks and off-road equipment.

Also, a major new brazing facility is nearing completion in Nanning, China, with production slated to begin later this year.

Brazing of copper-brass heat exchangers is about to occur or already happening at about a dozen facilities around the globe. To name a few, SJT, Radicon, RADAC and Young Touchstone recently have added brazing capability at facilities in Finland, Thailand, Kentucky and Tennessee, respectively, and production is already under way by other companies in France, Japan and the US.

The Brazing Advantage

The main reason for switching to brazing is clear. A soldered copper-to-brass joint is not nearly as strong as a brazed copper-to-brass joint. Yet, unlike welding, brazing does not melt the base metals, so the dimensions can be tightly controlled and dissimilar alloys can be joined.

The advantages of brazing over other methods such as welding, soldering or adhesives are well documented by companies with special expertise in brazing, e.g., Lucas-Milhaupt [1] and BrazeTec [2].

Older methods of brazing copper, e.g., for plumbing and related applications, are unsuitable for brazing the thin-walled fins and tubes that are used in mobile heat exchangers. By comparison, the *Cu*proBraze process is a new type of controlled atmosphere brazing (CAB) that does not require a separate fluxing step; hence, it eliminates subsequent rinsing and water treatment steps. The slurries or pastes include a small amount of flux to remove zinc oxide only in brass-to-brass applications, such as tube-to-header or header-to-tank. No flux is necessary for copper-to-brass applications, such as fin-to-tube. Overall, the process avoids strong fluxes such as are required in aluminum brazing. Moreover, it is economical enough for mass production.

*Cu*proBraze technology was the subject of a recent review article in which the authors describe the advantages of brazing with new anneal-resistant copper and brass alloys [3].

Why Now?

"For many years, a major obstacle to the use of brazing to join copper and brass in heat exchangers was that conventional alloys of copper and brass would anneal at brazing temperatures," says Leif Tapper, an expert on brazing materials at Outokumpu's Brazing Center in Västerås, Sweden. "Annealing occurs when the atomic lattices of the base metals are reformed at high temperatures. In conventional alloys of copper and brass, the ordering of atoms resulted in a large drop in yield strength. In the new alloys, this reordering is inhibited."

Closing the Gap

Brazing is defined as a metal-joining technique involving a filler metal alloy that melts above about 450 °C. In Fahrenheit degrees, 800 °F is sometimes used in this definition, considering that 450 °C equals 842 °F.

The many advantages of brazing are based on two defining characteristics.

First, unlike welding, brazing does not melt the base metals to be joined. It is sufficient to heat the assembly to the filler-metal-alloy melting point.

Secondly, when it cools and solidifies, the filler metal alloy forms a metallurgical bond between the base metals. This bond is often stronger than the parts being joined.

The filler metal alloy for *Cu*proBraze melts from 600 to 610 °C, so *Cu*proBraze clearly is a brazing process. It is typically blended with a binder, forming a paste or slurry that is applied prior to the heating step. "As the assembly passes through the furnace, the binder evaporates and only the filler metal alloy remains," says Nitin Shah, a brazing expert from Lucas-Milhaupt. "Once the filler metal alloy becomes molten it is distributed between close-fitting parts by capillary attraction. The filler metal alloy flows between the base metals, allowing for the formation of metallurgical bonds that completely seal the gap between the two base metals," he adds. "Such joints are impractical to achieve by welding, because welding must melt the base metals and spot welds usually are limited to exterior surfaces."

"Successful brazing is dependent upon successful distribution of the filler metal alloy on the base metals prior to the brazing process," says Harmut Schmoor, a brazing expert from BrazeTec. "To achieve the desired application results, the filler metal alloy is normally blended with a binder to form a paste, paint or slurry."

Heat exchanger manufacturers could develop their own formulas and recipes for slurries and pastes, starting with OKC600 alloy in powder form, which is available from high quality powder suppliers; however, most manufacturers prefer to purchase ready-to-use brazing slurries and pastes from established suppliers.

"The paste and slurry supplier often works with the manufacturer in the early stages of planning, before the equipment is specified, to fit the brazing process to the product," explains Hartmut Schmoor of BrazeTec. "The paste supplier can assist in choosing the right paste application equipment and optimize the paste to the application equipment demands."

"There is much to know about the proper preparation and handling of brazing materials," says Shah. "For example, expertise is required in blending and storing the materials, applying pastes and slurries to the component parts, and assembling the parts into products."

And the Winner Is ...

The above factors make brazing extremely attractive in product design. Properties of materials can be fitted to the local function of specific parts of the assembly, without compromising the strength and integrity of the structure.

In the off-road market for heat exchangers, strong brazed joints allow for the use of brazed copper-brass serpentine fins. The latter are more durable than either soldered serpentine fins or brazed aluminum fins, and they are more economical than plate-fin designs. In some off-road applications, triangular-shaped serpentine fins tend to clog in the narrow corner; a square-wave or intermediate-shaped fin can be used in such applications.

For the over-the-highway market, clean diesel engines require charge air coolers that can withstand higher temperatures than current materials. Unlike aluminum CACs, *Cu*proBraze CACs can take the heat.

It's no wonder manufacturers are switching to brazed copper-brass for heat exchanger production. It has decisive advantages over all other candidates! ■

Supplier	Tube pastes	Header slurries and pastes	Fin-tip pastes
BrazeTec, Hanau, Germany +49 6181 59-03 **www.brazetec.de**	CST600, CWT600, CPO600	CSH610	CTF600, CSF600
Lucas-Milhaupt, A Handy Harman Company Cudahy, Wisconsin +1 414 769-6000 **www.lucasmilhaupt.com**	CUPROFLO-100	CUPROFLO-200	CUPROFLO-110
ProTechno, Ribérac, France +33 (0) 5 53 92 53 00 **www.protechnogasflux.com**	CUPROFLO-100	CUPROFLO-200	CUPROFLO-110
SCM Metal Products, North American Höganäs Research Triangle Park, North Carolina +1 919 544 8090 **www.hoganas.com**	ST600	SH621, PH621	SF600

*Cu*proBraze pastes and slurries are available from major suppliers of brazing products. Their staffs include specialists who can assist with product design and process development.

For general mailing information about the *Cu*proBraze process or ICA's *Cu*proBraze consulting services, please contact International Copper Association at mrosario@copper.org. For technical information contact cuprobraze@copper.org. For European inquiries contact ndc@eurocopper.org.

REFERENCES

1. Lucas-Milhaupt, "The Brazing Book," Online version at www.handyharmancanada.com/TheBrazingBook/bbook.htm

2. BrazeTec, "Principles of Brazing," PDF version available for free download http://www.brazetec.de/brazetec/content_en/pdf/Principles_Brazing_Technology_S.pdf

3. Y.L. Shabtay, M. Ainali and A. Lea, "New brazing processes using anneal-resistant copper and brass alloys," *Materials and Design* **25** (2004) 83-89. This paper is available for purchase online through www.sciencedirect.com.

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