New designs based on CuproBraze technology benefit from simpler tube designs for faster assembly and lower cost.

CuproBraze®
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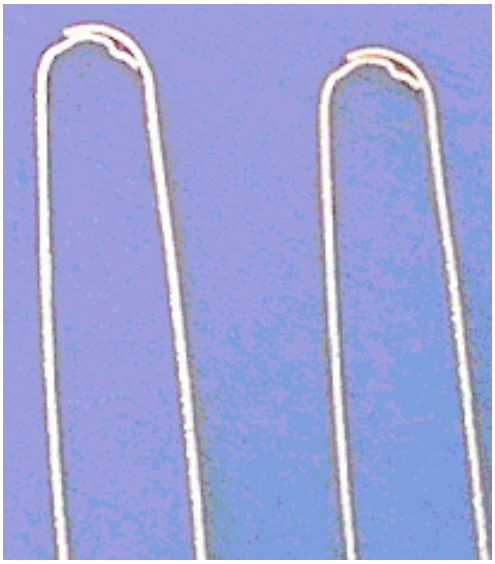
New Tubes Simplify Assembly of Mobile Heat Exchangers

The brazing process that binds copper fins to brass tubes results in fin-to-tube joints much stronger than could be obtained with traditional soldered joints. The same brazing process also can bind the folded seams of brass tubes with a much stronger seal than any solder joint. Consequently, *Cu*proBraze technology has a windfall benefit. It allows the development of new tube designs that would not be possible if solder were used to seal the seams of the brass tubes. The potential exists for a renaissance in heat exchanger design based on the availability of new kinds of tubes.

New radiators based on *Cu*proBraze technology benefit from simpler tubes. Brazing creates a joint that is stronger than a soldered joint and comparable in strength to a welded joint. The brazed joint is sufficiently strong to bind the two edges of the strip into a tube with no need for mechanical interlocking of the strip edges.

The simplest tube design is probably the overlap fold tube, also known as the snap-over tube, which has a symmetrical oval-shape. Under development for use with the *Cu*proBraze process for more than three years, the snap-over tube simplifies the design of a radiator because it fits neatly into an oval hole in the header. Only one brazing process is needed to braze the tube seam, the fin-to-tube joints and the header assembly. Snap-over tubes can be fabricated from brass strip as thin as 0.080 mm or even thinner.

The very thin walls of brass tubes for new radiator designs are especially important in developing high performance, compact and lightweight radiators. The strength of *Cu*proBraze tube



Cross section of brazed snap-over tubes, also known as overlap-fold tubes.

alloys allows for tube walls approximately one-third as thick as aluminum tubes. Although brass is denser than aluminum, the thin walls of brass tubing result in a similar weight per unit length compared to aluminum. As a result, brass tubes with copper fins are now competitive with aluminum even in automotive applications.

The limitation on the tube strip gage is the structural strength of the tube during the fabrication process. The tube needs to be inserted into the header. A very thin wall increases the tendency for the tube to bend during radiator assembly operations. When the tube wall is made very thin and the tube length and depth are great then the tube tends to buckle (or dog-bone) as it is inserted into the header. This bending becomes aggravated at 0.075-mm wall thickness and below for simple overlap-fold tube designs in typical radiator assemblies.

The International Copper Association, Ltd. (ICA) 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.

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

Fortunately, several new folded-tube designs under development promise stronger tubes with thinner walls. One is the B-tube design, which is made by folding both edges of the strip to the middle of the strip where the two edges can form a third wall. The edges are brazed together at the center and the third wall provides additional support to the tube.

Conventional Tube Designs

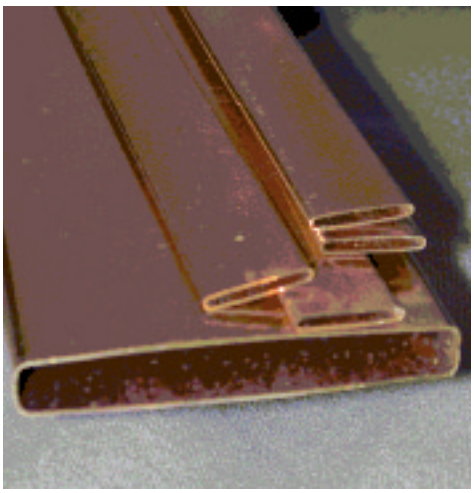
Tubes can also be manufactured by a variety of methods that do not depend on folding the edges of the brass strip together. High frequency (HF) welding, for example, allows the edges to be melted and butted together to form a very strong welded joint with no double layer of strip. HF welding has come a long way since it was first introduced nearly thirty years ago. Production lines now exist for making tubes with extremely tight control of the tolerances by this method. The limitation of HF welding is that it becomes impractical when the wall thickness is below 0.12 mm because the edges cannot be reliably butted together.

Nonetheless, HF welding is a very attractive high-volume process for radiators and charge air coolers.

Improvements over the years have made it possible to use this process for tubing with walls as thin as 0.127 mm (127 microns). These tubes are suitable for use in large radiators for trucks and off-highway vehicles, where the large size of the radiator demands tubes with relatively thick walls. They are also suitable for use with charge air coolers where the fluid carried in the tube is a gas rather than a liquid and so again the design criteria are compatible with relatively thick-walled tubing. However, using high frequency welding is not the best design choice in all cases. Similar considerations apply to laser welded tubing.

Many radiator makers prefer to continue to use their lock-seam mills even as they change over to the *Cu*proBraze process. Although lock-seam tubes were developed to overcome the limitations of the soldering process, lock-seam tubes can be fabricated with *Cu*proBraze brazing. The main difference is that the *Cu*proBraze paste should be applied to the lock-seam from the inside of the tube when the tube is formed. A single brazing process then is used to seal the tubes, to attach the fins to the tubes, and to attach the tubes to the header.

Process development has demonstrated that the *Cu*proBraze brazing paste applied in this manner is drawn into the lock seam and an excellent bond is obtained at the seam.



This large charge air cooler tube and these small automotive radiator tubes were bonded by high frequency welding.

Conclusion

The design trend for radiator tubes is toward very flat and wide tubing with brass walls that are as thin as possible. Brass is strong enough to allow very thin walls in a variety of new configurations. These new tube designs are allowing radiator makers to rethink previous radiator designs and overcome past limitations.

Meanwhile, manufacturers who have already invested in lock-seam mills and high frequency welding lines can recoup their investments by continuing to use such equipment. The lock-seam approach works on brass strip gauges as thin as 0.08 to 0.07 mm and high frequency welding has been successfully applied to the manufacture of heavy-duty radiators and charge air coolers using the *Cu*proBraze alloys. ■

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