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Automated Induction Brazing with Robots

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Brazing is a process of joining two or more metal parts by using a melted filler material commonly referred to as brazing alloy. The treated workpieces can be made from identical or different materials.

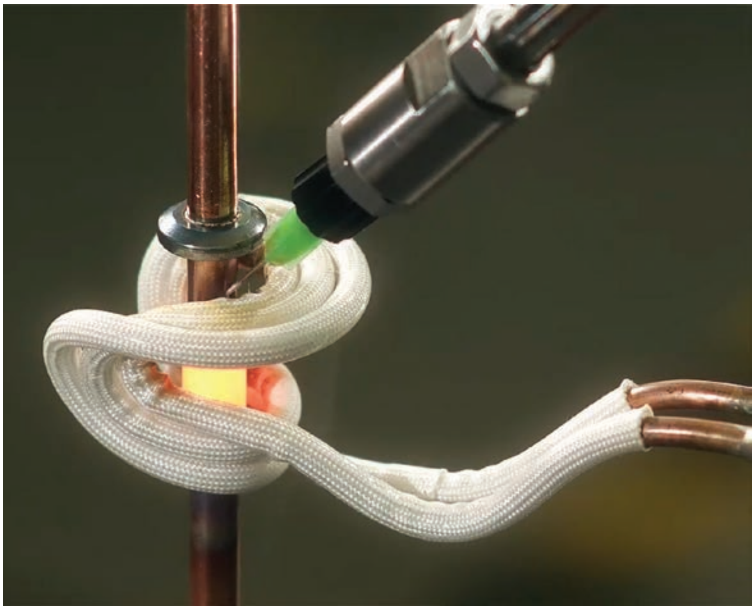

Fig. 1. Automated induction brazing

To perform brazing, metals must be heated up to high temperatures, usually about 800°C (1472°F) and above. Induction heating is a popular heating method used for brazing.

Why braze with induction?

Induction heating is an efficient approach for contactless heating of conductive materials by placing them inside a high-frequency magnetic field. It provides the brazing process with enhanced safety and high repeatability. Due to the increased efficiency, a significant time optimization can be achieved as well. As a contactless method, induction heating is relatively clean, which guarantees high-quality brazes and prevents the treated surfaces from being contaminated.

Induction heating is a preferred solution for many brazing applications in the HVAC and appliance industries. Pipes with different shapes and sizes can be heated with induction. Copper and stainless steel are among the most common materials for these applications.

Implementing Robotics to the Induction Brazing Process

Well known for their accuracy, robotic arms contribute to the repeatability of induction brazing. A combination of the fine power regulation by the induction generator and the precision of the coil positioning by the robotic arm guarantees high quality and repeatability of the brazed workpieces. Moreover, because the process is fully automated, no assistance by a skilled operator is required.

Robots can be programmed to braze complex assemblies consisting of multiple joints. The overall brazing time is further reduced by the fast repositioning of the work coil. This allows productivity of several (usually between 5 and 10) seconds per joint to be obtained, depending on the size of the brazed pipes and the type of alloy used.

Parameters of the Induction Brazing Process

The parameters of the brazing process may vary widely depending on both the material and the size of the treated workpieces. For example, high-resistivity substances such as stainless steel are easier to heat compared to low-resistivity metals such as copper and aluminum. This effect is due to the resistive losses in the materials as a result of the eddy currents generated by the electromagnetic field.

The induction generator power is determined by the overall diameter and the wall thickness of the treated pipes. The last dimension defines the requirements for the electromagnetic-field frequency as well. In order to obtain higher efficiency, the tube wall should be at least twice the field penetration depth, which makes the workpiece "visible" to the field. The depth of penetration itself is also dependent on the material of the treated part.

In accordance with the described effects, the brazing process of two copper pipes with ¼-inch diameter would require about 10 seconds at approximately 7 kW generator power and about 85 kHz field frequency. For comparison, stainless steel tubes with the same diameter would require only about 2 kW at 130 kHz to braze within three seconds.

Reducing the process time down to several seconds makes the brazing itself much faster than the preceding assembly setup and the work coil positioning. Combining the induction heating machinery with robots significantly optimizes this preparation time.

Brazing Alloys, Fluxes and Protective Atmosphere

As with conventional induction brazing equipment, alloys may come in different shapes and sizes. The use of pre-formed rings is often recommended because they provide the best results. They usually require a hand-made brazing setup, however, which involves a skilled operator. Therefore, many applications implement feeding of the alloy in the shape of wire. This approach is far easier for automation and allows more-accurate

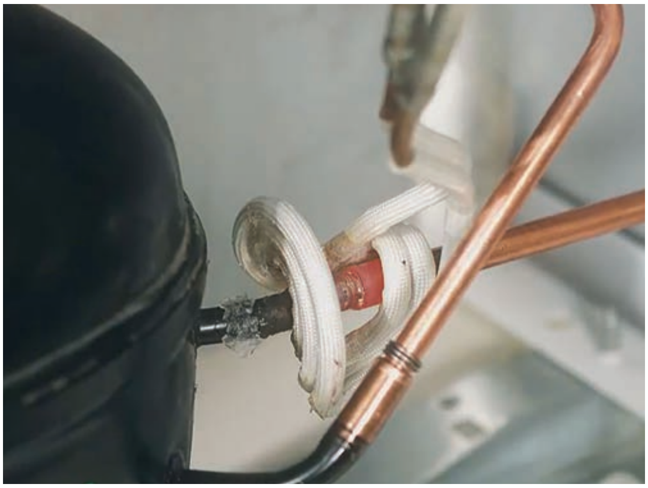

Fig. 2. Induction brazing in a refrigerator assembly

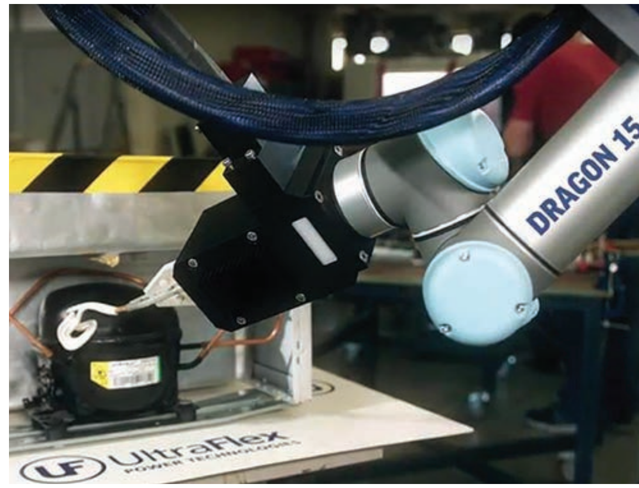

Fig. 3. Induction brazing robot

alloy dispensing. However, additional considerations about the feeder positioning and the preheating of the wire should be made.

A good combination of the two approaches is the use of alloy paste. It has the advantages of both the rings and the wire, but it requires additional flux to be applied to the joints prior to brazing them to prevent from oxidation and contamination. Such flux is usually contained inside the core of the wire and the rings.

With the use of automated systems, however, the proper quantity of the two substances – alloy and flux – can easily be dispensed. When using alloy wire or rings, this quantity can be further adjusted by changing the diameter of the wire. Moreover, the automated systems provide significant brazing-alloy cost savings because operators usually overdose it, which increases the price of the joint.

As with the conventional induction brazing equipment, inert gases (such as argon) are often used as protective atmosphere. Such gases can either be blown toward the treated joints by a nozzle or the whole assembly can be set inside a specially designed sealed chamber.

Temperature Control

Precise thermal control is crucial to obtain high-quality brazed joints. The induction heating equipment allows setting a power profile in order to indirectly regulate the temperature. In addition, energy monitoring can be used to determine if the applied heating energy during the brazing process is within a predefined range.

For realization of even more-accurate temperature monitoring and control, a thermal sensor can be used. Infrared pyrometers are often recommended for brazing processes since they can provide contactless measurement with sufficient accuracy within the range of operation. Considerations about the treated material emissivity should be made in this case.

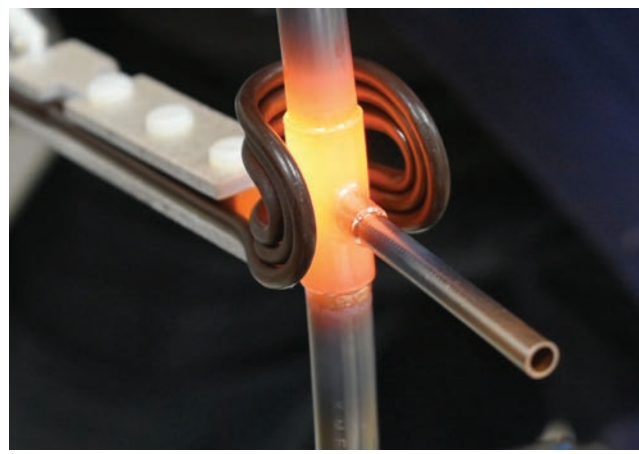

Fig. 4. Induction brazing of T-shaped assembly

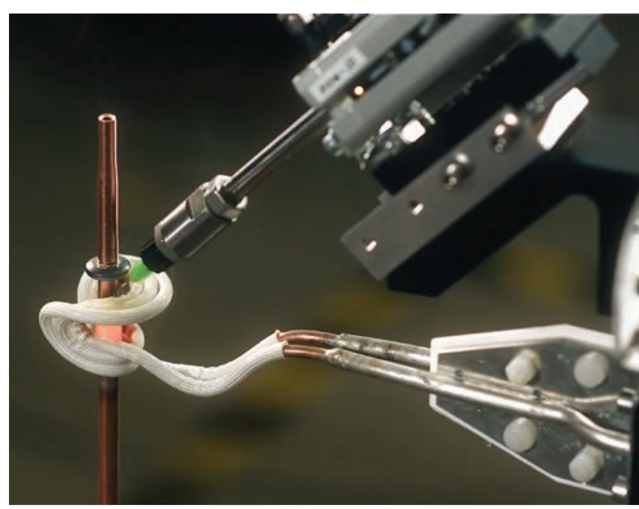

Fig. 5. Automated induction brazing of copper pipes with a wire feeder

UltraFlex POWER TECHNOLOGIES

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Check out the additional graphics, including a great animated GIF file showing the automated induction brazing in action. Find it online at www.industrialheating.com/indbraze.