Advancing the Science of Automatic Brazing

Forty-five years of engineering has added precision and higher quality to mass-produced brazed parts

BY ROGER LOHREY AND GENE STOUT

Fusion, Inc., headquartered in Willoughby, Ohio, has been building automatic brazing machines since 1962. Over the last four decades, these machines have improved in performance, sophistication, and versatility. Figure 1 displays a photograph of an early machine built in the 1960s. While functional, it features a very small electrical enclosure, minimal safety guarding, “contact” limit switches, and is driven by a relatively inaccurate ratchet and pawl indexer.

Evolution of Brazing from Hand to Machine

Even the very first brazing machines were more productive than manual torch brazing with brazing rod and messy, separate flux. Most brazed assemblies were fairly simple designs derived from straight tubes, castings, and machined parts. Part tolerances were not as critical then and aluminum was not yet in widespread use.

Revolution to Evolution

In the late 1970s, America’s love affair with the automobile was growing. The first “gasoline crisis,” along with government-mandated mileage standards, caused auto manufacturers to seek lighter-weight materials like aluminum. Most of the air-conditioning components under the hood were made from aluminum — and many were brazed. As a result, the first aluminum brazing pastes were developed. These pastes were then adapted to automatic machines for high-speed joining of a variety of aluminum subcomponents.

As part tolerances became more critical, brazing machines became more complex. At the core of the rotary brazing machine is a barrel cam indexer that conveys the parts through the application of filler metal, heating, and cooling. These units offer repeatable indexing of ± 40 arc-seconds which is equivalent to ± 0.004-in. tolerance on a 42-in.-diameter tool plate. This high precision translates into a consistent brazing process. A 12-position indexing machine is shown in Fig. 2. Figure 3 is a 3-D rendition of a modern brazing machine with multiple safety features.

Where We Are Today: Fixture Design

Most of the engineering time spent on a brazing machine involves the fixture (tooling) design. Currently, the company uses Solidworks 3-D CAD software for all of its fixture designs. By importing the customer’s part drawings directly into the program, errors and redrawing are minimized, and the development time from concept to finished machine is reduced. Where possible, the company implements the Poka-yoke (mistake-proofing) concept into fixture design to prevent operators from loading parts into fixtures incorrectly, thereby minimizing scrap.

Heating

An important aspect of today’s ma-
chines is their precise control of the heating function. Natural gas (or propane) is the most common choice of fuels, with compressed air added to promote combustion. Where more intense heat is required, oxygen replaces the compressed air. In most cases, a common manifold feeds a number of burner tips that heat parts over three or four stations. More flexibility is achieved by mounting the burners on a retractable slide since the heat time is not directly coupled to the machine’s dwell time. Linked with part sensing, the machines do not heat or cool a part that does not have all its components assembled correctly, thereby minimizing scrap. Some installations employ automatic ignition so operators are not required to reach inside the machines to light the burners manually. Hi-lo gas controls are standard for improving fuel efficiency.

**Use of Recipes**

 Manufacturers usually want to braze several different parts on the same brazing machine. Common fixture bases with easily removable details are commonly utilized. Through the machine’s programmable controller, “recipes” are stored with settings for each part style, making for fast changeovers. In addition, a large number of fault-reporting diagnostics, using a panel view interface, are incorporated to assist the operator and maintenance people in solving machine problems.

**Robotics**

In general, most modern machines utilize brazing filler metals in paste form. For applications with multiple joints—spaced at different intervals on the same axis—the paste-dispensing device can be mounted to a single-axis robot. This servo-driven device guides the paste dispenser across the entire length of the component, depositing paste at preprogrammed points. Heating is also accomplished by mounting the burners on a single-axis robot, which then brings the multiple joints to brazing temperature — Fig. 4.

**Advances in Brazing Pastes and Part Quality**

The company continually works on developing improved brazing pastes. Its technical staff works closely with the machine group to custom tailor pastes, when necessary, from a large selection of standard products. For more information, visit www.fusion-inc.com.

However, automation, machine advances, or advanced brazing pastes cannot compensate for bad parts. Parts to be brazed must be clean, free of burrs, designed for proper joint clearances, and made to print.