CHAPTER 14

FURNACE BRAZING

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Furnace brazing (FB) is a brazing process in which assembled components with preplaced brazing filler metal are joined together in a furnace. The furnace is purged with a gaseous atmosphere or evacuated of air to provide a specified low partial pressure of air. It is then heated to a temperature above the liquidus of the brazing filler metal but below the melting point of the base metals. The resulting brazements are then cooled or quenched using appropriate methods to minimize distortion and produce the required properties in the filler and base materials. This cycle is designed to produce the required melting and solidification of the brazing filler metal to join the components without melting or damaging the base metals.

Furnace brazing offers two advantages. First, it utilizes a protective brazing atmosphere that substitutes high-purity gases or vacuum for mineral fluxes. Second, it provides the ability to control and record every stage of the heating and cooling cycles with computerized instrumentation. The latter has facilitated the repeatability of the brazing cycle, permitting large production runs that yield high-quality brazements along with minimizing costs.

Additional information on furnace brazing is provided in the standard *Specification for Furnace Brazing*, AWS C3.6.1, 2

2. At the time of the preparation of this chapter, the referenced standards were valid. If a standard is cited without a date of publication, it is understood that the latest edition of the document referred to applies. If a standard is cited with the date of publication, the citation refers to that edition only, and it is understood that any future revisions or amendments to the code or standard are not included; however, as standards undergo frequent revision, the reader is encouraged to consult the most recent edition.

The difficulties presented by flux entrapment resulting from the use of chemical flux first motivated engineers to consider furnace brazing with nonferrous brazing filler metals such as silver and aluminum, which had low-temperature melting ranges.

In the 1920s, the use of copper (BCu) as a brazing filler metal in a batch furnace with exothermic and endothermic gaseous atmospheres was a giant step toward fluxless furnace brazing. Since the original furnace designs and atmospheres were introduced, advancements in atmospheres and furnaces have further increased the practicability of the process. Included are inert gases such as hydrogen, nitrogen, and argon. Improved furnace designs, including improvements in insulation, have moved the technology forward to accommodate the production standards of today.

The success of the furnace copper brazing of carbon and low-alloy steels in batch furnaces led to the widespread use of continuous belt-type furnaces. Better reducing atmospheres such as dissociated ammonia improved the process and facilitated bright annealing and the copper brazing of stainless steels.

In the 1970s and 1980s, nitrogen-based atmospheres consisting of controlled mixtures of high-purity nitrogen and hydrogen gases literally rejuvenated the use of continuous belt-driven furnaces. The combination of the ultra-dry hydrogen atmosphere and improved furnace equipment resulted in the development of many nickel-based brazing filler metals. It also led to the utilization of a new group of brazing filler metals that often include large percentages of precious metals such as gold, palladium, and platinum. This new equipment was welcomed by the aircraft engine and aerospace industries as well as metalworking industries fabricating brazements for...