Added Life for Brazing Fixtures

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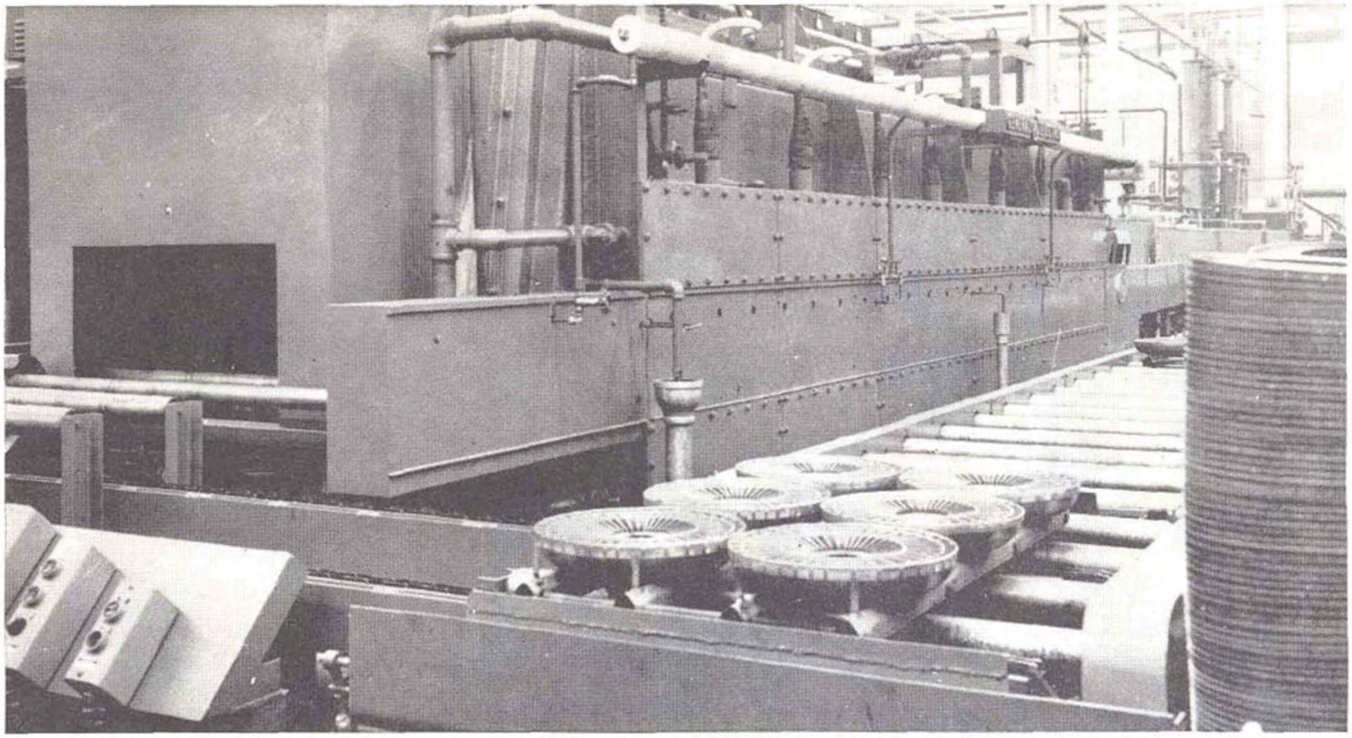
In a series of informative articles on the uses and properties of alloys for high temperature service.



Proper alloy selection and good design mean . . .

Added Life for Brazing Fixtures

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DESIGNERS of furnace trays and fixtures often hold the key to low-cost brazing operations. Selection of the proper alloy is only part of the story. It's equally important to know what will happen to the assembly when it encounters job conditions.

By integrating design with the required properties of the alloy, the designer can increase the service life of fixtures and frequently reduce his materials costs. As more manufacturers turn to high-volume furnace brazing, the future of the process is tied more importantly to tray and fixture life and their replacement costs.

First Rule — There are many variations of trays or fixtures, but the designer should keep light weight, articulation and loose joints in mind. Heat resisting alloys expand and contract about 7/32-in. per ft through a cycle from room temperature to 2050° F, so adequate clearance must be provided in all directions.

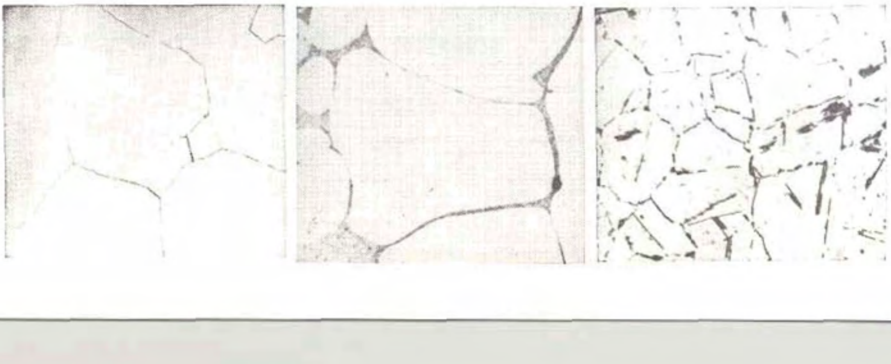
One tight joint that will not allow for this movement can sufficiently overstress the involved member to cause immediate fracture or preliminary deformation leading to ultimate fracture.

Another Reason—The tray or fixture should be flexible and uniformly supported. If it is made rigid, it will be subjected to greater stresses than if articulated in some manner. These stresses could be caused by expansion and contraction of the alloy and the load carried by the fixture, or even from the weight of the fixture itself.

For example, a new fixture entering a new furnace might be uniformly supported by level rollers. But rolls seldom stay level, and a rigid tray is then subjected to severe bending moment as it rides over high spots in a warped roll.

Barn-Roof Design—A widely

Satisfactory structure of heat-resisting alloy is shown at left. Intergranular penetration of copper caused by spillage of braze metal (center) and heavy carbide precipitation (right) ultimately destroy fixture strength



Typical base tray of "barn-roof" design shows articulated fabrication with tie rods and spacer tubing. This one was made of 330 alloy steel

used tray is the barn-roof type, so called because supporting channels are rolled into this shape. Alloy sheet of 0.078 to 0.125 in. thickness is used. Lengths usually do not exceed 36 in. If trays are longer than 36 in., a joint to reduce bending should be provided.

These channels have holes punched about every 8 in. through which 5/16-in. round bars are loosely fitted. They are capped on each end by a welded-on washer. Spacers of pipe, welded or unwelded tubing are then strung on the bars to support the channel legs in the vertical plane.

Copper Problem—Molten copper braze metal has a tremendous affinity to wet over a large surface. When punching or shearing parts for the fixture, minute fractures in adjacent metal often result when tools have become dull. Copper seeps into the exposed metal, and a resultant copper-nickel alloy that is weak may be formed. This weakness can result in further fracture.

Since you can't always keep copper away from the fixture, it should be protected from the metal. One precaution, aside from using sharp tools, is to use rolled sections that have not been pickled. They will offer a protective oxide coating.

By the way, it's desirable to run new, empty trays through the furnace for an hour or so at 1950° F.

Selecting the Alloy — Primary factors to consider, as in the selection of all high temperature alloys, are tensile strength, creep strength, corrosion resistance, thermal expansion, thermal and mechanical shock, stability and cost. The number of alloys acceptable for brazing applications is immediately limited to only a few (see table). They are the chrome-nickel types which are superior to the straight-chrome steels in load-carrying capacity.

Heat resistance of the alloys is derived from the formation of protective oxide coating which retards or prevents further attack on the underlying metal. Chromium is the principal alloying element that provides such protection, with nickel and silicon as supporting elements.

About Atmospheres — Operating continuously in a straight oxidizing atmosphere at 2000° F, the order of oxidation resistance of the three alloys would be 310, 309 and 330. Under protective atmosphere, however, all three resist scaling well.

In installations where control of atmosphere is difficult, sulphurous gases are sometimes present. In this case the higher chromium alloys outperform higher nickel alloys. Conversely, in slightly carburizing atmospheres higher nickel, such as in the 330, offers better resistance to carburization.

Choose the Right Alloy

Type	Evaluation
330 (35 Ni—15 Cr)	Excellent thermal shock resistance, such as encountered in oil quenching from temperatures above 1500° F, combined with greatest load-carrying strength. Possesses maximum resistance to absorption of carbon and nitrogen in working temperatures, and oxidation resistance up to 1950° F.
310 (25 Cr—20 Ni)	Stands up under moderate thermal shock and adequately resists corrosion from neutral or mildly carburizing atmospheres. In presence of sulphur, it is preferred over higher nickel alloys. Excellent characteristics and resistance to scaling up to 2000° F.
309 (25 Cr—12 Ni)	Excellent strength and oxidation resistance to 2000° F. Particularly suited for parts which operate at relatively constant temperature or receive moderate cyclic heating and cooling. Offers no resistance to carbon or nitrogen absorption.
430 (17 Cr)	Resists oxidation for intermittent use up to 1600° F. Should not be used continuously over 1450° F because of excessive scaling. Has lower coefficient of expansion than nickel-bearing types, work hardens less, and has tightly adhering scale when used in right temperature range.
446 (27 Cr)	One of the most oxidation-resistant alloys that can be produced. High-chrome content means less ductility and formability. Resists distortion from heating and cooling. Life of equipment operating in the intermediate temperature range can be increased by periodic annealing.

BULLETIN NO. 4

Practical information on the properties and selection of heat resisting alloys. Facts proved by experience on the design, construction and operation of high temperature equipment essential to successful performance of the alloy.

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