181
12-11-74

62-1093

LA-5766-MS
Informal Report

UC-38
Reporting Date: October 1974
Issued: October 1974

Braze Weld Joints for Vacuum System Assemblies

by

R. D. Clayton

MASTER

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87544

UNITED STATES
ATOMIC ENERGY COMMISSION
CONTRACT W-7405-ENG. 36

In the interest of prompt distribution, this LAMS report was not edited by the Technical Information staff.

**Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22151
Price: Printed Copy \$4.00 Microfiche \$2.25**

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

BRAZE WELD JOINTS FOR VACUUM SYSTEM ASSEMBLIES

by

R. D. Clayton

ABSTRACT

A method of tungsten inert gas (TIG) welding using brazing alloys has been developed, which has particular utility for vacuum system assemblies. The technique is presented as a suitable alternative to other procedures for certain applications.

I. INTRODUCTION

During the early and middle 1960's, the author experimented at the Los Alamos Scientific Laboratory (LASL) with a tungsten inert gas (TIG) welding approach to joining similar and dissimilar metals, using brazing alloys as filler material. Both Easy-Flow #45 and BT alloys were effective for this purpose, melting and flowing nicely and properly wetting stainless steel, copper, nickel, etc.

II. APPLICATION

Early in the 1970's, difficulties with joint repair on the Los Alamos Meson Physics Facility's (LAMPF's) accelerating structures provided an opportunity for applying this technique in the field. In this instance, several unsuccessful attempts previously had been made to repair a joint between 304 stainless steel and OFHC copper (in a bridge coupler), using brazing in a hydrogen furnace. A standard weld using copper or stainless steel filler was not feasible for this particular repair because of the nature of the joint; a thick copper wall, representing a large heat sink, was attached to a much thinner stainless steel flange, making it very difficult to get sufficiently high-current densities into the joint. Since a lower working temperature appeared desirable, a TIG weld using CuSi1 alloy (28% copper/72% silver, melting temperature 1435°F) was attempted and, after some experimentation to determine proper gas mixture and

arc current, a satisfactory vacuum-tight weld was achieved. These results were obtained using a pure helium atmosphere and a 500-A current. Later, this technique was applied (in situ) to a similar repair with equally good results.

A later second instance in which TIG welding with brazing alloy was used to salvage LAMPF components involved several cast stainless steel radio frequency spacers. These components, which had been machined, leak checked, and installed in the accelerator were later found to be leaking. Upon investigation, it became apparent that the material contained long capillary paths to atmosphere, consisting of linked pores which had been emptied of blocking contaminants after prolonged exposure to high vacuum. Because of the unavailability of spares and restrictions on accelerator down time, the decision was made to attempt to repair the spacers. Conventional silver soldering was rejected because of the high probability of trapping large quantities of flux in the pores, which would subsequently have presented an intolerable out-gassing load in the vacuum system. As before, the necessary repairs were effected with brazing alloy using a TIG welder. This approach was once again successful, and the components are still in use at present.

In both of the above-mentioned cases, the technique was useful for the following reasons: It permitted (1) the salvaging of several parts in

MASTER

which a great deal of fabrication time and materials cost had been invested, (2) the saving of substantial amounts of accelerator time, and (3) repairs to be made in situ in a manner that was compatible with high vacuum without extensive clean up. Finally, this technique could be used where conventional welding or brazing techniques were inapplicable or ill advised.

III. EXPERIMENTATION

Recently the opportunity has arisen for fabricating an entire vacuum manifold assembly (for an ion source test stand) using the TIG welding-with-braze-alloy technique. The method made it possible to use ordinary wrought copper water-service (sweat) fittings for assembly of the vacuum system, rather than the more orthodox but also more expensive and less readily available vacuum fittings. Water-service fittings, in that they lend themselves to trapping copious amounts of flux and other contaminants which cause serious outgassing problems, are generally avoided for vacuum work. However, with the fluxless procedure that has been outlined here, these drawbacks are avoided, and the use of such fittings becomes an attractive and inexpensive approach to building a high quality vacuum system.

For this particular manifold, the braze alloy used was GS-2433 (LASL stock item), which is 60% silver/30% copper/10% tin, and has a low melting temperature of 1115°F, which minimizes oxidation in the welding process. This alloy also contains no cadmium or zinc, a highly desirable feature for vacuum system use and for safety.

Details of the welding procedure for a typical joint are as follows: Parts to be joined are bead blasted or cleaned of their oxide coating with emery cloth. To remove silica powder, the parts should be washed after bead blasting. Following this, the joint surfaces should be cleaned with ethanol. The components can then be assembled, oriented, and tack welded. After checking for satisfactory orientation and fit, the weld is completed. If prevention of oxidation is a consideration, inert gas can easily be flowed through the vacuum system being welded. When using low melting temperature brazing alloy, it is sometimes convenient to make a joint in two or three steps, allowing

it to cool between welds; this prevents the finished bead from melting and becoming difficult to handle. The TIG welding braze alloy procedure outlined here is illustrated in a series of photographs (Figs. 1-4) that demonstrate the basic steps involved.

After completion, the vacuum manifold joints were leak checked with a helium mass spectrometer with a sensitivity of 2×10^{-10} std cm³/s of helium. Reproducibility was good, and directly proportional to the skill of the welder. Repairs were rapid and easy to make. With very little practice, one should be able to make braze alloy TIG welds comparable in quality to similar joints in 304 stainless steel using 304 stainless steel filler.

IV. CONCLUSIONS

It is apparent that the use of TIG welding with braze alloy for vacuum system work has many advantages, in comparison with conventional brazing or welding. These advantages are summarized below.

- A. In many cases, commonly available and inexpensive water-service fittings can be used instead of standard high-vacuum fittings.
- B. High-quality, leak-tight joints can be conveniently made in place.
- C. In development projects where modifications are frequently required, joints can be changed without disassembly of the system, and with much reduced risk of fire damage.
- D. Furnace-brazed components can be repaired at much reduced cost in time and effort, compared with other available options.
- E. Expensive but defective pieces, which would otherwise have to be rejected, can frequently be easily and cheaply saved with no compromise in vacuum performance.

It is not the intent of this paper to suggest that TIG welding with brazing alloy can replace furnace brazing, silver soldering, or brazing with the oxy-acetylene torch in any general way. However, it is clear that many instances arise, particularly in connection with (although not limited to) vacuum system work in which this technique offers the engineer or technician an attractive and superior alternative to these more conventional approaches.

Fig. 1. Shows typical wrought copper, TIG brazed assembly.

Fig. 3. A typical TIG brazed bead using #603 alloy on wrought copper fittings.

Fig. 2. 304 S.S. tube 25.4 mm o.d. with a 0.8128 mm wall TIG brazed to a copper flange 12.7 mm thick and 88.9 mm in diameter. Two alloys were used, Sil-Fos and #603 (LASL stock GS-2433).

Fig. 4. A sectioned TIG braze joint in typical water fittings, as might be used in a vacuum manifold.