Welding of Naval Brass using GMAW process

[Paper presented in the National Welding Meet, Visakhapatman in August 2008]

Avinash Abnave, Dileep Kulkarni
L&T, HED-Powai

ABSTRACT

Carbon steel tube sheet of a Turbine surface condenser was planed with explosive bonded brass at shell side, as the working medium was seawater, Diameter of tube sheet is more than three meter and the maximum brass plate available was not able to meet size requirement making weld joint unavoidable in brass plate. Manufacturing cycle of tube sheet includes joining of two halves of brass plate, explosive bonding of brass plate on carbon steel and then cutting clad plate to make required size of tube sheet.

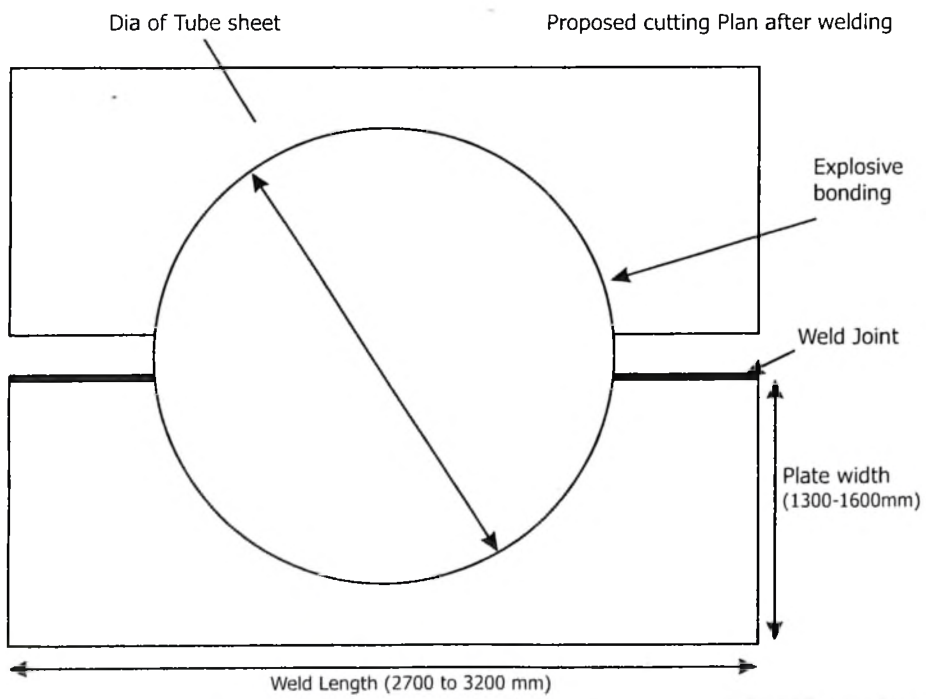
Naval brass grade UNS SB 171 C46400 selected as brass plate and planned for import from UK with a cycle time of 8 weeks followed by welding and explosive bonding at Orissa, India. After completion of bonding & Ultrasonic testing, tube sheet will be brought to Mumbai works for cutting followed by 8560 nos. Tube hole drilling on deep hole drilling machine and the final gasket face machining. The critical path is clear as Tube sheet, which is making hurdle in the timely delivery of the project. Over and above the tight manufacturing schedule, Weld joint of Naval Brass (Cu:Zn 60:40) needed to be porosity free to clear final DP test and to sustain the impact during explosive bonding.

Extensive trials taken before start of production welding followed by Procedure qualification. Job of welding total 30 meters of 13 mm thk naval brass completed within 12 days time as per schedule depositing 64 kg of weld metal using track mounted GMAW process.

The work undertaken exhibits that Naval Brass weld joints, when welded with automated process and with optimum duilution can give acceptable radiographic quality weld joints.

SCOPE OF WORK

The work involved joining of total 16 nos brass plates, which include weld seam length of around 30 meters. Since end application of the plate is explosive bonding with carbon steel plate after joining of brass, weld is needed to be flush ground and surface to be porosity free and flatness of plate after required after completion of welding is 2mm maximum



DETAILS OF BRASS USED

Details of Naval Brass used are as below :

a) Chemical Composition :

Element	Composition %	Test Method
Copper (Incl. Silver)	59.0 to 62.0	E 478
Tin	0.5 to 1.0	E 478
Zinc	Remainder	E 478 (Titametric)
Lead	0.20	E 478 (AA)
Iron	0.10	E 478

Sum total of copper + named element to be 99.6% single values are maximum

b) Mechanical Properties

Property	SB171 C46400
Tensile strength min. Ksi (Map)	50 (345)
Yield strength min Ksi (Map) 0.2% offset	20 (140)
Elongation in 2" in %	35 min.

c) Physical Data

Property	SB171 C46400
Density	8.41 g/cm3
Electrical Resistivity (microhmcm at 68 Deg F)	39.9
Melting Point (Deg F)	1630

Welding process selection

Soldering is rated as "excellent", brazing is rated as "excellent", oxyacetylene welding is rated as "good", gas shielded arc welding is rated as "fair", coated metal arc welding is "not recommended", spot welding is rated as "good", seam welding is rated as "fair", and butt welding is rated as "good"

After knowing the materials details and the clear scope of work, next step is the selecdon of process for joining. Process used fos joining of two plates of brass should be

1. Accepted as joining method as per ASME sec VIII Div. 1

2. Accepcable to AI, TPI & customer QC

3. Minimal change in chemical composition after joining (minimum Zinc loss)

4. Should withstand the impact during explosive bonding

5. Able to join 13 mm thk, 1600 mm wide and 3200 mm long plate

6. Economically feasible for implemeatation.

Finally process short listed for implementation are GMAW & FSW. Work started for implementation of GMAW as well as FSW in parallel. On priority, Brass plate of same grade and ordered so that trials, parameter setting, WPS/PQR etc are completed before actual job plates arrived for production welding.

a) Friction stir welding process :

After going through literature on solid state welding processes, FSW found to be more approprlate and feasible. Compared to fusion welding proccesses, Solid state welding process considered to be more appropriate for tbe Job view minimum dilution and to avoid zinc loss after welding. Friction Stir welding (FSW) process is short-listed and feasibility study carried out as follows

- Availability of machine / vendor for FSW

- Trials and tests required before undertaking production job

- Arrangement of clamping & Manufacturing Cycle time

- Commercial feasibility

- Implementation of FSW:

To implement FSW on the job, various organizations contacted and name a few are IIT Delhi, University of Missouri, Rolla, USA & TWI, UK

All these organizations have experience I friction stir welding, but they have never welded and valuated Naval brass weld joint neither data is available for "effect on impact on weld joint during explosion bonding". TWI, UK confirmed that the facility and the machine are available where welding trails can be taken and also subsequent job. Due to limited time available and the commercial implications of shifting plates from manufacturer to TWI, UK further work on FSW stopped and more focus given to GMAW process.

b) Gas Metal Are Welding Process

GMAW process evaluated as most suitable process of welding brass. Study carried out as follows :

Welding consumable selection and availability

1. Trails before start of PQR to have experience for welder

2. Parameter setting and Welding of PQR

3. Testing of PQR & Approval from AI,

TPI and customer QC

4. Testing of weld to sustain impact during explosive bonding

5. Test for evaluating Corrosion rate for base metal and weld metal

6. Arrangement for production job

i) Parameter setting and initial trials :

Bead on plate : First bead on plate on carbon steel plate is carried out with Aluminium bronze wire. (ERCu-Al-A2). In a very short time, we are able to achieve very good bead finish and spatter less welding. But when trials made on Brass plate, we got lots many Undercut, porosity and spatters.

First Conclusion: Process need to be automated to control dilution with brass Action Taken: Use Bug-O-Track mounted torch

Weld Edge Prreparation : Bead finish is and Finally WEP as per Trails No. 3 is planned on the actual job. It is Planned to have single "V" with Back purging and there will be chip back to have balance welding and thus controlling distortion.

Weaving is necessary to reduce number of passes for completing the total joint thickness of 13 mm. More the passes, more zinc evaporation and this is result in more porosity in weld metal.

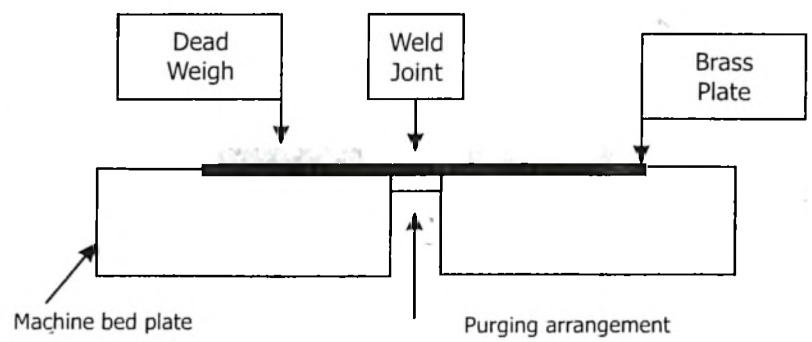
Finally WEP as per Trails No. 3 is planned on the actual job. WEP made as single "V" with back purging and also there will be chip back to have balance welding to control distortion. Weaving is necessary to rednce total number of passes that are required for completing the joint of thickness 13 mm. More the number of passes, more is the zinc evaporation and it will result in more porosity in the weld metal.

ii) Test for checking weld strength in explosion boding: One test plate of length 750 mm welded recording all parameters during welding, DP tested after flush grinding of the weld seam followed by Radiography test. This plate was explosive bonded on carbon steel plate followed by testing. Weld seam checked for DP test after boding and found to be satisfactory. With the data available, it is ensured that with the same parameters and the known porosity, (as per RT report) weld can sustain the impact durlng explosion bonding and the same parameters and technique is followed for welding of all job plates.

iii) Test for checking Corrosion resistance: Since the application involves seawater, it is necessary to retain minimum zinc in the base metal after welding. Care is taken during welding and it is supported by testing of plates for chemical test at weld, HAZ and base metal. Weld metal along wlth HAZ and Base metal tested for seawater corrosion and the test values found to be in order.

Various Stages of Manufacturing

First set-up of bed plates made on shop floor. Machined bed plates are water leveled and gap of 50 mm kept between two bed plates so that purging arrangement can be made. Set-up of



Welding in progress at two work stations showing bed plates, machine and track arrangement

Trial No	Parameter	Dimensions	Result
I	Root Face Root Ga Inchided agl e	0.5 to I mm 2-3 mm 70-7S°	Burn througb, weavlng is not possible Not able to establish continuous aring
2	Root Face Root Included angle	0.5 to 1 mm 1-2 mm 70-7S°	Burn through and E~cess penetration
3	Root Face Root Gap Included anhle	I -2 mm 0mm (+0.5) 70-7S°	Witb Argon purging, Penetration is achdeved. Weaving is possible for very first layer. Set-up beca.m~e easy.

two brass plates made as per WEP Trail No 3 (as abave) in free condition and to avoid distortion, dead weight kept on both the sides of the joint.

Area around Weld edge applied with Anti spatter spay / chalk powder for easy removal of spatter. First parameter setting is done on trial plate befae starting actual welding on the joint. Torch angle and weaving adjusted in such a way that torch will remain for the least possible time on the base metal. Also care is taken to avoid lack of sidewall fusion. As far as possible next layer is deposited on the weld metal. Weaving is applied right from the first layer. Welding started from center of the joint and progressed towards sides to avoid distortion.

After deposition of two layers from first side, chip back is carried out followed by DP test carried out with optimum removal of weld metal. Welding is completed from chip back side and then first side welding is completed to control distortion. Flatness of the plates getting welded measured after every two layers.

Welding of total 30 meters of 13 mm thk naval brass completed wlthin l2 days time as per schedule. Total 64 kg of weld metal deposited using track mounted GMAW pracess. All plates are DP tested after final welding and found within flatness requirement and successfully explosive bonded on carbon steel tube sheet without affecting the integrity of weld joint. All plates are tested for Ultrasonic testing after boding and found to be in order.

Conclusion

The work undertaken exhibits that Naval Brass weld joints, when welded with automated process and with optimum dilution can give acceptable radiographic quality weld joints.

Acknowledgement

Authors are grateful to M/s L&T management for giving approval to present this paper.