Analysis of Welding of high Thickness Brass by Tig Welding and Mechanical Properties

T.Selvaraj[1], P. Mahendraprabu[2], K.P.Padmanaban[3], K.lingeswaran[4], G.prabu ram[5]
1. Asst. Professor, Mechanical Engineering, SBM CET,
2. Asst. Professor, Mechanical Engineering, SBM CET, DGl
3. Professor, Mechanical Engineering, SBM CET, DGL
4. PG Scholar, Mechanical, Engineering, SBM CET, DGL.
5. Asst. Professor, Mechanical Engineering Sri Krishna college of Engineering ,CBE

***Abstract:*-The purpose of this research work is to determine suitable parameters by investigating the weldability of high thickness brass materials, and the difficulties involved in carrying in the process. In order to enable low and controlled heat input into the welding bead, TIG welding is used. An attempt has been made to analyze the effect of process parameters in qualitative manner for welding of brass. In this project Brass is welded by preparing Welding Procedure Specification (WPS) with respect to American Welding Society (AWS) that is prepared for TIG. The welding process is carried out for different parameters (arc voltage, arc current, welding speed) and various positions. The Weldments are subjected to testing to find the qualitative properties. The test specimen is prepared by TIG process and various tests such as chemical test, microstructure test, bend test & NDT is carried out before and after the welding process. The actual value from the test before and after the welding process is compared with allowable value from the AWS. Improved product quality and decreased production costs are the important objectives of this paper.**

Keywords:-High Thickness Brass ,Tig Welding, Welding Test Methods.

1. INTRODUCTION

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the workpiece.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding may be performed in many different environments, including open air, under water and in outer space. Welding is a potentially hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation.

Until the end of the 19th century, the only welding process was forge welding, which blacksmiths had used for centuries to join iron and steel by heating and hammering. Arc welding and oxyfuel welding were among the first processes to develop late in the century, and electric resistance welding followed soon after. Welding technology advanced quickly during the early 20th century as World War I and World War II drove the demand for reliable and inexpensive joining methods. Following the wars, several modern welding techniques were developed, including manual methods like shielded metal arc welding, now one of the most popular welding methods, as well as semi-automatic and automatic processes such as gas metal arc welding, submerged arc welding, flux-cored arc welding and electro slag welding. Developments continued with the invention of laser beam welding, electron beam welding, electromagnetic pulse welding and friction stir welding in the latter half of the century. Today, the science continues to advance. Robot welding is commonplace in industrial settings, and researchers continue to develop new welding methods and gain greater understanding of weld quality and properties.

2. LITERATURE REVIEW

Brass materials are widely used as engineering materials in industry because of their high strength, high corrosion resistance, and high electrical and thermal conductivity. They are easily shaped and they possess a pleasant appearance. However, it is difficult to weld brasses. The main problem with these alloys in fusion welding is the evaporation of zinc during the welding process. After welding, the weld metal becomes porous. Moreover, since the amount of zinc in the alloy is reduced due to evaporation, the brass material loses the physical and chemical properties which it normally possesses.

Nd-YAG laser Jae-Do Kim etal [1] stated that studies on weld ability of brass materials are very few. There is very little information concerning the weld ability of brass materials in the literature and general definitions are often seen. It is impossible to find studies on experimental investigations of the welding of brass materials apart for a few exceptions. There are Virtually no studies to support experimental data about whether welding of brass materials are possible. The purpose of the present study is to determine suitable parameters by investigating suitable parameters by investigating the weld ability of brass materials, and the difficulties involved. In order to enable low and controlled heat input into the welding bead, TIG pulse welding is used during experimental studies. The physical and chemical properties of welding beads (penetration, tensile strength, Erichsen deep drawing value, chemical composition of internal structure) have been determined and evaluations have been made.

Cemal meren[2] stated that it is difficult to fusion welding of brasses. The main problem of these alloys in fusion welding is the evaporation of the zinc during the welding process. After the welding, the weld metal becomes porous. Moreover, since the amount of the zinc in the alloy is reduced due to evaporation, the brass material loses its physical and chemical properties which it normally possesses... It seems that friction stir welding which is one of the new method developed nowadays, will solve these problems. So, it needs experimental investigations in this subject. Even though there are so many researches in the literature about friction stir welding in aluminum and its alloys, researches about copper and its alloys especially brass are limited. In this research, it was pointed out friction stir welding capability especially brass plates which are 3 mm in thickness. For this reason, experiment conditions were determined and friction stir welding procedures were applied to brass plates in different rotation and welding speeds. Obtained welded joints subjected about physical virtual, mechanical tests and microstructure investigations and the results had been evaluated

S. C. Juang and Y. S. Tarng[3] , stated that the selection of process parameters for obtaining optimal weld pool geometry in the tungsten inert gas (TIG) welding of stainless steel is presented. Basically, the geometry of the weld pool has several quality characteristics, for example, the front height, front width, back height and back width of the weld pool. To consider these quality characteristics together in the selection of process parameters, the modified Taguchi method is adopted to analyze the effect of each welding process parameter on the weld pool geometry, and then to determine the process parameters with the optimal weld pool geometry. Experimental results are provided to illustrate the proposed approach.

3. MATERIAL SELECTION OF BRASS

Brass is the generic term for a range of copper-zinc alloys with differing combinations of properties, including strength, machinability, ductility, wear-resistance, hardness, color, electrical and thermal conductivity, and corrosion-resistance. Brass also has excellent thermal conductivity making it a first choice for heat exchangers (radiators). Its electrical conductivity ranges from 23 to 44% that of pure copper. Their relatively high conductivity, combined with corrosion resistance, makes them an ideal choice for the manufacture of electrical equipment, both domestic and industrial. Brass has higher malleability than zinc. The relatively low melting point of brass (900 to 940°C, depending on composition) and its flow characteristics make it a relatively easy material to cast. By varying the proportions of copper and zinc, the properties of the brass can be changed, allowing hard and soft brasses. The compositions of these early "brass" objects are very variable and most have zinc contents of between 5% and 15% wt which are lower than in brass produced by cementation. These may be "natural alloys" manufactured by melting zinc rich copper ores in reducing conditions. It is possible that some copper-zinc alloys were accidental and perhaps not even distinguished from copper. However the large number of copper-zinc alloys now known suggests that at least some were deliberately manufactured and many have zinc contents of more than 12% wt which would have resulted in a distinctive golden color. Red Brass having good strength and ductility, corrosion resistance, machinability, conductivity and many other attributes, are widely used in the manufacture of components and finished goods. The Strength of Brass is substantially retained at temperatures up to around 200°C and reduces by only about 30% at 300°C, which compares favorably with many alternative materials. Brasses have excellent resistance to corrosion that makes them a natural, economic first choice for many applications. Brasses have good electrical and thermal conductivity. In common with the other copper based alloys, the brasses have excellent resistance to normal atmospheric corrosion and this is one of the key properties vital in materials selection decisons.for this reasons brass is the first choice material to give many years of satisfactory service for many common but critical applications such as electrical components, scientific and other accurate instruments, clocks, hose and pipe fittings and valves.

A.Weldingprocedure Specification

A Welding Procedure Specification (WPS) is a formal document describing welding procedures. The purpose of the document is to guide welders to the accepted procedures so that repeatable and trusted welding techniques are used. A WPS is developed for each material alloy and for each welding type used. Specific codes and/or engineering societies are often the driving force behind the development of a company's WPS. A WPS is supported by a Procedure Qualification Record (PQR or WPQR). A PQR is a record of a test weld performed and tested (more rigorously) to ensure that the procedure will produce a good weld. Individual welders are certified with a qualification test documented in a Welder Qualification Test Record (WQTR) that shows they have the understanding and demonstrated ability to work within the specified WPS.

The following are definitions for WPS and PQR found in various codes and standards: According to the American Welding Society (AWS), a WPS provides in detail the required welding variables for specific application to assure repeatability by properly trained welders. The AWS defines welding PQR as a record of welding variables used to produce an acceptable test element and the results of tests conducted on the element to qualify a Welding Procedure Specification.

The American Society of Mechanical Engineers (ASME) similarly defines a WPS as a written document that provides direction to the welder or welding operator for making production welds in accordance with Code requirements. ASME also defines welding PQR as a record of variables recorded during the welding of the test coupon. The record also contains the test results of the tested specimens.

B.Weldment

1. Types of Testing

- Destructive test
- Non destructive test

2. Destructive Test

Destructive tests are conducted for the purpose of testing the mechanical properties like tensile strength, yield strength & impact strength. After the successful result from NDT the material is supposed to attain the some destructive tests to check the strength of material.

The common destructive tests conducted in welded test piece are

- Tensile test
- Bend test
- Chemical test

3. Tensile Test

The tensile test is mainly used to determine strength, ductility, toughness, resilience and other mechanical properties. If a metallic specimen is subjected to a gradually increasing unaxial tensile load, it gets plastically deformed and finally fail (breaks) during plastic deformation, changes in cross-sectional area and length occurs. In tensile testing the metallic specimen is gripped at opposite ends of a tensile testing machine and subjected to a progressive increasing tensile load till it fractures. A data of load acting on the specimen with progressive extension of the specimen is obtained. The machine used for tensile testing is the universal testing machine (UTM). During specimen preparation care should be taken to avoid sharp changes in section to reduce stress value. A standard specimen is prepared.

4. PREPARATION OF TEST SPECIMEN

A. Transverse Tensile Test

Using Radius Reduced Specimen Using Reduced Specimen

B. All weld Metal Tensile Test

A transverse Tensile Test specimen is cut from a welded butt joint (at right angle to the weld direction and is used to determine its transverse tensile strength. Reduced transverse test specimens are not intended to give the tensile strength of the weld metal, but Radius reduced specimens do occasionally.

Table1: Test specimen for plate thickness

Width	Gauge Length*	Minimum Parallel Length	Minimum Radius at Shoulder	Total Length
b	**Lo**	**Lp**	**R**	**L**
Plate	50	60	25	200
thickness	100	110	25	300
but not less than 25 mm	200	225	25	375

In an all weld metal tensile test, the specimen is prepared from all weld metal. This type of specimen is prepared by machining a groove in a plate of steel and then completely filling the groove with deposited weld metal. The surrounding steel is then machined away leaving a specimen of weld metal. The purpose of such a test is to test

(i) Electrodes for their suitability for the job concerned,

(ii) The quality of deposited metal in welded joint.

Table 2: Test specimen for cross sectional area

Cross-sectional Area,Ao,mm^2	Diameter do	Gauge Length, Lo	Minimum Parallel Length, Lc	Minimum Radius, R
400	22.56	113	124	23.5
200	15.96	80	88	15.0
100	11.28	56	62	10.0
25	5.64	28	31	5.0

C. Test Procedure

If a metallic specimen is subjected to a gradually increasing unaxial tensile load, it gets plastically deformed and finally fail (breaks) during plastic deformation, changes in cross-sectional area and length occurs. In tensile testing the metallic specimen is gripped at opposite ends of a tensile testing machine and subjected to a progressive increasing tensile load till it fractures. A data of load acting on the specimen with progressive extension of the specimen is obtained. The machine used for tensile testing is the universal testing machine (UTM). During specimen preparation care should be taken to avoid sharp changes in section to reduce stress value. A standard specimen is prepared.

Mechanical properties of Lead Brass used in this study were given shows the specimen prepared for the tensile test. Specimens for tensile test were taken as perpendicular to weld direction. Tensile test were carried out on the weldment of Lead Brass welded by gas tungsten arc welding (GTAW).

As Per the ASME procedure the tensile properties for red brass materials should be 150-220 Map. The Position of fracture occur on the weldment area.

As Per the Specimen the tension strength Found should be 167 Mpa is within the allowable value

Table 3: Welding condition and parameter used

Materials	Welding method	Filler material	Current in amps	Welding groove	Shielding gas
Lead Brass	GTAW	Pronzoid	1.pass 80 2.pass 100	DOUBLE V	Argon

.**Table 4:** Chemical composition and mechanical properties of base material

Base material	Chemical composition (wt %)					Mechanical properties
	Cu	Mn	Ni	Al	Zn	
Lead Brass	86.33	0.08	0.09	10.08	0.24	σts = 150-220 MPa

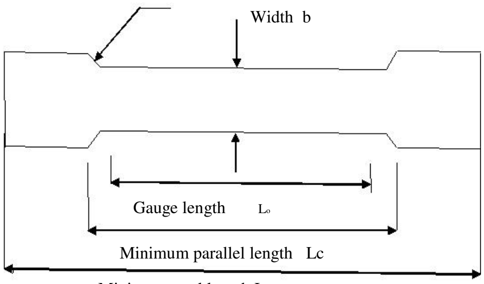

Figure 1: Tensile piece preparation

D.Bend Test

A Bend Test may be carried out on a tensile testing machine with the help of certain attachments as described later in this section. A bend test is an easy and inexpensive test to apply. The method is fast and shows most weld faults quite accurately.

Bend tests may be used to find a number of weld properties such as

(i) Ductility of the welded zone
(ii) Weld penetration
(iii) Fusion
(iv) Crystalline structure (of the fractured surface)
(v) Strength.

The bend test assists in determining the soundness of the weld metal, the weld junction and the heat affected zone. The test shows the quality of the welded joint. Any cracking of the metal will indicate false fusion or defective penetration.

The stretching of the metal determines to some extent its ductility. Fractured surface shows the crystalline structure. Large crystals usually indicate wrong welding procedure or poor heat treatment after welding. A good weld has small crystals

To conclude, the bend test is an easy and useful method of comparing one welded joint with another of the same type and of revealing abnormalities and defects at or near the surface in tension.

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E. Types of Bend Tests

Bend tests may be categorized as

(a) Free Bend Test
(b) Guided Bend Test

Bend tests may be further classified as

(i) Transverse bend test
Root bend test Face bend test
(ii) Longitudinal bend test
(iii) Side bend test.

F.Transverse Bend Test -

A transverse bend test is useful in qualifying welders because it quite often reveals the presence of defects that are not detected in tension test. However, in this test, non-uniform properties along the length of the specimen can cause non-uniform bending.

An over matching weld metal strength may prevent the weld zone from conforming exactly to the bend die radius and may force the deformation out into the base metal, causing less than the desired elongation of the weld. With under matching weld strength, the specimen may tend to kink in the weld and there occurs more severe elongation in the weld. The specimen for transverse bend test is of the full thickness of the material at the welded joint and the upper and lower surfaces of the weld are dressed flush with the base metal surface.

The specimen is bent by the movement of a plunger or former. Suitable gauge marks if scribed at the outside surface of the specimen help estimating % elongation. In a Face bend test the specimen is placed with its face down. The former is depressed until the piece becomes D shaped in the die (a guided bend test). If upon examination, cracks greater than 3 mm appear in any direction, the weld is considered to have failed. Face bend tests are used to inspect the degree of fusion, the absence or presence of inclusions and the weld porosity, if any.

In a Root bend test the specimen is placed in the jig with the root down or in just the reverse position of the face bend test. The results must show no cracks to be acceptable. Root bend tests are used primarily to determine the degree of weld penetration.

G.Longitudinal Bend Test -

The problems of weld mismatch (as described in transverse bend test) can be avoided by using longitudinal bend specimens in which the weld runs the full length of the bend specimen; the bend axis being perpendicular to the weld axis.

In longitudinal bend test, all zones of the welded joint (i.e., weld, heat affected zone and the base metal) are strained equally and simultaneously. This test is generally used for evaluations of joints in dissimilar metals. Specimens for longitudinal bend test are prepared in the same manner as for transverse bend tests.

H.Chemical Composition Test

The BRASS material is tested to chemical composition to find the various grades and chemical mixture

Table 5: Chemical report.

ID NO	C%	Mn%	Ni%	Al%	Zn%
SS	86.33	0.08	0.09	10.08	0.24

I.Non Destructive Test

It is a technique used to find the internal and surface defects without destroying the work piece. According to the principle of working it is classified into many types. But four of them are mainly used in industries to serve for the purpose due to ease of operation, accuracy and economy.Non destructive test are applied to welded portion to determine their suitability for the serviceconditions to which they will be subjected. These tests neither break nor alter the physical properties of the welded components.

Non destructive test have the ability to detect invisible subsurface defect. Non destructive tests make component more reliable and safe.

A welded component found defective after non destructive testing can be rectified and subsequently used.

There methods are commonly used for,

- Detection of flaws, such as crack, shrinkage, gas porosity, inclusion and other dislocations in weld and castings.
- Dimensional measurements such as wall thickness internal and outside dimensions, coating/plating thickness etc.
- On process monitoring of system.
- Porosity, blowholes, pipes, exposed inclusions, unused welds, unfilled craters etc.
- Surface cracks in the weld metal, heat affected zone or the parent metal.
- Undercutting, burning or overheating of the base metal adjoining weld metal.

J.Radiograph Inspection

Radiography is one of the most useful of the non-destructive tests which can be applied for assessing the quality of the welded joints. Radiograph has been used for the inspection of welds of all types and thicknesses ranging from minute welds in electronic components to welds up to half meter thick employed in heavy fabrications.

Radiography can detect flaws or discontinuities in welds such as:

(i) Cracks.
(ii) Porosity and blow holes.
(iii) Slag, flux or oxide inclusions.
(iv)Lack of fusion between the weld metal and the parent metal
(v) Incomplete penetration.

1. Principle

Radiography technique is based upon exposing the components to short wavelength radiations in the form of X-rays (wavelength less than 0.001 x 10-8 cm to about 40 x 10-8 cm) or gamma (y) rays (wave length about 0.005 X 10-8 to 3 X 10-8 cm) from a suitable source such as an X-ray tube or cobalt-60.

The characteristic feature of X-ray and y-ray which makes them to work is their power to penetrate matters opaque to light. X-rays operating at 400,000 volts can inspect steel objects having thickness up to 62 mm.

γ -rays given off by radium and radioactive isotopes such as cobalt-60, lridium-192 and caesium-167 can penetrate and thus inspect joints of bigger thickness than examined by X-rays.

2.X-Ray Radiography Procedure -

X-rays are produced in an X-ray tube where a (cathode) filament provides electrons which proceed towards the target (anode); strike and are suddenly stopped; a part of their kinetic energy is converted to energy of radiation or X-rays.

The portion of the weldment where defects are suspected is exposed to X-rays emitted from the X-ray tube. A cassette containing X-ray film is placed behind and in contact with the weldment, perpendicular to the rays.

During exposure, X-rays penetrate the welded object and thus affect the X-ray mm.

Since most defects (such as blow holes, porosity, cracks, etc.) possess lesser density than the sound parent metal, they transmit X-rays better than the sound metal does; therefore the film appears to be more dark where defects are in line of the X-ray beam. The exposed and developed X-ray film showing light and dark areas is termed as RADIOGRAPH (or precisely known as an EXOGRAPH). The radiographs of sound metal and metals containing blow holes and porosity respectively.

5. CONCLUSION

In this paper produce the following advantages and disadvantages of weld abilty It Gives a permanent record and Covers a wide variety of components, a permanent record of defects in a welded object is obtained and reference standards for defects are available. The main disadvantages of the work are radiation hazard, High recurring cost (film & chemicals), trained operator is required. The material is used for Pressure vessels and boilers, Penstocks, Aircraft and ship structures. And also clearly indicate the test methods.

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