Micro Structure Investigation of TIG Welding Parameters for Brass 3019

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Abstract – Previously we had done experiment on Welding of Brass, which is widely used as engineering material in industry. And find out it is difficult to weld brasses. The main problem with this alloy in 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, and it loses the physical and chemical properties which it normally possesses. And the experiment helped out for study for supporting experimental data about whether welding of brass material is possible or not. Now in our paper the effect of TIG welding parameters brass3019 (70%Cu–30%Zn) joints are investigated by SEM Analysis and compared with the mechanical properties which are investigated previously. The main parameters in this study were the root gap, flow rate, diameter of electrode and flow of current. And SEM analysis with Electron voltage of 10Kv and magnification 500x with the width of 10.5mm is done then the Evaporation of zinc is observed at weld zone, HAZ1 and HAZ2.

Keywords: TIG welding; Brass; SEM; Weld Zone; and HAZ.

1. INTRODUCTION

Brass is an alloy of copper and zinc and has a yellow color, similar to the appearance of gold. This metal can have varying proportions of zinc and copper, which produces a broad range of types with different properties. Brass is commonly used for decorative fixtures because of its bright gold appearance. It is also used for plumbing valves, bearings, locks and musical instruments. There are three common forms of brass.

1.1 Brass

Brass is the name used to describe a copper alloy, which has certain zinc content. Copper is one of the metals that were first able to be worked by humans, as it melts at a temperature of around 1,080°C and is very easy to work due to its low hardness. Zinc has an even lower melting point (420°C) and is able to form mixed crystals with copper. By combining copper with zinc, an alloy is formed, which is harder than copper, but still has very good working properties [1, 2].

Humans have been using brass for around 5,000 years. This material therefore one of the oldest alloys there is. The only exception is bronze, which has been used for more than 6,000 years. Bronze is also a copper alloy; however, it contains the heavy metal tin instead of zinc. It was always a popular material as this alloy produces very attractive colour nuances if the zinc fraction is varied.

At this point it is noted that it is not possible to estimate the zinc fraction by interpreting the colour, as modern brass alloys contain other alloying elements, which on the one hand affect its hardness and corrosion resistance, but on the other hand also affect its colour. Aluminum, iron, manganese, nickel and silicon are most frequently added as alloys, as that brass can be adapted to the present day needs of industry.

1.2 Properties of brass

Despite its high copper content, it is not harmful. Quite the opposite, copper-zinc alloys have a bactericidal effect and prevent the colonization of bacteria. For this reason, brass door handles are useful fittings, for example, in public buildings and in public transport [3, 4].

Unlike steel alloys, brass cannot be hardened by heating. Brass can only be strain or work-hardened. The hardening occurs when the material is worked mechanically, e.g. by cold working. The action of force does not harden brass. Modern alloys contain virtually no air or slag and for this reason cannot be hardened. The hardness is produced instead by straining (stretching) the metal microstructure. The stresses produced during working affect the hardness of the material.

If cold-worked brass is heated to 450 – 600°C, the hardening achieved can be removed again, depending on its composition. At this temperature, the crystals in the metal microstructure can rearrange. If the heating remains within a range of 300 – 450°C, depending on the temperature, different degrees of hardness can be achieved. If the alloy is heated to 250 – 300°C it can be relaxed to such an extent that at least no more stress corrosion cracking can occur.

If special hardness or machinability requirements are set for a copper-zinc alloy in Saxony, a suitable alloy composition should be chosen, because of the material properties named above. If lead is added to the alloy, the properties for machining improve increasingly. Aluminum on the other hand reduces susceptibility to corrosion and increases the strength of brass [5].
### 1.3 Composition of brass 3019

Copper (Cu) %: 68.5-71.50,  
Lead (Pb) %: 0.07,  
Iron (Fe) %: 0.05,  
Zinc (Zn) %: remaining.

### 1.4 Scanning Electron Microscopy (SEM)

The scanning electron microscope (SEM) uses a focused beam of high-energy electrons to generate a variety of signals at the surface of solid specimens. The signals that derive from electron-sample interactions reveal information about the sample including external morphology (texture), chemical composition, and crystalline structure and orientation of materials making up the sample. In most applications, data are collected over a selected area of the surface of the sample, and a 2-dimensional image is generated that displays spatial variations in these properties. Areas ranging from approximately 1 cm to 5 microns in width can be imaged in a scanning mode using conventional SEM techniques (magnification ranging from 20X to approximately 30,000X, spatial resolution of 50 to 100 nm). The SEM is also capable of performing analyses of selected point locations on the sample; this approach is especially useful in qualitatively or semi-quantitatively determining the sample; this approach is especially useful in chemical compositions, provide qualitative chemical analyses and identify crystalline structures. SEMs can be as essential research tool in fields such as life science, biology, geology, medical and forensic science and metallurgy. In addition, SEMs have practical industrial and technological applications such as semiconductor inspection, production line of miniscule products and assembly of microchips for computers.

In addition to topographical, morphological and compositional information, a Scanning Electron Microscope can detect and analyze surface fractures, provide information in microstructures, examine surface contaminations, reveal spatial variations in chemical compositions, provide qualitative chemical analyses and identify crystalline structures. SEMs can be as essential research tool in fields such as life science, biology, geology, medical and forensic science and metallurgy. In addition, SEMs have practical industrial and technological applications such as semiconductor inspection, production line of miniscule products and assembly of microchips for computers.

Advantages of a Scanning Electron Microscope include its wide-array of applications, the detailed three-dimensional and topographical imaging and the versatile information garnered from different detectors. SEMs are also easy to operate with the proper training and advances in computer technology associated software make operation user-friendly. This instrument works fast, often completing SEI, BSE and EDS analyses in less than five minutes. In addition, the technological advances in modern SEMs allow for the generation of data in digital form. Although all samples must be prepared before placed in the vacuum chamber, most SEM samples require minimal preparation actions.

### 2. METHODOLOGY

Readily available brass 3019 in the market is bought as a plate. Then this plate is cut into small pieces/plate by using cutting machine. Those 18 pieces are cut into 100mm x 50mm x 5mm. All these pieces are then filed at single side to 30° using smooth filing half of the thickness. Now these pieces are ready for the Butt joint welding. Each job is assigned with different parameters like root gap, current, electrode diameter and gas flow rate. As these all parameters are varied, the welding strength and the defects at the heat affected zone are to be carried out by different tests show in Table 1, Table 2 and Table 3.

<table>
<thead>
<tr>
<th>Job No.</th>
<th>Root gap, mm</th>
<th>Current, Amp</th>
<th>Electrode dia, mm</th>
<th>Gas flow rate, Ltr/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>100</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>120</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>150</td>
<td>2.4</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>0.5</td>
<td>120</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>150</td>
<td>2.4</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>1.5</td>
<td>100</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>0.5</td>
<td>150</td>
<td>2.4</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 2 Tensile Test Results

<table>
<thead>
<tr>
<th>Test piece</th>
<th>Ultimate load, kN</th>
<th>Tensile strength N/mm²</th>
<th>Elongation, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.64</td>
<td>27.102</td>
<td>1.600</td>
</tr>
<tr>
<td>2</td>
<td>14.2</td>
<td>143.347</td>
<td>2.600</td>
</tr>
<tr>
<td>3</td>
<td>12.560</td>
<td>126.295</td>
<td>1.920</td>
</tr>
<tr>
<td>4</td>
<td>7.960</td>
<td>83.464</td>
<td>0.720</td>
</tr>
<tr>
<td>5</td>
<td>23.520</td>
<td>245.563</td>
<td>4.700</td>
</tr>
<tr>
<td>6</td>
<td>3.080</td>
<td>31.454</td>
<td>1.240</td>
</tr>
<tr>
<td>7</td>
<td>9.440</td>
<td>100.053</td>
<td>1.800</td>
</tr>
<tr>
<td>8</td>
<td>9.000</td>
<td>90.964</td>
<td>1.160</td>
</tr>
</tbody>
</table>

Table 3 Hardness test

<table>
<thead>
<tr>
<th>Job No.</th>
<th>Root gap, Mm</th>
<th>Current, Amp</th>
<th>Electrode dia, mm</th>
<th>Gas flow rate, ltr/min</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>0.5</td>
<td>150</td>
<td>2.4</td>
<td>5</td>
</tr>
</tbody>
</table>

The maximum hardness determined by the weld zone is 160.33HV (hardness number) by Vickers hardness testing machine shown in Table 4 and Table 5.

Table 4 Hardness Test

<table>
<thead>
<tr>
<th>Job No.</th>
<th>Root gap, Mm</th>
<th>Current, Amp</th>
<th>Electrode dia, mm</th>
<th>Gas flow rate, ltr/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>120</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

3. MICRO STRUCTURE ANALYSIS

SEM analysis with Electron voltage of 10Kv and magnification 500x with the width of 10.5mm is done then the Evaporation of zinc is observed high at weld zone and medium at HAZ1 and HAZ2 (Fig. 1).

SEM analysis with Electron voltage of 10Kv and magnification 500x with the width of 10.5mm is done then the Evaporation of zinc is observed high at all zones (Fig. 2).

SEM analysis with Electron voltage of 10Kv and magnification 500x with the width of 10.5mm is done then the Evaporation of zinc is observed medium at weld zone low at HAZ1 and HAZ2 (Fig. 3).

4. CONCLUSION

As after welding, the weld metal becomes porous and 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. We found from the Micro structure investigation using SEM analysis for brass 3019 that the porosity due to welding is reduced in the job number 4 which may possess the properties as normal brass after welding.

Previously it was found that job number 6 and 7 possess high quality from the observed tabulated readings and values we can conclude that the optimum values of the readings were found in experiment 6. But in SEM analysis experiment 4 is found better than 6 when the root gap was minimum value, And all parametrs are in medium. Heat affected zones region had lower porosity compared to weld zone.

REFERENCES


