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FABRICATION OF COPPER AND MILD STEEL JOINTS BY GAS WELDING AND ITS MECHANICAL CHARACTERIZATION

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***Abstract:** The proposed work evaluates the mechanical characteristics of gas welded mild steel and copper . The welding of mild steel to copper without interlayer materials was performed, and varying degrees of success and mechanical joint strengths were observed. The joint was obtained by means of oxy-acetylene gas welding. In order to evaluate the gas welding for joining the dissimilar metal, its mechanical characteristics were analyzed. The joining quality of the dissimilar metals was discussed in this paper. Mechanical analyses and observations of the extent of metallic bonding and diffusion showed that incompatible materials may be gas welded without an interlayer and mechanically improved joints can be obtained. The joints were analyzed from the results of impact tests, hardness tests and compression test.*

***Keywords:** Gas welding, Mild steel, copper, Impact strength, compressive strength*

I. INTRODUCTION

Oxy-fuelwelding (commonly called oxyacetylene welding, oxy welding, or gas welding in the U.S.) and oxy-fuel cutting are processes that use fuel gases and oxygen to weld and cut metals, respectively. Oxy-fuel has an advantage over electric welding and cutting processes in situations where accessing electricity (e.g., via an extension cord or portable generator) would present difficulties; it is more self-contained, in this sense — hence "more portable". In oxy-fuel welding, a welding torch is used to weld metals. Welding metal results when two pieces are heated to a temperature that produces a shared pool of molten metal. The molten pool is generally supplied with additional metal called filler. Filler material depends upon the metals to be welded. Torches that do not mix fuel with oxygen (combining, instead, atmospheric air) are not considered oxy-fuel torches and can typically be identified by a single tank (Oxy-fuel cutting requires two isolated supplies, fuel and oxygen). Most metals cannot be melted with a single-tank torch. As such, single-tank torches are typically used only for soldering and brazing, rather than welding. Acetylene is the primary fuel for oxy-fuel welding and is the fuel of choice for repair work and general cutting and welding. Acetylene gas is shipped in special cylinders designed to keep the gas dissolved. The cylinders are packed with porous materials (e.g. kapok fibre, diatomaceous earth, or (formerly)asbestos), then filled to around 50% capacity with acetone, as acetylene is acetone soluble.

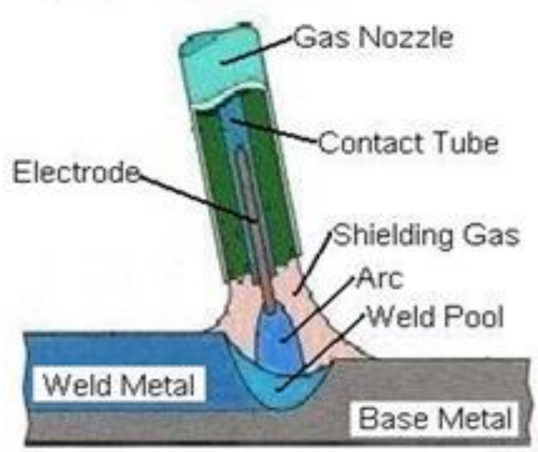

Figure 1.Gas welding machine

This method is necessary because above 207 kPa (30 lbf/in²) (absolute pressure) acetylene is unstable and may explode. There is about 1700 kPa (250 psi) pressure in the tank when full. Acetylene when combined with oxygen burns at a temperature of 3200 °C to 3500 °C (5800 °F to 6300 °F), highest among commonly used gaseous fuels. As a fuel acetylene's primary disadvantage, in comparison to other fuels, is high cost.

II. MATERIALS AND PROCESS

A. Mild steel

Mild steel also called as plain-carbon steel, is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications, more so than iron. Low-carbon steel contains approximately 0.05–0.3% carbonmaking it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can be increased through carburizing. It is often used when large quantities of steel are needed, for example as structural steel. The

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density of mild steel is approximately7.85 g/cm^3 (7850 kg/m^3 or 284 lb/in^3) and the Young's modulus, like all steels, is 210 GPa (30,000,000 psi). The specimens according to the required size was machined and the joining faces of the mild steel plates are polished.

B. Copper

Copper is a chemical element with the symbol Cu (from Latin: cuprum) and atomic number 29. It is a ductile metal with very high thermal andelectrical conductivity. Pure copper is soft and malleable; a freshly exposed surface has a reddish-orange color. It is used as a conductor of heat and electricity, a building material, and a constituent of various metal alloys.The softness of copper partly explains its high electrical conductivity (59.6×10^6 S/m) and thus also high thermal conductivity, which are the second highest among pure metals at room temperature. This is because the resistivity to electron transport in metals at room temperature mostly originates from scattering of electrons on thermal vibrations of the lattice, which are relatively weak for a soft metal. The maximum permissible current density of copper in open air is approximately 3.1×10^6 A/m^2 of cross-sectional area, above which it begins to heat excessively. As with other metals, if copper is placed against another metal, galvanic corrosion will occur.

TABLE 1. PROPERTIES OF COPPER

Young's modulus	110–128 GPa
Shear modulus	48 GPa
Bulk modulus	140 GPa

Pure copper is orange-red and acquires a reddish tarnish when exposed to air. The characteristic color of copper results from the electronic transitions between the filled 3d and half-empty 4s atomic shells – the energy difference between these shells is such that it corresponds to orange light.

III. RESULTS AND DISCUSSIONS

A. Brinell Hardness Test

The steel ball is pressed on a metal surface to provide an impression. This impression should not be distorted and must not be too deep since this might cause too much of plastic deformation, leading to errors of the hardness values. If we consider the plastic zone beneath the Brinell indenter, this plastic region is surrounded by elastic material which obstructs the plastic flow. This condition is said to be plane strain compressive where plastic deformation is limited. If the metal is very rigid, the metal flow upwards surrounding the indenter is possible. The hardness values are taken at the interface of the arc welded mild steels processed at 100A, 150A and 200A. There are variations found in the hardness values of the specimens interface. The hardness values are tabulated below.

Figure 2.Brinell hardness testing machine

TABLE 2. BRINELL HARDNESS NUMBER

Welding	Gas welding
Brinell Hardness Number (BHN)	1.750

B. Charpy Impact Test

Charpy impact test is practical for the assessment of brittle fracture of metals. The Charpy test sample has 8x8x55 mm dimensions, a 45^{o}V notch of 2 mm depth will be hit by a pendulum at the opposite end of the notch as shown in figure. To perform the test, the pendulum set at a certain height is released and impact the specimen at the opposite end of the notch to produce a fractured sample.

Figure 3. Impact testing machine

The greater of the high of the pendulum swings to the other side of the machine, the less energy absorbed during the fracture surface. This means the material fractures in a brittle manner. On the other hand, if the absorbed energy is high, ductile fracture will result and the specimen has high toughness. The impact strength of the specimen joints are in different ranges because of the variation of current in the welding process. The values are tabulated below.

TABLE 3. CHARPY IMPACT STRENGTH

Welding	Gas welding
Impact Strength (J/mm^2)	4.45

C. Izod Impact Test

Izod impact testing is an ASTM standard method of determining the impact resistance of materials. An arm held at a specific height (constant potential energy) is released. The arm hits the sample and breaks it. From the energy absorbed by the sample, its impact energy is determined. An un notched sample is generally used to determine impact energy. The test is similar to the Charpy impact test but uses a different arrangement of the speciemen under test. The impact strength of the specimen joints are in different ranges because of the variation of current in the welding process. The Izod impact test differs from the Charpy impact test in that the sample is held in a cantilevered beam configuration as opposed to a three-point bending configuration. The specimen size of 8*8*55 mm square rod was machined and welded for the evaluation. The values of the impact strength of specimens processed at various current are tabulated below.

TABLE 4. IZOD IMPACT STRENGTH

Welding	Gas welding
Impact Strength (J/mm^2)	2.5

D. Compression Test

The Compression test was done in Universal Testing Machine. The compressive strength is the maximum compressive stress a material is capable of withstanding without fracture. The specimen size of 40*40*8 mm was machined and welded for the evaluation.

TABLE 5. COMPRESSION STRENGTH

Welding	Gas welding
Compressive Strength (KN)	12.5 KN

Figure 4. Universal testing machine

A compression test is a method for determining the behavior of materials under a compressive load. Compression tests are conducted by loading the test specimen between two plates, and then applying a force to the specimen by moving the crossheads together. The compression test is used to determine elastic limit, proportional limit, yield point, yield strength, and (for some materials) compressive strength. Brittle materials fracture during testing and have a definite compressive strength value. The compressive strength of ductile materials is determined by their degree of distortion during testing.

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IV. CONCLUSION

From the study made in this paper, it was found that the hardness of the gas welded sample is 1.750 BHN. Where as, the impact strength of the gas welded sample is 4.45 J/ mm^2. Mean while the compressive strength is 12.5 KN.

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