Journal of Futuristic Sciences and Applications
Vol. 7(1), Jan-Jun 2024, pp. 74-79
doi: 10.51976/jfsa.712410
www.gla.ac.in/journals/jfsa

Assessment of the Effects of Welding Parameters on TIG Weld Bead Quality

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ABSTRACT

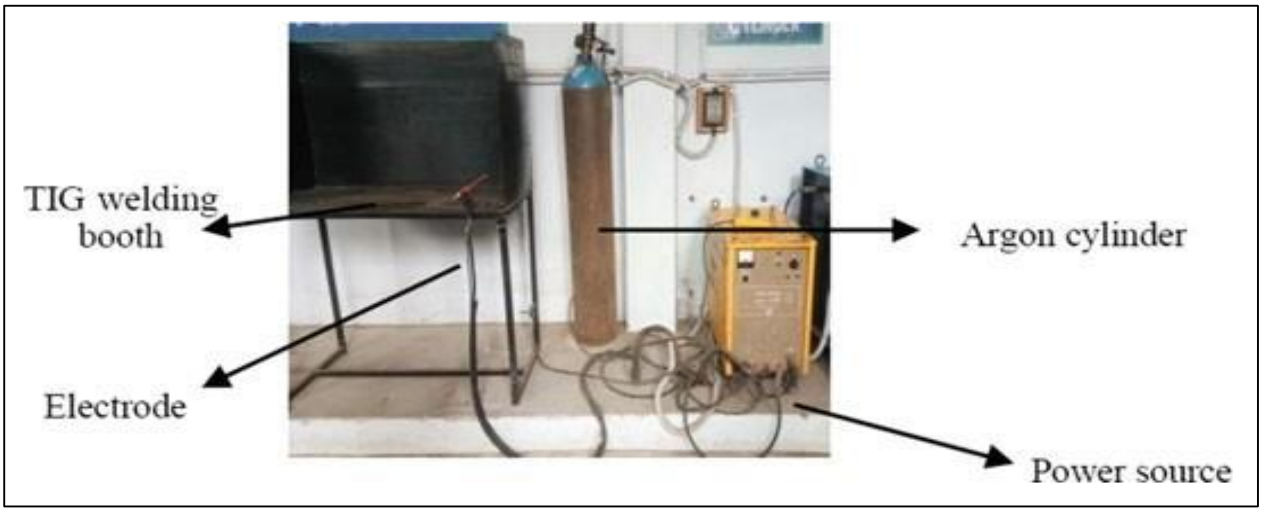
In the industrial sector, TIG welding is a common method of combining metals. The strength and integrity of these weld beads are frequently what determine the quality of a building's welds. Understanding and modifying welding parameters is necessary to produce high-quality weld beads because, according to research, the ideal welding current can increase joint hardness up to a point when diminishing returns happen. Overcurrent can cause problems such as material gaps, splashing and workpiece damage, which will ultimately lower the quality and efficiency of the weld. Dye penetration testing is a standard procedure to improve TIG weld bead quality, and microscopic inspection of weld zones aids in assessing the influence of welding parameters on weld quality.

Keywords: *HAZ Test, TIG Welding, Dye Penetration Test, Hardness Test.*

1.0 Introduction

TIG welding is a weld method in which the weld metal is in a liquid condition. It is necessary to utilize an inert gas shield for this kind of non-consumable tungsten electrode welding. Non-consumable tungsten electrode produces arc between workpiece and electrode.

Figure 1: Experimental Setup



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Inert shielding gas is used to shield tungsten electrode, arc, and weld pool from air's destructive effects during the welding process. TIG welding is distinct from other types of arc welding because the arc is generated quickly and the electrode is not consumable. TIG welding may be automated to boost productivity because of its high level of accuracy [1–3]. TIG welding can weld a variety of materials with varying degrees of success by using a V or U notch to boost the specimen's hardness. In order to optimise a process parameter, several studies employed Taguchi and ANOVA techniques [4–7]. TIG welding was used to examine the specimens' hardness and microstructure in this work.

1.1 Working of TIG welding

Tests on TIG welding are shown in Figure 1. At a temperature of around 5890°C, the spark is generated. Melting of the workpiece causes the formation of a weld pool at this temperature. Argon and helium gases are employed as a kind of shielding. The weld bead is well-protected by an argon gas shield because it is heavy.

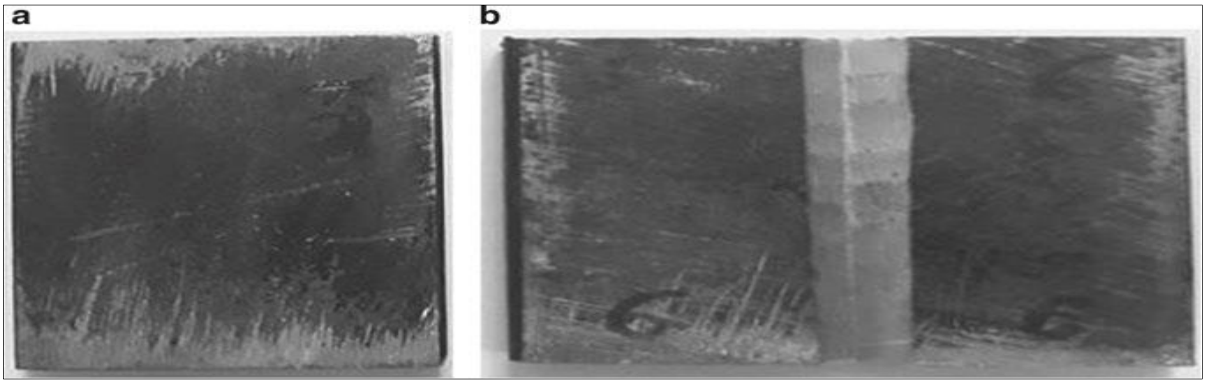
2.0 Experimental Procedure

Welding tungsten inert gas is used to attach mild steel plate specimen with dimensions of 55 x 50 x 6 mm^3.

2.1 Setting-up samples for welding

There are two parts to the mild steel specimen: one that measures 55 mm by 50 and one that measures 55 mm by 25.

Figure 2: Sample a without Notch b with V-notch (30°)



Once the V-notch is ready, it is filed at a 30° angle on one of the parts. A 12rr flat rough file is used for the filing. Images of the grove-free and grooved specimen are shown in Figure 2.

3.0 Results

3.1 Toughness of sample

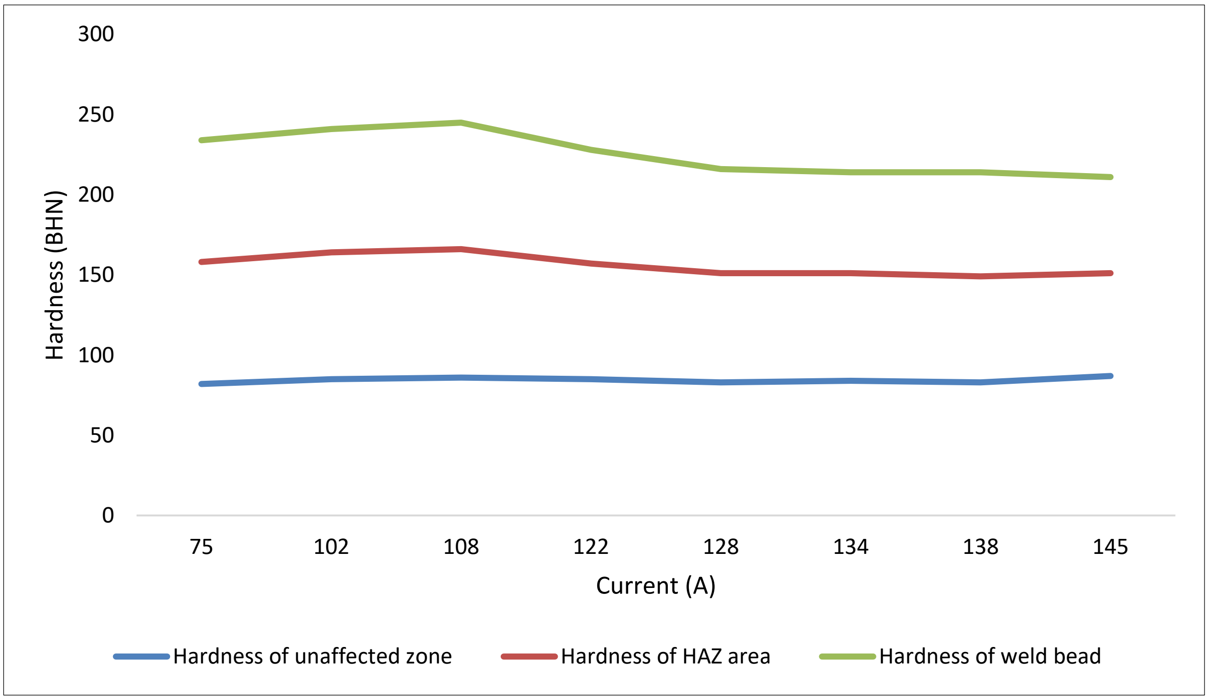
Weld bead and heat-affected zone areas are tested using Rockwell hardness testing machines to determine specimen hardness. As shown in Table 1, the hardness test is carried out on eight specimens, each of which was made using a different welding parameter.

Doi: 10.51976/jfsa.712410

Table 1: Welded Sample under Different Current and Voltage

Workpiece	*I* (A)	*V* (V)	*T* (S)	Hardness of unaffected zone first series	Hardness of HAZ area Second series	Hardness on weld bead Third series
4	75	12.4	2.52	82	76	76
5	102	12.4	1.38	85	79	77
8	108	12.5	0.35	86	80	79
2	122	12.5	1.18	85	72	71
1	128	12.5	0.50	83	68	65
7	134	12.4	1.04	84	67	63
6	138	12.5	0.38	83	66	65
3	145	12.6	0.42	87	64	60

Figure 3: Hardness of the Weld Bead



According to this investigation, the weld bead, heat affected zone (HAZ), and unaffected area all saw an increase in current of 108 A. More than 108 A of hardness loss occurred at high amps. If you look at Fig. 3, you'll see that the hardness of the material decreases significantly at higher currents, notably 122 and 145 A.

3.2 Preparing sample for microstructural analysis

Nital etchant is used to prepare the specimen for microstructure analysis. Nital etchant is made up of 89 ml distilled water, 1 ml nitric acid, and 10 ml ethanol, as its main ingredients. The water droplets on the weld surface may be removed using a dryer. The image at a 100-micron size was captured using an inverted microscope

Figure 4: Example of Mild Steel before the Welding Process

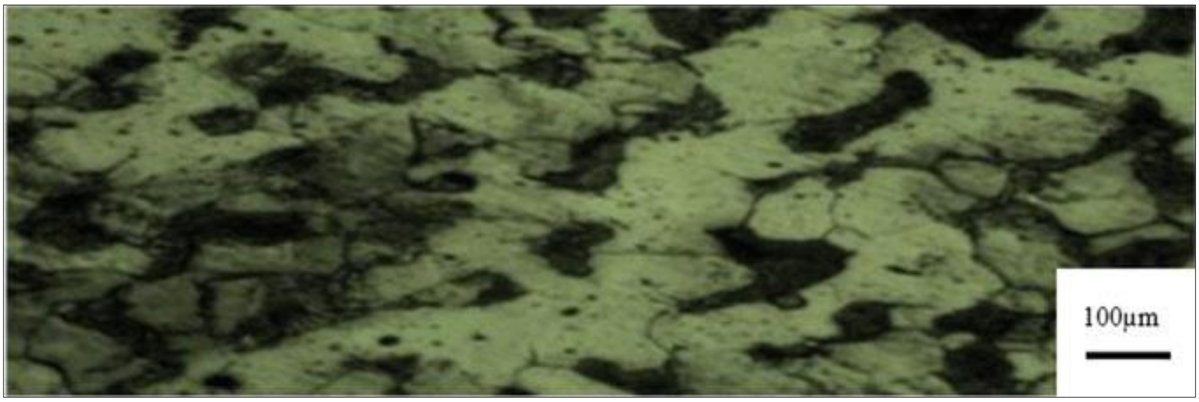


Figure 4 depicts the microstructure of mild steel without welding, as seen When welding at 102, 128, and 145 A, these figures show the microstructure of the weld.

Welding parameters were studied to see how they affected the average grain size. Microscopy picture of mild steel specimen Fig. 5 shows a little black spot. There is a term for this black spot: -Mg phase. The -phase is also observable after raising the current from 102 to 128 A. In Fig. 6, the dendritic grain and spline grain are clearly visible. At a current of 128 A, the fracture first appeared. Figure 7 at 145 A shows it clearly.

Figure 5: Example of Mild Steel after the Welding Process

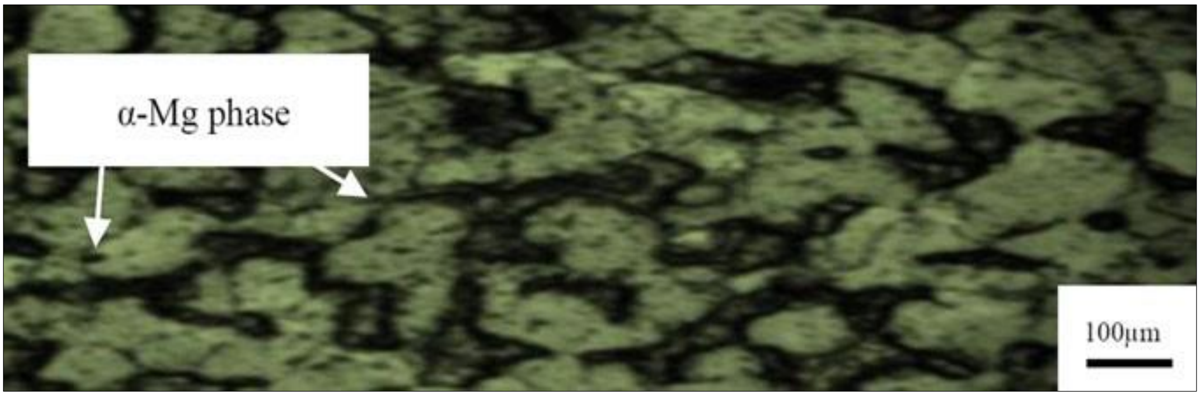


Figure 6: Microstructural Sample at 128A

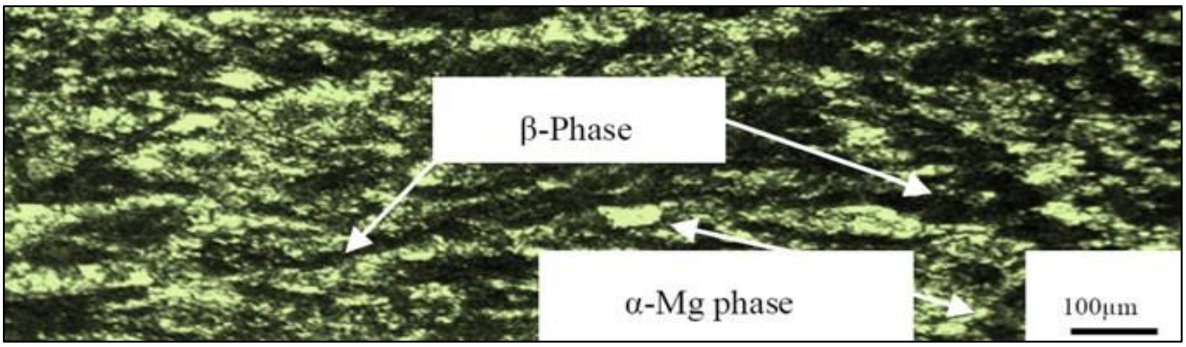


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Figure 7: Microstructural Sample at 145A

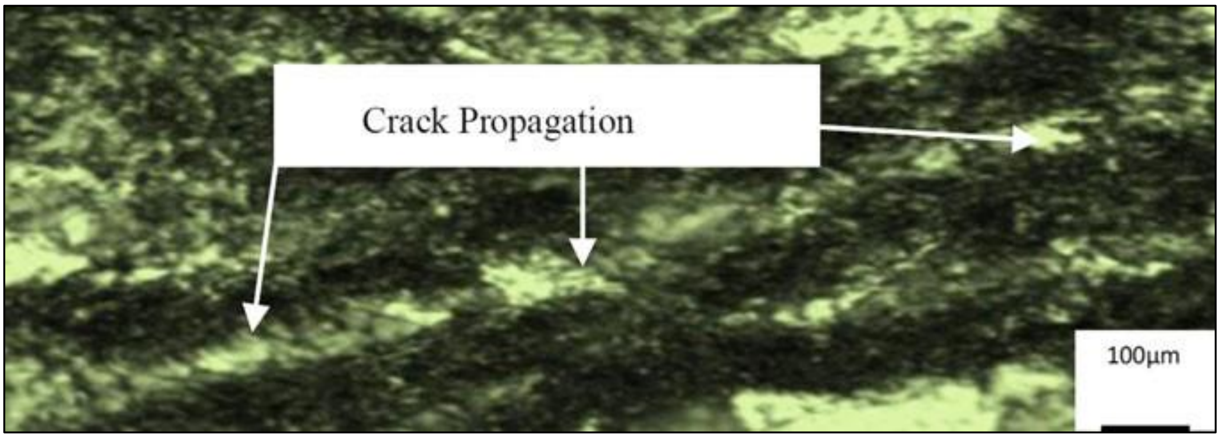
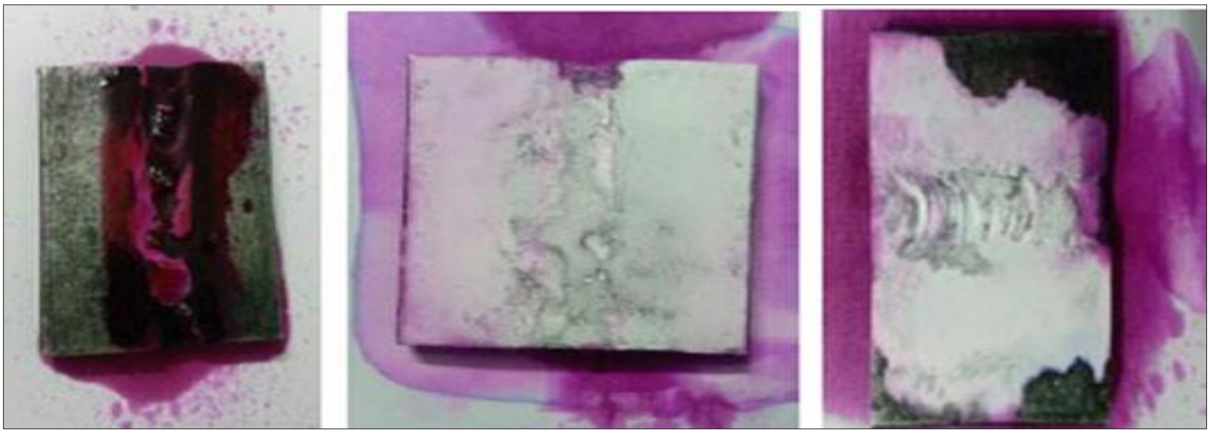


Figure 8: Dye Penetration Test



3.3 Dye penetration test

In the welded specimen, it's utilized to check for fractures, porosity, and fatigue cracks in the casting. Cracks and porosity are detected using a five-step examination procedure. To begin, the specimen's surface is cleaned to remove any dust, oil, or paint. Cleaning might make use of degreasing solvents and vapors. It's tool for polishing surfaces. To prepare the specimen for the next step in the finishing process, vaporized solvent is used. It is only possible to remove excessive penetration by removing it in one direction alone, either horizontally or vertically. The developer is applied to the specimen's surface after the excess penetrate has been removed.

It's attracted to surface flaws that are visible to the naked eye. The specimen's faults had to be identified and characterized using the findings from the test. Figure 8 depicts the test procedures.

4.0 Conclusions

This paper investigates the effect of current on the welding heat. Weld bead hardness rises to a peak of 110 A before declining. High current causes an increase in welding heat input [8]. Grain boundaries transform into more tightly packed and grain size increases when high energy is applied to welded microstructures. Grain boundaries that serve as locks for dislocation movement are reduced, allowing more dislocations to migrate as line defects. Welded metal's hardness will suffer as a result. Because of the evaporation of Mg during welding, the hardness of the HAZ is lower than that of the base material. The microstructure clearly shows that after 108 A, fracture propagation is observable. The weld bead's toughness peaks at 108 A, as may be shown in Table 1. After then, a crack begins to form, which has the potential to expand all the way to 134 A before it is finally sealed. Higher current values in the dye penetration test show increased fracture progression.

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