Journal of Futuristic Sciences and Applications
Vol. 5(2), Jul-Dec 2022, pp. 90-95
doi: 10.51976/jfsa.522212
www.gla.ac.in/journals/jfsa

To Investigate the Weld Bead Hardness at Various Current through TIG Welding

Dharmendra Kumar Tiwari and Rajendra Prasad Verma***

ABSTRACT

In the industrial industry, TIG welding is the most frequent method of putting metals together. The electrode is held at a 10°–15° angle to the vertical by the welder while he initiates the weld by striking an arc and creating a puddle. By moving the electrode and arc in tandem, the welder "pushes" the molten metal forward and toward weld. welder strength of a building is determined by the quality of its weld beads. The weld's mechanical qualities are mostly enhanced by the weld's quality. The writers of this article explain how to weld with high weld bead quality by using the proper welding parameters. In this research, it has been proven that the hardness of welded joints improves with the increase in welding current up to 110 A for 6 mm thick plates, and afterwards declines with the rise in welding current. Splash and damage to the workpiece could occur when the current is raised to an excessively high level. Because the workpiece is so thin, high current might cause the material gap to grow. This practise may result in an increased weld affected area and a longer time to deposit the same amount of filler material, as well as damage from high heat. Inverted microscopic analysis of the weld zone was performed in order to assess the effect of the welding parameters on the weld quality. As part of the TIG weld bead quality improvement process, dye penetration testing is performed.

Keywords: *HAZ test; TIG welding; Dye penetration test Hardness test.*

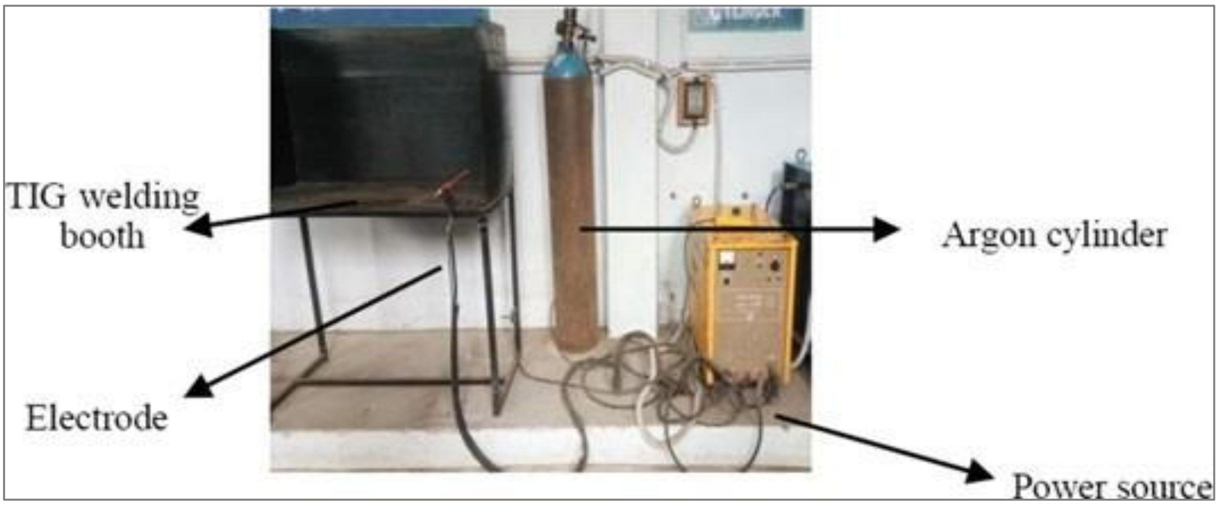
1.0 Introduction

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. 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.

**PhD Scholar, Mechanical Engineering, United University, Jhalwa, Ravatpur, Prayagraj, Uttar Pradesh, India (E-mail: dharmu.tiwari@gmail.com)*
***Corresponding author; PhD Scholar, Department of Mechanical Engineering, United University, Rawatpur, Prayagraj, Uttar Pradesh, India (E-mail: rajendraverma62yahoo.com)*

Figure 1: Experimental setup



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.

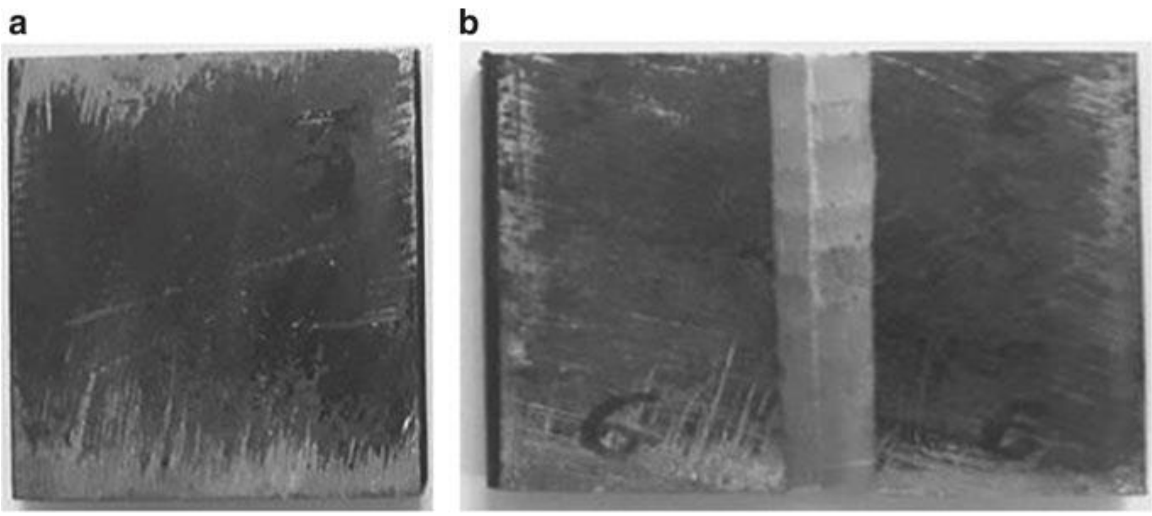
2.0 Experimental Procedure

Welding tungsten inert gas is used to attach mild steel plate specimen with dimensions of 55 x 50 x 6 mm3.

2.1 Specimen preparation 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: a. Specimen without Notch; B. Specimen with V-notch at 30°



Doi: 10.51976/jfsa.522212

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

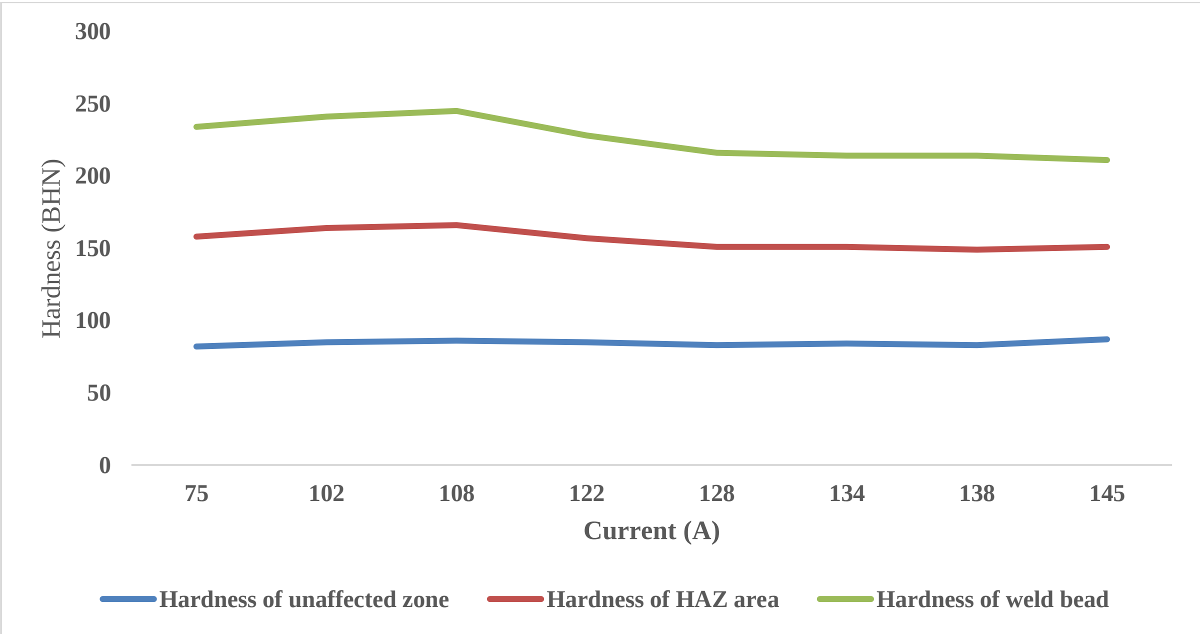
3.1 Hardness of the specimen

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.

Table 1: Welded Specimens at Various Current and Voltage

Workpiece no.	I (A)	V (V)	T (S)	Hardness of unaffected zone series 1	Hardness of HAZ area series 2	Hardness on weld bead series 3
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 Specimen preparation for microstructure

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: Mild Steel Specimen without Welding

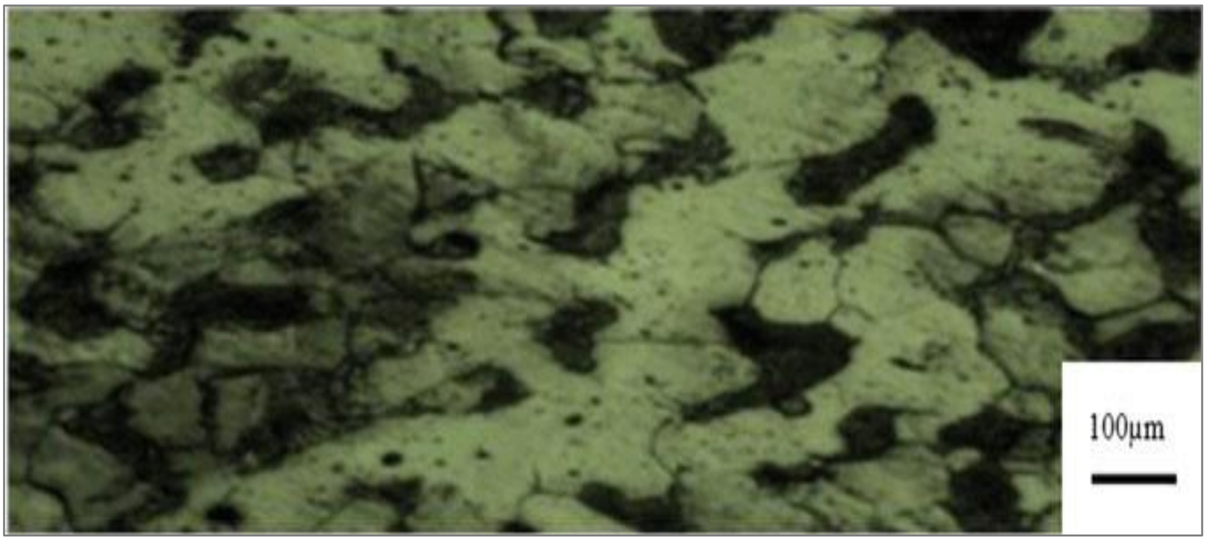
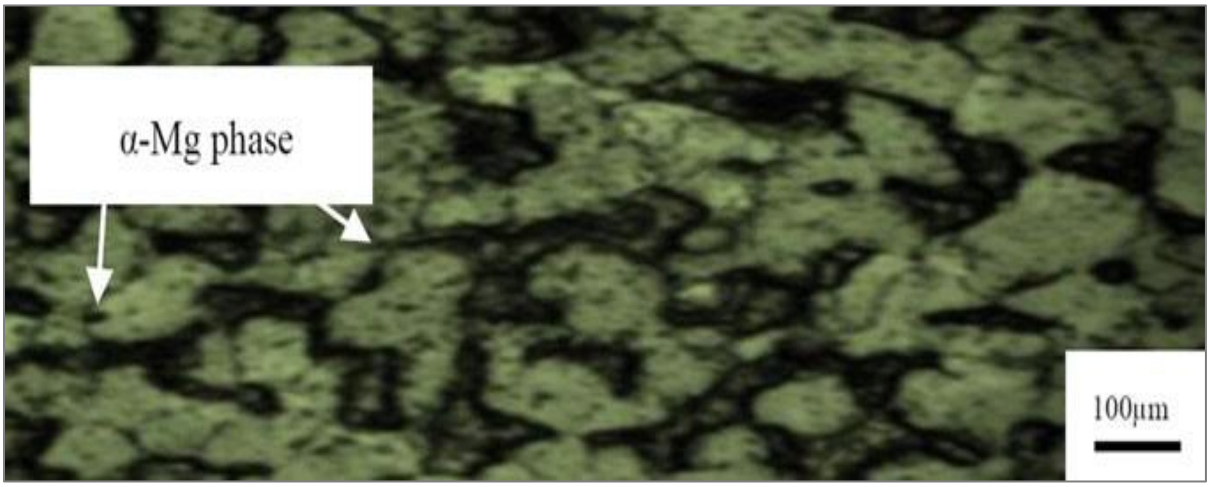


Figure 4 depicts the microstructure of mild steel without welding, as seen When welding at 102, 128, and 145 A, these figures show the microstructure of the weld.

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: Mild Steel Specimen with Welding



Doi: 10.51976/jfsa.522212

Figure 6: Microstructure of Specimen at 128A

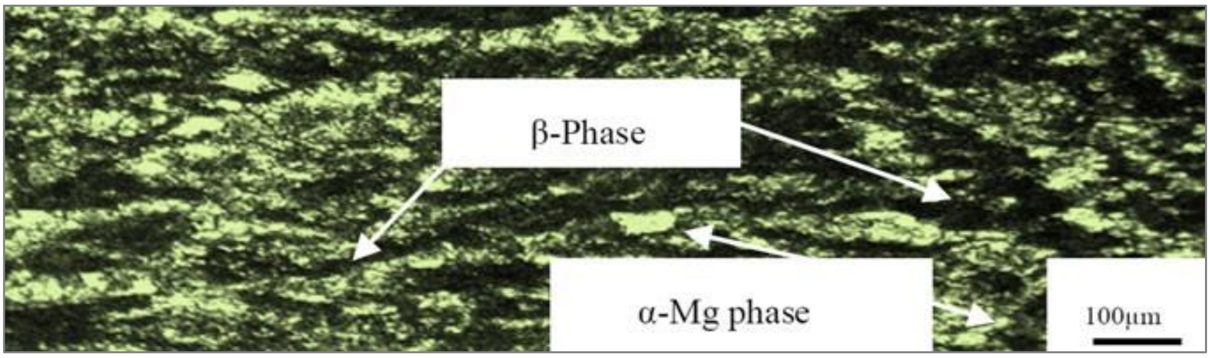


Fig. 7 Microstructure of specimen at 145A

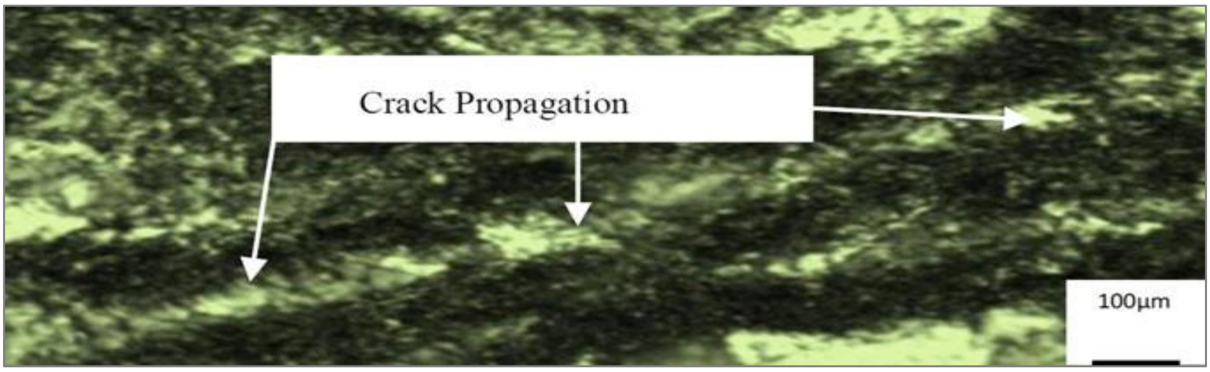
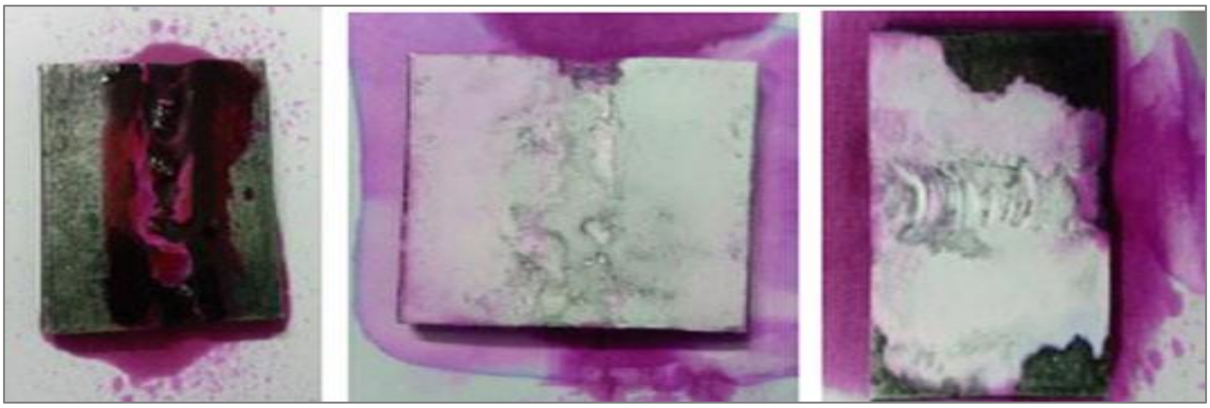


Figure 8: Dye Penetration Test



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 vapours. 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

Weld bead hardness rises to a peak of 110 A before declining. High current causes an increase in welding heat input [8]. When high energy is delivered to welded microstructures, grain size increases and grain boundaries become more concentrated. 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. In the dye penetration test, more fracture propagation is shown at higher current levels.

References

[1] Thakur, Y., Kumar, K., Kumar, K.: Influences of TIG welding parameters on tensile and impact behaviour of aluminium alloy joints: a review. IOSR J. Mech. Civ. Eng., Special Issue, AETM’16, 54–58 (2016)

[2] Randhawa, V.J., Suri, N.M.: Effect of a TIG welding process parameters on penetration in mild steel plates. J. Mech. Ind. Eng. 3(2), 27–30 (2013)

[3] Jeyaprakash, N., Haile, A., Arunprasath, M.: The parameters and equipments used in TIG welding: a review. Int. J. Eng. Sci. 4(2), 11–20 (2015)

[4] Singh, G., Bansal, A., Gupta, A.K., Singh, A.: Study the parametric optimization of TIG welding. Int. Res. J. Eng. Technol. 3(5), 412–417 (2016)

[5] Bhavsar, A.N., Patel, V.A.: Influence of process parameters of TIG welding process on mechanical properties of SS304L welded joint. Int. Res. J. Eng. Technol. 3(5), 977–984 (2016)

[6] Gopinath, V., Manojkumar, T., Sirajudeen, I., Yogeshwaran, S., Chandran, V.: Optimization of process parameters in TIG welding of AISI 202 stainless steel using response surface methodology. Int. J. Appl. Eng. Res. 10(13), 11053–11057 (2015)

[7] Vijayan, D., Rao, V.S.: Process parameter optimization in TIG welding of AISI4340 low alloy steel welds by genetic algorithm. IOP Conf. Ser. Mater. Sci. Eng. 90, 012066 (2018)

[8] Singh, P., Singh, V.: Experimental investigation of weld bead hardness of tig welding of grade ss316. Glob. J. Eng. Sci. Res. 1(3), 42–48 (2014)