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A Study of Mechanical Properties on Tig Welding at Different Parameters with and without use of Flux

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Abstract

Tungsten inert gas (TIG) welding in which the arc is formed between a pointed tungsten electrode and the work piece in an inert atmosphere of argon or helium but the activated TIG welding is that in which oxides of fluxes are used on work piece also called A-TIG. Current and voltage can have profound effect on the material in terms of strength and hardness. This research aims at the study of using conventional TIG (tungsten inert gas) and activated TIG welding process to investigate the effect of different levels of factors (current, voltage, gas flow rate, electrode diameter) on the mechanical properties of the mild steel using mixture of MgO and CaO flux. Mild steel specimens were used during the experimentation. The results of conventional TIG have been compared with the activated TIG welding. The method of design expert is used to carry out the experimentation.. Moreover it is observed that there is decrease in hardness of weld but the quality of weld is increased as compared to conventional TIG welding.

Keywords

Activated Tungsten Inert Gas (A-TIG), Calcium Oxide (CaO), Magnesium Oxide (MgO) and Design Expert.

Introduction

Tungsten Inert-Gas Arc Welding, as the name suggests, is a process in which the source of heat is an arc formed between a non-consumable tungsten electrode and the work piece, and the arc and the molten puddle are protected from atmospheric contamination with a gaseous shield of inert-gas such as argon, helium or argon-helium mixture. The welder, if required, adds filler metal, externally to the arc in the form of a bare wire. It is often referred to in abbreviated form as TIG welding. Some authors prefer to call it inert-gas tungsten-arc welding.

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The most important component of all TIG equipment is the high frequency (HF) unit, by means of which high-frequency high-voltage is superimposed on the welding current. Due to this, the shielding gas gets ionized. The electrons, which become free during the process of ionization, form a conducting path between the work piece and the tungsten electrode. Thus the arc can be started without directly touching the tungsten electrode to the work piece. Starting the arc by touching the tungsten electrode to the work piece must be avoided as it contaminates and wears out the electrode tip, and gives rise to tungsten inclusion in the weld deposit, thereby degrading the weld metal properties.

Welding Parameters

Selection of the correct welding conditions for the plate thickness and joint preparation to be welded is very important if satisfactory joints free from defects such as cracking, porosity and undercut are to be obtained. Process parameters directly affect the cooling rate. The process variables, which have to be considered, are:

1. Welding current,
2. Arc voltage
3. Welding speed
4. Electrode size
5. Electrode polarity
6. Gas flow rate

Current, voltage and welding speed are the three welding parameters that have maximum effect on weld bead, heat input and cooling rate [3].

Experimentation

Weld bead on mild steel was carried on Tungsten arc welding machine. Extensive trial runs were carried out to find out the working range of input welding parameters. After finalized of welding parameters, the complete sets of eight trials were down thrice as per design matrix and experimental runs were conducted at random order to eliminate any systematic error. The experimentation was performed in Amandeep Industries, Ludhiana, Punjab.

Mild steel plates having size of 120×75×6 mm were used in this investigation, mild steel plate were cut into required length with help of power hacksaw. The test plate were cleaned using wire brush and emery paper.

Experiment Design and Execution

The experiment was conducted with the following steps as follow

1. Identification of process parameters and finding their upper and lower levels
2. Developing the design matrix
3. Conducting the experiment as per design matrix
4. Recording the response parameters
5. Presenting the result in graphical form
6. Analysis of result

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Identification of Process Parameters and Finding their Upper and Lower Levels

The working range was decide upon by investigating the bead for smooth appearance without any visible defects such as surface porosity, undercuts and pock marks. The upper limit factor was coded as (+1) and lower limit as (-1) or simply (+ -). The decided value of process parameter with their units and limitations are given in the table shown below.

Welding Parameters and their Working Range

Parameters	Units		Limits	
			Upper Limit	Lower Limit
Welding Current	Amp	I	140	105
Arc Voltage	Volts	V	18	16
Electrode Diameter	Mm	D	2.4	1.6
Gas Flow Rate	L/mm	G	10	8

Table 1: Welding Parameters and their Working Range

Development of Design Matrix

The design matrix developed to conduct the eight trial of 2^{4-1} = 8. The two level half factorial design matrixes are delta.

Trail No	C	V	D	G
1.	+	+	+	+
2.	-	+	+	-
3.	+	-	+	-
4.	-	-	+	+
5.	+	+	-	-
6.	-	+	-	+
7.	+	-	-	+
8.	-	-	-	-

Table 2: Design Matrix

For investigation the bead on the plate were deposited without use of flux and for investigation A TIG welding, a specific activated flux has been developed in the current work by mixing CaO and MgO in right portion and then dissolving the mixed powder in acetone to make a paste. The flux in the form of paste was then applied on the specimen. The flux was applied on the work piece using brush for a width 8 mm. the flux quantity applied on the work piece is 5 to 6 mg/cm2. After deposition the flux, the acetone was allowed to be evaporating leaving flux on the surface before welding. A bead on a plate surface was made in order to study the effects.

Observation Table for Hardness on Weld Metal

S.No	Current (A)	Voltage (V)	Dia. of electrode (mm)	Gas flow (L/min)	Hardness without flux(HRC)	Hardness with flux(HRC)
1.	140	18	2.4	10	56.2	52.5
2.	105	18	2.4	8	60	57
3.	140	16	2.4	8	62.8	59.6
4.	105	16	2.4	10	64	62.5
5.	140	18	1.6	8	58	55
6.	105	18	1.6	10	53	51.8
7.	140	16	1.6	10	59	50.5
8.	105	16	1.6	8	65	58

Table 3: Observation Table for Hardness on Weld Metal

Results and Discussions

A novel variation of tungsten inert gas welding called activated TIG (A-TIG) welding which use a thin layer of activated flux coating applied on surface area prior to be welded.

In this research work the effect of welding parameters on the welded joint with and without use of flux has been investigated. For critical analysis of results the effect of welding parameters on penetration and hardness has been investigated and presented in graphical forms.

Effects of Welding Parameters on Hardness

Effect of Current on Hardness without Flux

Figure shows the effect of current on hardness of weld metal without use of flux. Figure shows the hardness decrease from 60.4 to 58.2 when current increase from 105A to 140A.Figure indicates that negative effect of current on the hardness of weld metal, the hardness of weld metal decreases with increase in current. Due to high heat input and high current density the cooling rate is low due to which the hardness of weld metal is also low.

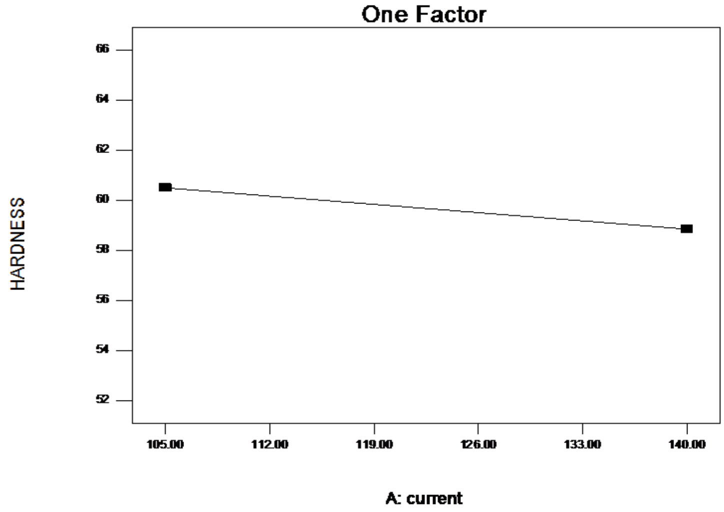

Figure 1

Effect of Current on Hardness with Flux

Figure below shows the effect of current on hardness of weld metal with use of flux. It depicts that Hardness decrease 5.4 to 54.2 when current increase from 105A to 140A Figure indicates that negative effect of current on the hardness of weld metal. Hardness of weld metal decreases slowly when increase in current. When the current is high then the heat input is high, current density is also high and less cooling rate, due to that hardness is less when the current is high.

It shows that hardness is less in case of welding with flux as compare to the without flux.

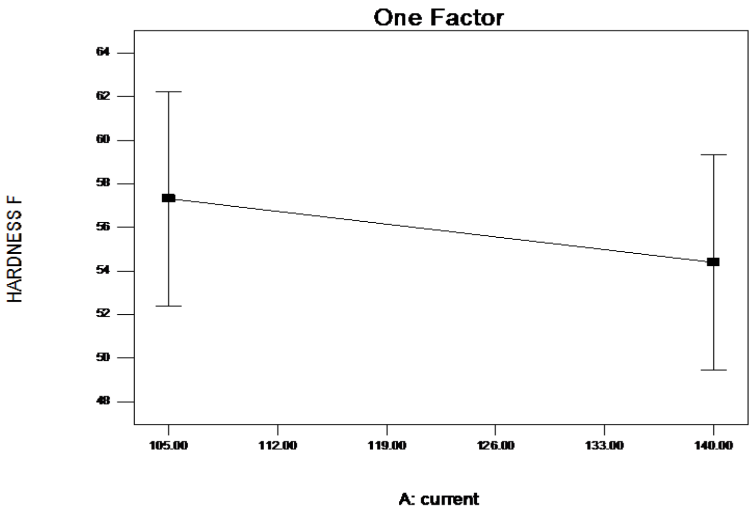

Figure 2

Effect of Voltage on Hardness without Flux

Figureshows the effect of voltage on hardness of weld metal without use of flux.Figure indicates the negative effect of voltage on the hardness of weld metal. When the voltage is high, the arc length is increased due to that the cooling rate is lower than normal. It leads to the decrease in hardness.

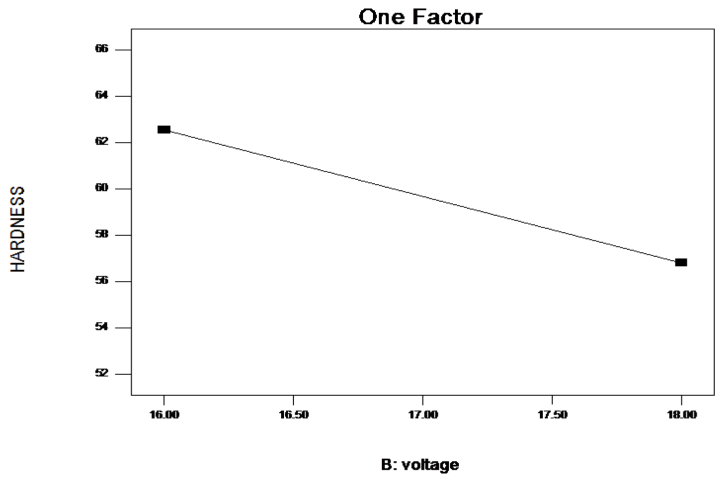

Figure 3

Effect of Voltage on Hardness with Flux

Figure indicates the negative effect of voltage on the hardness of weld metal. Hardness of weld metal decreases with increase the voltage. When voltage is increased then the arc length is also increased, due to increase the arc length hardness of weld metal decrease because of less cooling rate.

It shows that hardness is less in case of welding with flux as compare to the without flux and hardness decreases rapidly in case of welding without flux as compare to welding with flux.

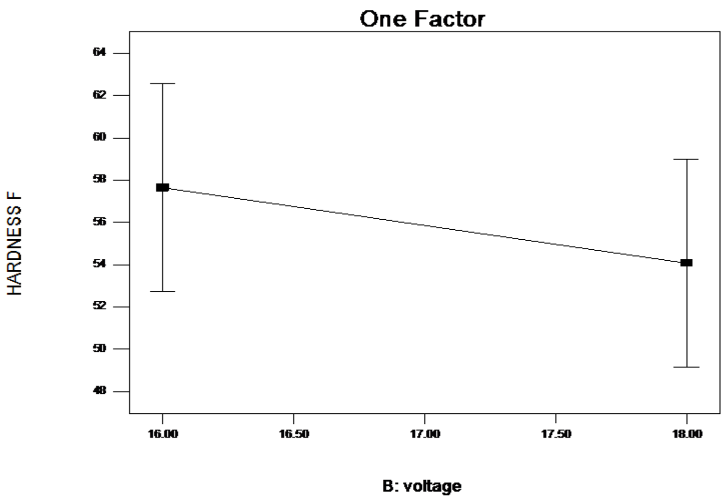

Figure 4

Effect of Diameter of Electrode on Hardness without Flux

Figure shows the effect of diameter of electrode on hardness of weld metal with and without use of flux.

Figure shows that with the increase in electrode diameter, the hardness of weld metal increases due to heat affected zone increases with larger electrode diameter.

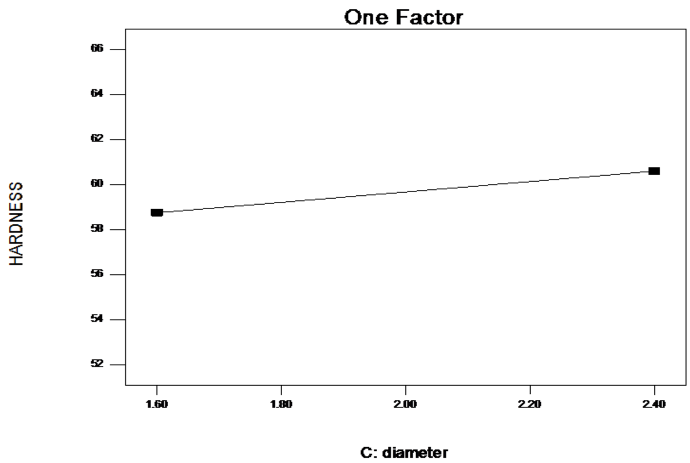

Figure 5

Effect of Diameter of Electrode on Hardness with Flux

Figure shows the effect of diameter of electrode on hardness of weld metal with use of flux.Figure indicate that positive effect of diameter of electrode hardness of weld metal. Hardness of weld metal increases with increase the diameter of electrode. When diameter of electrode is increased then the cooling rate is also increased. Due to increase the cooling rate, hardness of weld metal increased because of high cooling rate then material Quenched.

It shows that hardness is less in case of welding with flux as compare to the without flux.

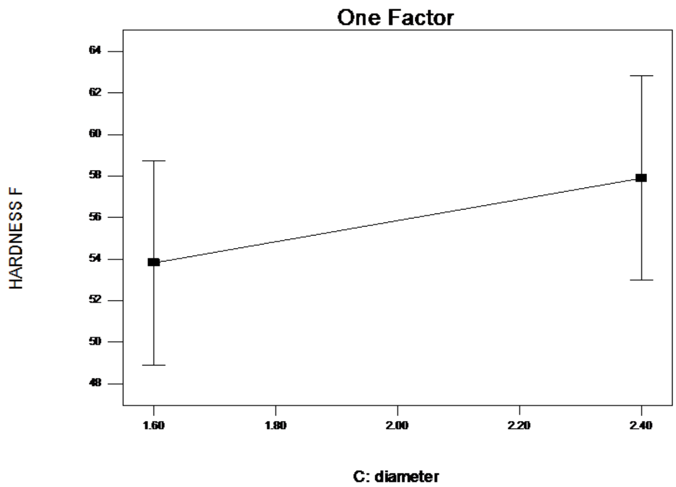

Figure 6

Effect of Gas Flow on Hardness without Flux

Figure shows the effect of gas flow on hardness of weld metal without the use of flux. It indicates that the hardness of weld metal decreases with increase in gas flow rate. It happens due to high heat input and low cooling rate.

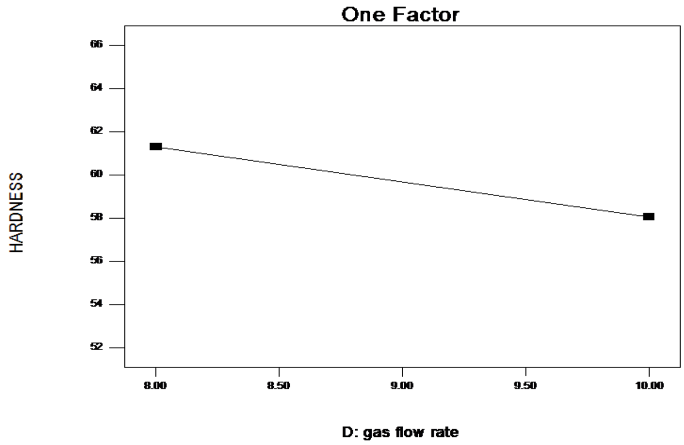

Figure 7

Effect of Gas Flow on Hardness with Flux

Figure shows the effect of Gas flow on hardness of weld metal with use of flux. Figure indicates hardness of weld metal decreases with increase the gas flow. Hardness decreases slowly when gas flow increase. When gas flow is increased then the heat input is also increased. Due to increase the heat input, hardness of weld metal decreased because of less cooling rate.

It shows that hardness is less in case of welding with flux as compare to the without flux.

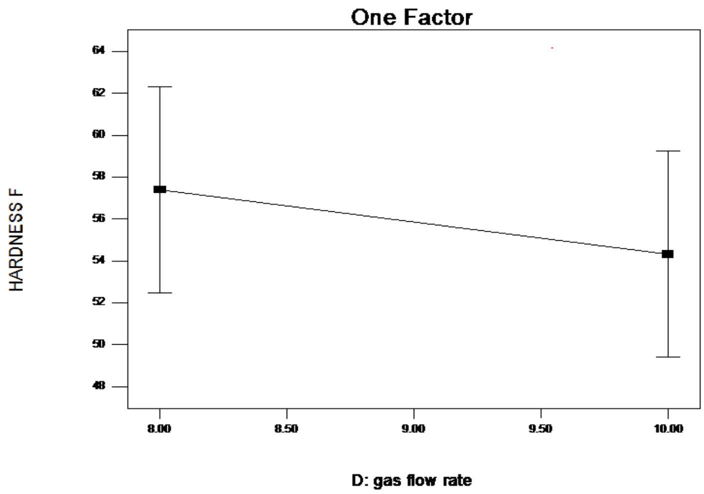

Figure 8

Conclusion

1. It observed that hardness of weld metal decreased from with increase in current, voltage and gas flow rate. Because due to increase in current, voltage and gas flow rate the heat input and arc length increased, hence hardness decreased.
2. It studied that hardness of weld metal increased with increase in diameter of electrode, because due to increase in diameter of electrode the heat affected zone will increase hence hardness increase.
3. It also observed that hardness of weld metal is less in case of welding without flux as compare to welding with flux.

Future Scope

In this research the hardness test and microstructure are done on the mild steel. There is also scope of to find the impact strength. Also the tensile test could be done. This research includes the use of mixture of two fluxes CaO and MgO but in future other oxide fluxes and there mixtures could be used to find out the required results.

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