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Mechanical and Metallurgical Characterisation of Cold Wire Tig Welding Using Low Carbon Steel

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A B S T R A C T

Tungsten Inert Gas (TIG) welding is one of the most common welding process used for joining steels. In the present work Mechanical and metallurgical characterisation of cold wire TIG welding using low carbon steel. Welding Current, Welding Speed, Flow rate of inert gas, filler wire diameter are considered as welding input parameters. Tensile strength, hardness and impact Strength is considered as output responses. Experiments will be performed by using Design Of Experiments. Multi- objective optimization technique will be used for optimization of theInput parameters to obtain the desired output responses. TIG welding is a gas shield welding process and is one of the fusion welding process. It is used welding wherever optimum quality and spatter free weld seams are required. TIG welding is suitable, among other things, for stainless steel, aluminium and nickel alloys as well for thin sheet metal made of aluminium and stainless steel. It is used in pipeline and container construction, in portal construction and in aerospace applications.

Keywords: rock well hardness test, microstructure, macrostructure

1. Introduction

Welding is a fabrication process that joins materials, usually metals or thermoplastics,by using high heat to melt the parts together and allowing them to cool causing fusion. Welding is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal. In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that, based on weld configuration (butt, full penetration, fillet, etc.), can be stronger than the base material (parent metal). Pressure may also be used in conjunction with heat, or by itself,to produce a weld. Welding also requires a form of shield to protect the filler metals ormelted metals from being contaminated or oxidized. Many different energy sources can be used for welding, including a gas flame (chemical), an electric arc (electrical), a laser, an electron beam, friction, and ultrasound.

While often an industrial process, welding may be performed in many different environments, including in open air, under water, and in outer space. Weldingis a hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation.

2. Experimental Procedure

In this study the low carbon steel are welded using tig welding process was carried out using GMAW welding machine. Additive layers (wire arc additive manufacturing (WAAM)) are made on low carbon steel plate using 70S6 filler wire through TIG welding process with cold wire addition. WAAM are sectioned using wire cut EDM process. WAAM specimens are mounted and polished (metallographically prepared samples). Finally, the polished WAAM samples are etched with a suitable etchant to reveal the macrograph. The macrographs are presented below for process parameters

Welding Current - 100 Amps; Welding Speed - 75 mm/min; Welding Voltage – 19.9 V. Shielding gas environment: 90% Argon + 10 % CO2; 15 l/min and 20 bar. Microhardness measurements (load of 500g with a dwell time of 10s) are carried out on the welded samples to find out the mechanical

integrity.

Table 2.1 Process parameters and their limits

PARAMETER	Level		
	-1	0	+1
Welding Current(Amperes)	100	120	140
Wire Feed Rate (mm/min)	60	70	80
Edge Included Angle (Degrees)	30	45	60

Table 2 Welding conditions

Power source	ESAB(Tig 400i)
Polarity	DCEN
Mode of operation	Continuous mode
Electrode	2% thoriated tungsten electrode
Electrode Diameter	2mm
Plasma gas	Argon
Plasma gas flow rate	6 Lpm
Shielding gas	Argon
Copper Nozzle diameter	2.5mm
Nozzle to plate distance	1mm
Welding speed	200mm/min
Torch Position	Vertical
Operation type	Semi Automatic

Fig. 1 – Different samples of welding and layers of welding process

The fig 2.1 shows the picture of welded samples of different layers. After the weld the material machined for various test according to the standard measurements.

3. Results & Discussion

Various tests are carried out for the material. The results are compared to get that which combination of the weld have greater mechanical properties.

3.1 Rockwell hardness test

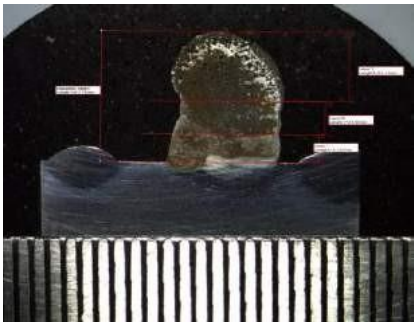
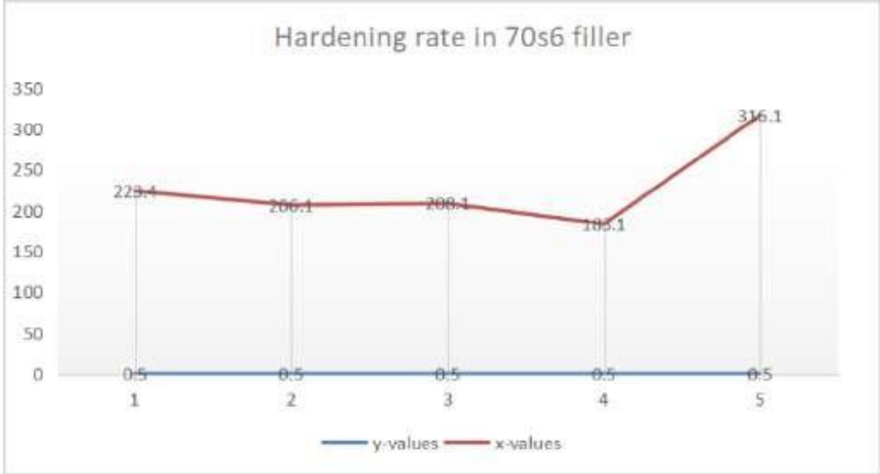


Fig 2 Trail 1 & 2 hardness results samples

3.2 Microhardness Survey

Table 5 Hardness survey of welded samples

Test point	**range**	**hardness**
1	0.5	223.4
2	0.5	206.1
3	0.5	208.1
4	0.5	183.1
5	0.5	316.1



Graph 1 shows a Rockwell hardness number

3.3 Microstructural Evaluation

The sample are prepared for the microstructural evaluation under metallurgical microscope. The specimen first polished and then etchant is applied on the surface of the specimen for the dwell time of 0.5sec. The etchant used is 4% Nital & Glyceregia. The microstructures are carried under 100x magnification. In the weld interdendritic structure formed. In the HAZ microstructure shows complete fusion between weld & base.

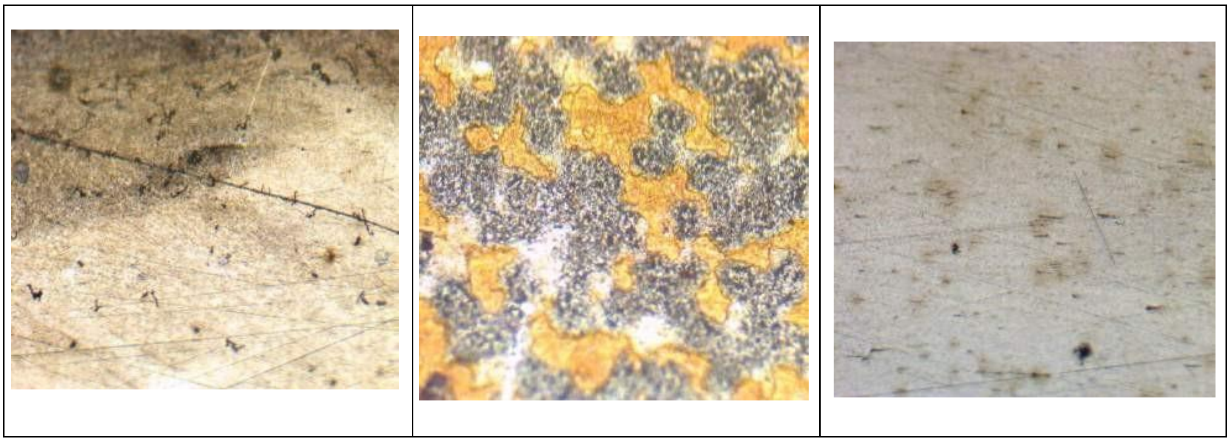


FIG 3 : Shows the layers of weld and microstructure evaluvation

4. Results & Discussions

Based on the experiments performed the following conclusions are drawn:

1) 70S6 Filler are successfully welded using continuous TIG welding process.

2) Experiments are performed as per Box Behnken Design matrix of Response Surface Method.

3) Empirical mathematical models are developed for Rockwell Hardness Number for 70s6 filler by considering the significant coefficients of the welding parameters considered.
4) For welding performed with high current (100 A),
5) With the automated welding system uniform welding of low carbon steel can be possible.
6) Welding strength of the weld joint depends on the welding parameters likewelding speed and welding current.
7) Hardness value of the weld zone change with the distance from weld centre dueto change of microstructure.
8) At lower welding speeds strength is more due to more intensity of current.

INFERENCE FROM THE RESULTS

The three layered deposits are having a strong overlapping phenomenon between the layers and from the macrograph image we can identify the bead height is less than 2 mm for the first and second beads. Further, the last bead has a layer height of more than 4 mm..

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