ANALYSIS OF DISSIMILAR METAL BY TIG WELDING OF 1020MILD STEEL AND 301 STAINLESS STEEL

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Abstract - **Welding is one of the most popular methods of metal joining process. Tungsten Inert Gas welding process is an important process in much industrial experience, for joining ferrous & non-ferrous metals. The TIG welding parameters are the most important factors affecting the quality, productivity and cost of welding. This doesn't ensure that the selected welding process parameters can produce the optimal or near optimal weld pool geometry, for that particular welding machine and environment. This paper discussed the effect of welding variables on the microstructure analysis, mechanical properties of welded 5 mm thick of 301 stainless steel plate and 1020 mild steel plate, welded using the Tungsten Inert Gas (TIG) welding method. However efficient welding of dissimilar metals has posed a major challenge due to difference in thermo mechanical and chemical properties of the materials to be joined under a common welding condition. So in this project weld hardness and the microstructure have been analyzed for dissimilar metal welding of 301 stainless steel to 1020 mild steel taking 302 stainless steel as the filler metal. Similarly taking strain developed as an index the susceptibility of the welded joint to stress corrosion cracking have been studied. It is found that when the filler metal is replaced by 301 stainless steel significant improvements is obtained in the welded joint in terms of reduction in stress developed and stress corrosion cracking.**

Index Terms— **Hardness, Microstructure, mechanical properties, Parameters comparison, TIG welding**

I. INTRODUCTION

Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and or pressure. During welding, the work-pieces to be joined are melted at the interface and after solidification a permanent joint can be achieved. Sometimes a filler material is added to form a weld pool of molten material which after solidification gives a strong bond between the materials. Tungsten Inert Gas (TIG) or Gas Tungsten Arc (GTA) welding is the arc welding process in which arc is generated between non consumable tungsten electrode and work piece. The tungsten electrode and the weld pool are shielded by an inert gas normally argon and helium. The tungsten arc process is being employed widely for the precision joining of critical components which require controlled heat input. The tungsten electrode and the welding zone are protected from the surrounding air by inert gas. The electric arc can produce temperatures of up to 20,000oC and this heat can be focused to melt and join two different part of material. Weld ability of a material depends on different factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position. So in present study the influence of such parameters on the strength and microstructural properties on mild steel gets investigated.

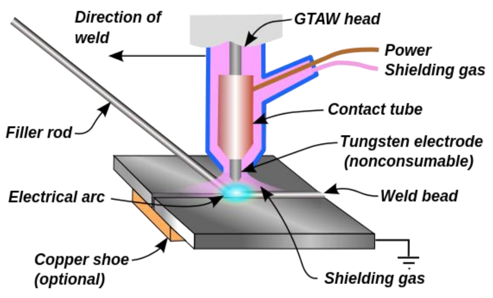


Fig 1 :TIG Welding Process

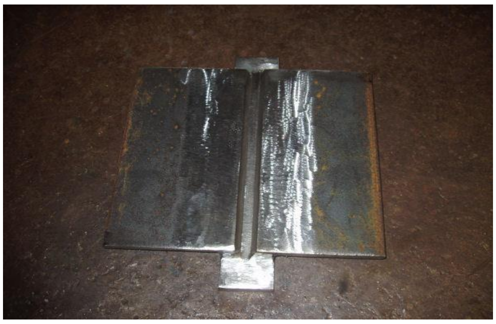


Fig 2 : Weld between Stainless steel and mild steel

II. LITERATURE REVIEW

- **V.Anand Rao et.al** in their experiment the mechanical properties and microstructure of 310 austenitic stainless steel welds are investigated, by using stainless steel filler material of different grades. In bend test the welding current with 120A and electrode 316L has produced maximum bending strength of 646.55MPa while the same welding current with electrode 347 has produced minimum bending strength of 211.37MPa for the specimen studied.
- **Rana A.Majed et al** concluded that the TIG welded pieces, both before and after heat treatment, lead to improvement in the tensile strength but on the expense of the microhardness, as it is less in comparison of the unwelded sample. This is the result of the ferrite formation in the inclusions. The MIG and TIG welded samples showed slightly lesser tensile strength results but considerable higher hardness owing to the higher formation of the perlite microstructure.
- **Pankaj C. Patil et. al** in their experiment TIG welding process is used to analyzed the data and evaluate the influence of input parameters on tensile strength and hardness of aluminium specimen .Welding current , gas flow rate and welding speed are the input parameters which affect output responses of aluminium welded joints .
- **Indira Rani** Investigated the mechanical properties of the elements of AA6351 during the GTAW /TIG welding with non-pulsed and pulsed current at different frequencies. Experiment carried out with plate dimension 300mm X 150mm X 6mm,welding was performed with current 70-74 A, arc travel speed 700-760mm/min, and pulse frequency 3 and 7 Hz. From the experimental results it was concluded that the tensile strength and YS of the elements is closer to base metal. Failure location of elements occurred at HAZ and from this we said that elements have better weld joint strength.
- **Chan** investigated the influence of welding parameters on mechanical properties and microstructure of the welds of laser-TIG double-side welded 5A06 aluminum alloyThe good weld profiles and free defects are responsible for the improvement of tensile properties. Due to low hardness of the fusion zone, this region is the weakest area in the tensile test and much easier to fracture. The loss of Mg element is responsible for the decrease of mechanical properties of the joints.
- **Wang** did the experiment Using He–Ar mixed gas as shielding gas, the tungsten inert gas (TIG) welding of SiCp/6061 Al composites was investigated without and with Al–Si filler.The microstructure and fracture morphology of the joint were examined. The results show that adding 50 vol.% helium in shielding gas improves the arc stability, and seams with high-quality appearance are obtained when the Al–Si filler is added. The microstructure of the welded joint displays non-uniformity with many SiC particles distributing in the weld center.
- **S.C.Juang** Performed experiment by the use of neural networks to model tungsten inert gas (TIG) welding. Both the back-propagation and counter-propagation networks are used to associate the welding process parameters with the features of the weld-pool geometry. Experiment carried out on Al plate with welding current 80A-110A, welding speed 24 cm/min -35 cm/min and arc length 2.4 mm-3.2mm. It is shown that both the back-propagation and counter-propagation networks can model the TIG welding process with reasonable accuracy.

III. EXPERIMENTAL WORK

STEP 1:

Mild steel and stainless steel plates having dimensions 70*50*5 mm were taken and been filed for this experimental work. In this experimental work, the specimen is welded at four different levels of input parameters i.e. current, Flow rate,dia of filler rod as shown in table 1.

Table-1:Different Input Parameters of TIG welding

Materials	Current (Amps)	Diameter of w-electrode (mm)	Diameter of filler rod (mm)	Flow rate of argon Liters/min (lpm)
Mild steel-stainless steel	70	3.0	3.2	10
Stainless steel-stainless steel	50	3.0	3.2	9

STEP-2:

Hardness Test: The samples used for measuring Hardness are first rubbed with emery paper of size no. 400, 600, 1000 & 2000 and then cleaned with acetone solution. The diagonals of the indents formed by pyramid- shaped diamond indenter on the samples.

After being welded the plates has been cut into no of small plates having dimension as (70*20*5) mm to test the hardness of different zones. Polishing of the surfaces is done as to take the readings of Rock well Hardness test. The input and output parameters of the Rockwell Hardness Test are mentioned below:

Input Parameters:
Intender: Diamond
Load: 150kgf
Strip Dimension: 70*20*5 (in mm)

Output Parameters:

Table 2:

LOAD(P)	DIA INDICATOR(D)	DIAMETER OF IMPRESSION(d)	BHN=2P/ $\pi D(D - \sqrt{D^2 d^2}$
250	5	1.3	187.24
250	5	1.4	159.15
250	5	1.5	138.39
250	5	1.6	122.42
250	5	1.7	109.76

AVERAGE=143.39

STEP-3:

Compressive Test(3-point bend test):-

The 3-point bend test conducted using universal testing machine and the specimen is of rectangular size having dimension 110*30 and thickness 6 mm then the specimen is placed in two supporting envil or point set a distance apart and the third loading pin is loaded from above at constant rate until the specimen failure occurs then the failure stress and strain is measured by stress-strain graph.

Table3:[3-point bend test criteria of mild steel and stainless steel by TIG welding]

Test Data	Test Result
Test Type- Compression Test	Ultimate compressive load(kw)- 17.240
Specimen Type- Cube	Ultimate compressive stretch(kg/mm²)-10.651
Width (mm)- 30	Deflection at ultimate load(mm)-7.900
Thickness(mm)- 5.500	Maximum deflection(mm)- 7.900

STEP-4:

Microstructure is one of the mechanical properties which are helpful for checking out the structure of the material. Microstructure of parent material before welding is shown in fig and microstructure of weld metal for sample-1 and sample-2 is shown in fig.

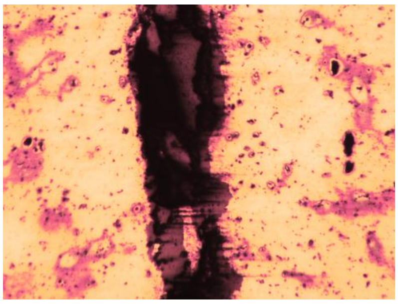
The results of the structures of microstructure of weld metal of mild steel represents a fine grains of Ferrite and Pearlite. No formation of Marten site takes place. So according our results we can conclude that our weldments have lower hardness because both pearlites are soft constituents & there is no sign of formation of marten site.

Micro preparation of the specimen and the material's surface requires that a rigid step-by-step process be followed. The first step is carefully selecting a small sample of the material to undergo microstructure analysis with consideration given to location and orientation.

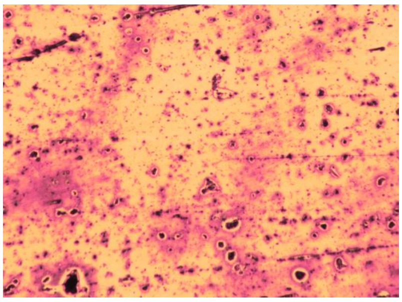
This step is followed by sectioning, mounting, grinding, polishing and etching to reveal accurate microstructure and content.

Detailed viewing of samples has been done with a metallurgical microscope that has a system of lenses (objectives and eyepiece) so that different magnifications (typically 50X to 1000X) can be achieved.
Scanning Electron Microscopes (SEMs) are capable of much higher magnifications and are utilized for highly detailed microstructural study structure Test.

Output Results after the Microstructure tests of two specimens:



Stainless steel and mild steel



Stainless steel and stainles steel

IV. CONCLUSION

1. Welding which is a significant cause of residual stress generates a large amount of residual stress in the weld metal and HAZ of the parent metals, which increases the final thermal stress and should be considered while determining the strength of the joint.
2. If the residual stresses are not considered, due to lower co-efficient of thermal expansion, 1020 mild steel develops tensile thermal stress while compressive thermal stress is generated in301 stainless steel during operating conditions.
3. The peak of the stress is reached in the weld interface of 1020 mild steel and weld metal near the mild steel side, which becomes the highest risk zone.
4. If A301stainless steel is replaced by mild steel 1020 then the developed peak stress falls by 15-30%, and hence the welded joint becomes safer.
5. Stainless steel is recommended to be used as the weld metal, because it also reduces strain which is an index of stress corrosion cracking as result of which the chances of stress corrosion cracking are reduced by 17%.

V. ACKNOWLEDGEMENT

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