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Experimental Investigation On Gas Metal Arc Welding Using 3Cr 1Mo Steel Served At High Temperatres

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Abstract:

Welding is a technique of joining two similar or dissimilar materials (regularly metals) through restricted combination coming about in view of a appropriate use of temperature, weight and metallurgical conditions. Dependent upon the blend of temperature and weight from a high temperature with no weight to a high weight with low temperature, a wide extent of welding structures has been made. There are various sorts of welding including Metal Arc welding, Submerged Arc welding, Gas Tungsten welding, Shielded Metal arc welding, Gas Metal Arc welding, Electron Slag welding etc. While there are various methods for joining metals, welding is a best among the most supportive and quick methodologies available.

The gas metal arc welding measure uses a solid wire terminal that is interminably reinforced into the weld pool.The wire anode is eaten up and transforms into the filler metal. Gas metal arc welding equipment is relatively low in cost compared with other methods. The low beginning expense, the ability to weld continually, and the ability to store weld metal faster, make gas metal arc welding a suitable choice for welding. This topic covers almost each part of GMAW. It includes all parts of GMAW like welding machine, safeguarding gases, filler/terminal wire and welding joint get together of welding plates.

From results it is interpreted that hardness of joint increases as we the temperatre increases and shielding gases does not have much effect on the joint. Tensile strength of the joint is very much effected by the temperature increasing. So low heat and Ar.CO2.O2 shielding gas promotes tensile strength with very good joint strength. As from the study of results it is seen changes in mechanical properties, microstructure of welded joint, gas absorption with the change in shielding gas and heat input in gas metal arc welding.

Keywords: *gas metal arc welding, 3cr 1 mo steel, UTM*

1. Introduction

Initially, the financial matters significance of welding was acknowledged basically to fix and rescuing of a wide range of damaged and harmed metallic supplies and portions. The financial matters and enhancements achieved by later procedures of cutting and welding forms had set them as an exceptional device for assembling, development and upkeep determinations. A portion of its applications are recorded underneath.

Supplanting throwing: A wide assortment of machine parts, which were produced by throwing, are currently being planned and manufactured by welding. Apparatus base, casings and sections are comprised of standard steel shapes and moved plates and joined by any of the welding forms.

Supplanting riveting and darting: Welding is picking up significance step by step in the joining of metals as it gives rapid and sound joints and in the meantime, the joined structure is lighter in weight.

Welding, the main methods for creation. Welding is the main arrangement in situations where types of gear is to be developed of steel plates, the thickness of which is more prominent than joined by methods for riveting and caulking.

Pragmatic utilizations of welding in assembling, development and support: Welding has been effectively received by the aeronautical business in the development and upkeep of plane motors and adornments, evaporator shells, weight vessels and tanks, spans, assembling of cranes, building development, cutting devices and kicks the bucket, earth moving types of gear, heaters and boilers.

GAS METAL ARC WELDING

The gas metal circular segment welding (GMAW) process utilizes a strong wire terminal that is ceaselessly bolstered into the weld pool. The wire anode is devoured and turns into the filler metal. GMAW hardware is moderately low in expense. Likewise, this procedure gives high statement rate in lbs/hr (kg/hr) than the protected metal bend or gas tungsten circular segment welding forms. The low starting cost, the capacity to weld constantly, and the capacity to store weld metal quicker, settle on GMAW an alluring decision for welding. GMAW can be utilized to create amazing welds on all economically

vital metals, for example, aluminum, magnesium, treated steels, carbon and compound steels, copper, and others. GMAW may likewise be done effectively in all welding positions.

2. OBJECTIVES OF PRESENT WORK

The various objectives of the above mentioned topic are given below:

- To concentrate on impact heat on mechanical, miniature primary and treat embrittlement properties of 3 Cr-1Mo steel weld.
- To concentrate on impact of heat on the shielding gases present around the weld.
- To concentrate on the impact of safeguarding gas (presence of oxygen in blended blend) on mechanical, miniature underlying and temper-embrittlement properties.
- To concentrate on impact of safeguarding gas on incorporation and gas retention properties.

3.RESULTS AND DISCUSSION. On the basis of experiments it can be determine that there is remarkable effect ofthe various process parameters on the mechanical properties welding joint of 3Cr-1Mosteel. During these experiments effect of two selected variables has been checked on properties such as hardness, tensile strength, microstructure, Inclusion, Gas absorption and temper-embrittlement.

The process parameters:-

1. Heat Input
2. Shielding Gas

In this study, the effects of above mentioned parameters on the following properties of the
3 Cr-1Mo weld metal steel has been analyzed.

1. Hardness
2. Tensile Strength
3. Microstructure
4. Inclusion
5. Gas absorption
6. Temper-embrittlement.

3.1 EFFECT ON HARDNESS

Highest hardness is observed when joint is welded with high heat input (HHI). However, this is noticeable that 7.8 kj/mm, high heat input has two values of hardness 207HV and 216 HV for Ar-CO2-O2 (M3B) and Ar-CO2 (M2B) blends respectively as

shown in Table 5.1. Following the same trend, low heat input (LHI), 1.6 kj/mm, has 172HV and 180HV hardness for Ar-CO2- O2 and Ar-CO2 blends respectively. The conclusion can be drawn from the graph shown in Fig.5.1, that, high heat input using Ar- CO2 blend as shielding gas results highest hardness value followed by Ar-CO2-O2 blend keeping heat input constant. Low heat input using Ar-CO2-O2 blend shows lowest hardness while with this input and double blend is on third place in descending order.**Table-5.1** Effect of welding parameters on hardness

Sr. No.	**Welding Speed(mm/min)**	**Heat input (kj/mm)**	**Welding Parameters**	**Hardness in Vickers(HV)**
1.	81.5	6.9	HHI-M2B	207
2.	83.0	6.6	HHI-M3B	216
3.	262.4	2.7	LHI-M2B	172
4.	271.0	2.4	LHI-M3B	180

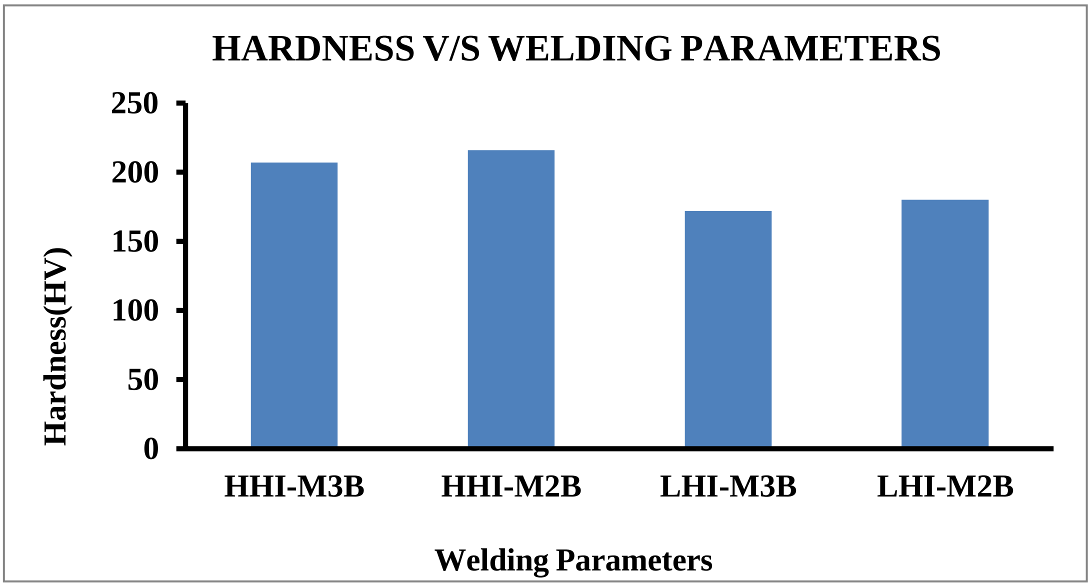


Fig. 5.1: Graph between hardness and welding parameters

3.2 EFFECT ON TENSILE STRENGTH

Four specimens are drawn from each joint has been tested on universal testingmachine. Yield strength (Y.S), ultimate tensile strength (U.T.S) and %elongation (EL) is

indicator of tensile strength. Table 5.2 and Fig. 5.2 show the variation of tensile strengthwith welding parameters.

Table-5.2: Effect of welding parameters on tensile strength

Sr. No.	**Weldin gSpeed (mm/min)**	**Heat inpu t (kj/mm)**	**Welding Parameter s**	**Tensile Strength (M Pa)**		
				YS	**UTS**	**% EL**
1.	83.5	7.9	HHI-M2B	431	650	24.8
2.	84.0	4.7	HHI-M3B	450	580	25.0
3.	251.4	3.5	LHI-M2B	556	410	24.4
4.	260.0	1.3	LHI-M3B	527	521	23.4

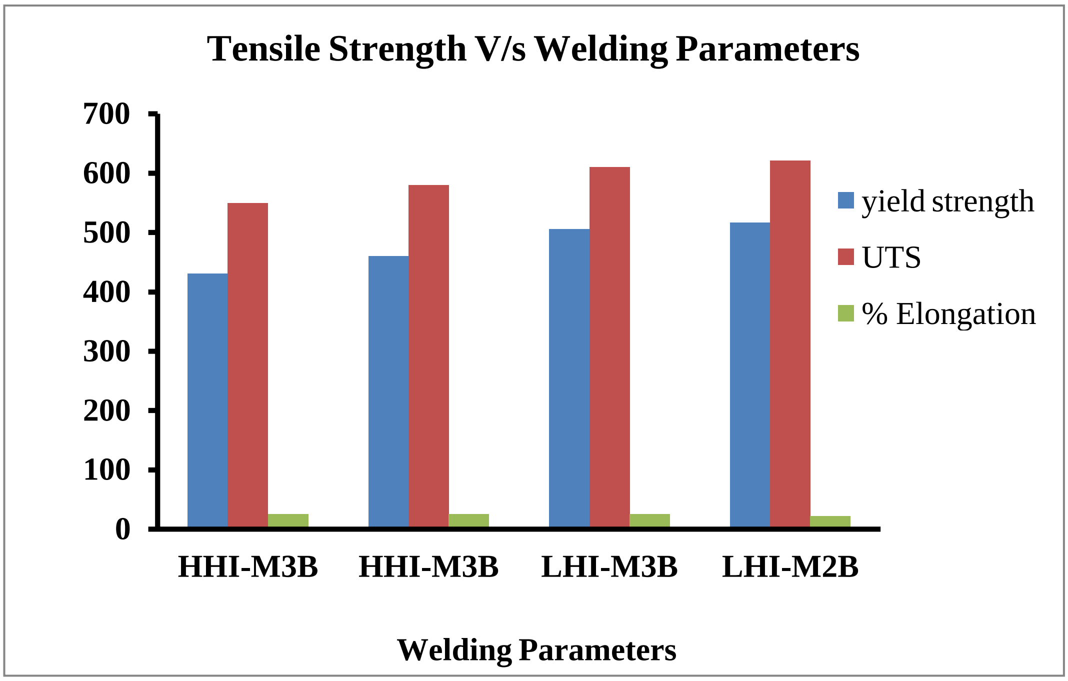


Fig. 5.2: Graph between tensile strength and welding parameters

Highest value of UTS and YS is achieved when specimen with LHI-M2B is tested, 517 and 621 M Pa respectively. However, percentage elongation (EL) is low (22.4%) as compared to M3B (25.4%) keeping heat input constant (1.6kj/mm). In later case value of UTS and YS value is 506 and 610 M Pa respectively. Lowest value of tensile strength from is achieved when HHI-M3B specimen is tested. HHI-M2B has given highest value of EL but could reach 580 M Pa UTS and 460 M Pa Y.S.

3.3 EFFECT ON TEMPER-EMBRITTLEMENT

From each welding joint one specimen has been prepared as discussed in chapter 4. The tolerance of 2 mm V-notch has been checked on profile projector before the impact test. To check the temper-embrittlement properties of weldments impact test has to be carried out at various temperature from room temperature to - 40^0C. This minus temperature is achieved with the help of solid CO2. The notched specimen has been placed into low temperature environment which is produced by solid CO2 up to 5-10 min. The desired minus temperature is achieved with in close tolerance ± 1^0C. Then it is tested on impact testing machine. The test must not be delayed more than 5 sec, after taken out the specimen from conditioned environment. Charpy test is performed at room temperature 25^0C, 0^0C,-20^0C and -40^0C.

Table5.3 and Fig. 5.3 illustrate the variation of impact value with welding parameters.

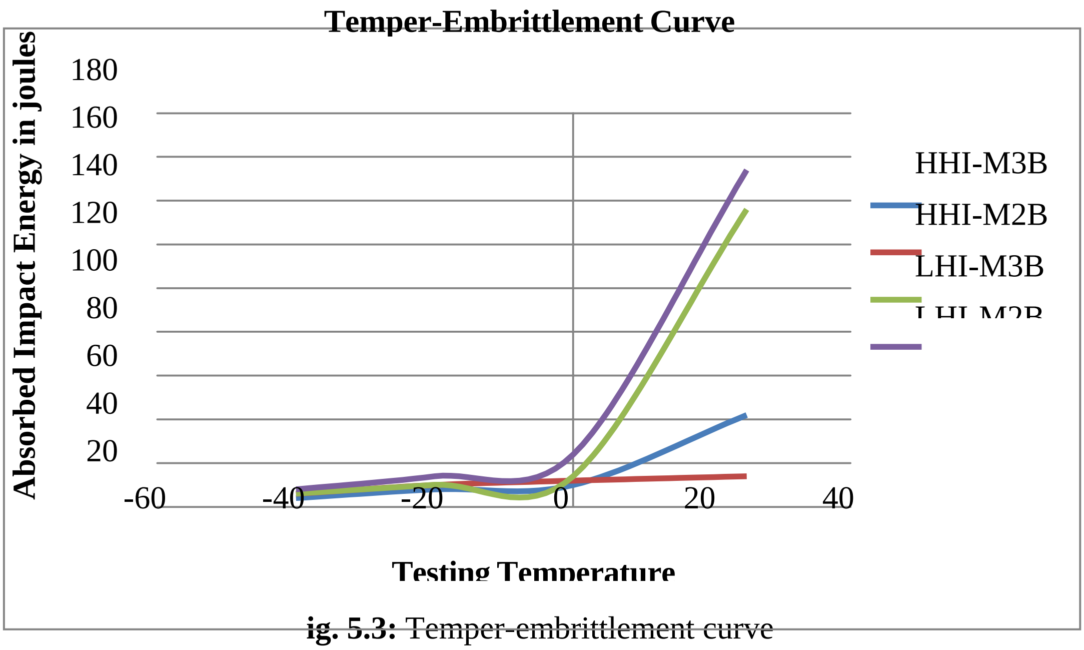
Table5.3: Effect of weld parameters on temper-embrittlement

Sr. No.	Welding Speed (mm/min)	Heat input (kj/mm)	Welding Parameters	Impact Energy (Joules)			
				25^0C (RT)	**0^0C**	**- 20^0C**	**- 40^0C**
1.	81.5	6.8	HHI-M3B	33	8	08	04
2.	82.0	7.8	HHI-M2B	45	10	08	06
3.	271.4	1.6	LHI-M3B	136	24	12	08
4	270.0	1.62	LHI-M2B	158	56	28	16

The scale of impact testing machine shows highest value of impact energy 158 J at room temperature, when a LHI-M2B specimen is tested as shown in Table 5.3. Specimens LHI–M3B, HHI-M2B and HHI-M3B have shown 136, 45 and 33J respectively. However, value of impact energy fall drastically when test tested at 0^0C, –20^0C and lower temperature, means, the metal is transformed from ductile state to brittle state. Maximum effect is analyzed on weldments which are welded with Ar-CO2- O2 blend. Moreover, in spite of low heat input M3B shows nose diving fall in impact value and reaches to 24 J at 0^0C as shown in Fig. 5.3. On the other hand, high heat input results low value of impact energy. In this case also M3B comes on last place with merely 8 J at

0^0C. All specimens show low value of impact at -20^0C and -40^0C it indicates the metal

3 Cr-1Mo is very sensitive to temper-embrittlement.



ig. 5.3: Temper-embrittlement curve

3.4 EFFECT ON MICROSTRUCTURE

Four specimens have been tested with optical microscope as discussed in chapter 4. All specimens should be etched in nital and washed in alcohol before going for examination. The surface image is captured at 100x magnification. A close view of the micro- images help to understand the difference between the structures of different specimens. Fig 5.4 shows the microstructure of specimens.

High heat input specimens have tempered coarse bainite structure. However, microstructure of HHI-M3B specimen is coarser than HHI-M2B. Both structures are in tempered form due to high heat input. In spite of low heat input LHI-M3B specimen showed coarse bainite structure. Reason for this is related with shielding gas. Using Ar-CO2-O2 as a shielding gas, results in coarser micro-structure than Ar- CO2 blend.

3.7 SUMMARY

In this chapter reveals the results of various tests performed on the specimens. The results of tests such as hardness, tensile strength, temper-embrittlement, inclusion and gas absorption have been discussed with the help of tables and graphs.

4. CONCLUSIONS AND FUTURE SCOPE

The following conclusions are derived from the current study:

1. The value of hardness increases with increase in heat input. The welding temperature goes very high in this case and when welding stops, the joint felt quenching effect. This results in high hardness. On the other hand, shielding gas has not much effect on hardness.

2. Tensile strength is much affected by heat input. High heat input results decline in yield strength (YS) and ultimate tensile strength (UTS) values. With low heat input high value of YS and UTS is achieved. Moreover, Ar-CO2 blend shielding gas promotes higher tensile value.

3. Higher warmth input reason temper-embrittlement. In administration life, material face temper-embrittlement after an extensive stretch of time however because of high warmth input temper-embrittlement happens amid welding itself, which drop down its effect an incentive at room temperature just as at low temperature, for example, - 200C and - 400C.

4. The microstructure of weld joints is pure bainite, there, is not any intermixing with other structures. Bainite turn out to be coarser as heat increases. Ar-CO2-O2 blend promotes oxide formation that further makes structure coarse. Also high heat input cause tempering during welding. Fine bainite came out when heat input is kept low.

5. Inclusion formation is not much effect by heat input. It is affected by shielding gas only. Sulfide, alumina and silicate are found in thin form only. Tendency of oxide formation is higher when welding with triple mixer blend (Ar-CO2-O2) of shielding gas.

6. High amount of oxygen and nitrogen is entrapped in weldmetals, when Ar-CO2-O2

blend of shielding gas is used. High heat input also promotes gas absorption. However, amount of hydrogen absorbed is negligible in all the cases.

To sum up, as heat input increases, hardness increases and tensile strength increases also impact strength fall drastically. Also, microstructure gets coarser but not much effect on inclusion is analyzed. On the other hand, welding with low heat input, results in high tensile strength, high impact value and fine bainite microstructure. Ar-CO2-O2 blend of shielding gas promotes oxide formation and absorption. Welding with low heat input and using Ar-CO2 as shielding gas promotes high quality welding.

FUTURE SCOPE

There is lot of future scope for arc welding researches. During this research onlytwo parameters are investigated only for five properties. Similarly other parameters such as change in polarity, cooling time, inter-pass temperature, blends of shielding gases can be investigated for similar properties or for other properties such as corrosion resistance, grain size etc. The effect of the process parameters can be investigated in other welding processes and other base metals such as 5 Cr-1Mo steel, 9 Cr-1Mo steel, stainless steels, manganese steel etc.

The present study may also be extended on the following point:

- To study the specimen under scanning electron microscope and X- ray diffractionmicroscope for indepth study of fractography.
- To study effect of welding parameters on hydrogen embrittlement properties.

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