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Improvement of Welding Penetration in MIG Welding

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ABSTRACT

This investigation is to review the technique of using ACTIVATED FLUX for optimum penetration & hardness of MIG welding. Two kind of fluxes, Al2O3 and Fe2O3 used on a mild steel plates of 50mm x 50mm square and 8 mm thick. The fluxes used were packed in powered form & applied through a thin layer of flux. The experimental results indicates that the Activated metal inert gas (Activated MIG) welding penetration and welding hardness increased compared to normal Metal insert gas (MIG) welding also known as Gas Metal Arch Welding (GMAW).

Keywords: MIG welding, plain carbon steel IS2062, Al2O3 and Fe2O3 chemicals.

I. INTRODUCTION

A.Welding

Welding is a metallurgical fusion process, where parts to be joined are brought together such that heating and solidification results into permanent joint. It is used in every large or small industry. It is a principal means of fabricating and repairing metal products. The process is efficient, economical and dependable as a means of joining metals. The process finds its application in air, underwater and space. Why welding is used – Because it is,

1) Suitable for thickness ranging from fractions of a millimetre to a third of meter.
2) Versatile, being applicable to a wide component shapes and sizes.

As per American Welding Society (AWS) It is defined weld as a localized coalescence of metals or non-metals produced either by heating the material to suitable temperatures with or without the application of pressure alone and with or without the use of filler material. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

B. Metal inert gas welding

MIG (Metal Inert Gas) welding, also known as MAG (Metal Active Gas) and in the USA as GMAW (Gas Metal Arc Welding), is a welding process that is now widely used for welding a variety of materials, ferrous and non-ferrous. In gas shielded arc welding both the arc and the molten weld pool are shielded from the atmosphere by a stream of gas. The arc may be produced between a continuously feed wire and the work.

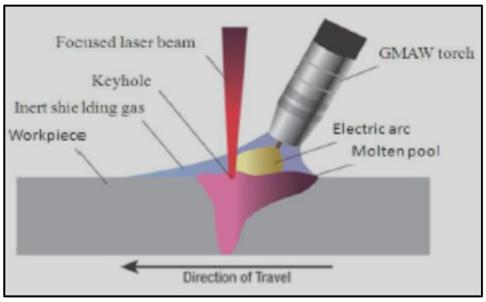

Figure 1. Schematic diagram of MIG Welding Process

The shielding gas can be both inert gas like argon and active gases like argon-oxygen mixture and carbon-di-oxide which are chemically reactive. It can be used on nearly all metals including carbon steel, stainless steel, alloy steel and aluminium.

Arc travel speed is typically 30-38 cm/minute and weld metal deposition rate varies from 1.25 kg/hr when welding out of position to 5.5 kg/hr in flat position. Metal transfer across the arc, is short circuiting transfer, globular transfer, spray transfer, pulsed spray transfer.

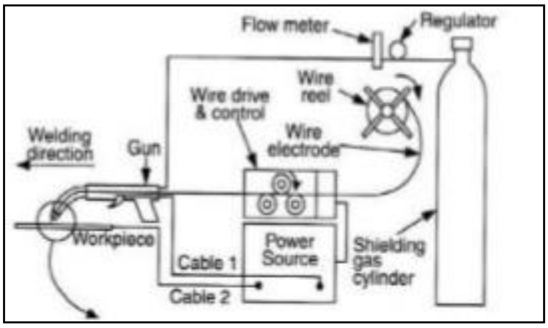

Figure 2. Schematic diagram of MIG welding Equipment Arrangement

The made of weld metal transfer is determined by the following welding current, electrode size, electrode composition, electrode stick out, shielding gas. Joint type in MIG welding, the most commonly used joint type are the butt joint, corner joint, edge joint, lap joint and T-joint. Here, in MIG the arc is maintained between a consumable electrode and the work piece in an inert gas atmosphere. MIG welding gives much greater penetration and higher speeds. It is fast and more economical efficiency then TIG (Tungsten Inert Gas) Welding.

C. GMAW / MIG welding applications

MIG may be operated in semiautomatic, machine, or automatic modes. All commercially important applicable metals such as carbon steel, high-strength, low-alloy steel, and stainless steel, aluminium, copper, titanium, and nickel alloys can be welded in all positions with this process by choosing the appropriate shielding gas, electrode, and welding variables.

D. Process parameter selection

The welding parameters are selected by operator based on experience or from a handbook. However, this does not ensure that the selected welding process parameters can produce the optimal or near optimal weld pool geometry for that particular welding machine and environment.

II. MATERIAL SELECTION

Mild Steel - The chemical composition and properties of the material are as follows: -

Physical Properties

1 Hardness in HRB - 90-91 [210 HV]

2 Tensile Strength - 649.66 N/mm2

3 Yield Strength - 540.88 N/mm2

4 Percentage Elongation - 11.79

5 The tests were conducted on metal strip of 50mm x 50mm square and 8 mm thickness sample.

Application areas in the field of welding

The tank and vessel industry consisting of boilers, pressure vessels, other storage tankers. This material is easily available and easily wieldable makes it suitable for the use of many more applications related to welding.

Chemical Composition Table-

TABLE 1

Sr. No.	Name of Constituent	Percentage %
1	Carbon	0.20
2	Nickel	0.01
3	Phosphorous	0.035
4	Manganese	0.65
5	Molybdenum	0.002
6	Silicon	0.23
7	Chromium	0.02
8	Sulphur	0.026

Material Selection

1. ASTM (A36) IS2062 Carbon steel
2. Also known as Plain carbon steel
3. Material contain carbon 0.05 to 025%
4. It is malleable in nature
5. It is also ductile in nature

6. It is having good weld ability
7. It is used in high pressure vessel and boilers
8. It is also used for manufacturing various machine parts
9. It has low tensile strength
10. It is having high fracture toughness
11. It is having melting point 1300^0C to 1400^0C
12. Density of material is7.85g/cm2
13. Young's modulus 200 GPA
14. Elements, such as niobium, vanadium and titanium added singly or in combination to obtain higher strength to weight ratio combined with better toughness, formability and weld ability as compared to unalloyed steel of similar strength level.

WELDING PARAMETERS

Variable

• Current- recommended 150A (results taken at 100A, 125A, 150A)

• Arc voltage- recommended 25V (results observed at 20V, 25V, 30V)

Gas flow
rate- 14L/min(results observed at 12L/min, 14L/min, 16L/min)

• Surface active elements/flux (Fe_2O_3 & Al_2O_3)

Fixed

- ✓ Filler wire diameter – 0.8 mm
- ✓ Wire speed-5m/min
- ✓ Welding speed-20cm/min
- ✓ Filler wire-ER70S

TABLE 2

Input Parameter	Range
Current	100-150A
Voltage	20-30V
Gas flow rate	12-16 lit/min

ACTIVATED FLUX

Figure 3. Flux and acetone liquid

- Inorganic powder suspended in organic solvent.
- Other flux material contains oxides and halides (chlorides and fluorides).
- Any compound which liberates either Oxygen or Sulphur in weld puddle can be treated as activating flux.
- 150-200ppm oxygen in molten weld puddle acts as surface active element and reduces the surface tension.
- Electron affinity elements such as halides used as flux increases the heat density by arc constriction.
- Combined effect of arc constriction and ad reverse flow yields high penetration.

III. EXPERIMENTAL PROCEDURE

The activated fluxes was mixed using acetone to form a sort of paste. Now apply the activated flux paste onto the workpiece before welding.

Wait for evaporation of acetone on workpiece. After evaporation there will be a layer of the flux adhering to the surface of the material where welding to be done. Ensure that the flux applied is constant over the surface of the weld.

Figure 4. The application of flux

Step 1: The base material is first cut as per required sizes of 50mm X 50mm X 8mm through a bench cutter.

Step 2: Using grinder on bench, the burr is removed from the workpiece to obtain smooth contact surface.

Figure 5. Application of flux between two plates to be welded

Step 3: For obtaining highly smooth contact surface, the surface are then buffed through buffing wheel.

Step 4: The next step is to apply acetone over the surface to remove dirt & dust particles over the surface.

Step 5: Now for welding, the plates are placed adjacent to each other and the welding portion is once again cleaned using acetone mixture.

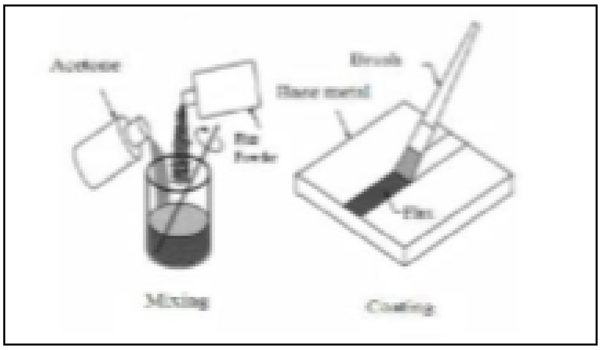

Fig.6: Method of applying flux

Step 6: Mixture of activated flux Fe2O3 with acetone and activated flux AL2O3 with acetone is prepared and ensured that the mixture is uniform and the same time should be in position that it can be easily applied over the two surfaces.

Step 7: Now with the help of brush the mixture is applied over the surface and the sufficient time was provided for evaporation of acetone otherwise, if the welding is started soon after application there is possibility of catching fire as acetone is highly flammable.

Step 8: Hence after 5 minutes of application of flux, the welding is done for joining the parts.

IV. RESULT AND ANALYSIS

The following inputs were provided during welding experimentation on the specimens by using Fe2O3 and Al2O3 flux which were used the welding:+

TABLE 3

Sr. No.	Welding Current Ampere I	Welding Voltage Volt V	Gas flow rate Lit/min L	Without flux D	Flux 1 Fe_2O_3 E	Flux 2 Al2O3 F
1	150	20	16	0.2233	0.4107	1.1268
2	150	25	12	0.4445	0.6768	1.0458
3	150	30	14	0.4663	0.9927	1.0354

Table 4

Without Flux D	
D7	Penetration –0.2233 Hardness Base Metal-198 At HAZ area-292
D8	Penetration –0.4445 Hardness Base Metal-195 At HAZ area-312
D9	Penetration –0.4663 Hardnes Base Metal-195 At HAZ area-343

Table 5

Flux Fe_2O_3 E	
E7	Penetration –0.4107 Hardness Base Metal-184 At HAZ area-336
E8	Penetration –0.6768 Hardness Base Metal-198 At HAZ area-310
E9	Penetration –0.9927 Hardness Base Metal-198 At HAZ area-328

TABLE 6

Flux Al_2O_3 F	
F7	Penetration –1.1268 Hardness Base Metal-178 At HAZ area-295
F8	Penetration –1.0458 Hardness Base Metal-212 At HAZ area-278
F9	Penetration –1.0354 Hardness Base Metal-184 At HAZ area-328

V. CONCLUDING REMARKS

This study discusses the effect of best process parameters and activated flux on the material IS2062 at 8 mm thickness. Selection of process parameters is on basses of literature review and economical suitability of industrial application.

1. Activating flux is most effective for MIG welding to increase welding penetration as well as weld strength.
2. The fluxes Fe2O3 and AL2O3 not only increased the welding area and weld penetration but also improved the tensile strength and hardness of the MIG joint.
3. The optimum parameter for penetration is obtained at Welding voltage 20V, Welding current 150 Ampere and gas flow rate 16 Lit/Min.

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