A Study of MIG Welding & Stainless Steel Alloy 202

Bhuvan Bahrdwaj[l] Ravinder Singh[2] Rajdeep Singh[3]
[1]M.Tech. Research Scholar [2]Assistant Professor [3]Professor & Head of Department
[1,2,3]Department of Mechanical Engineering
[1,2,3]Chandigarh Engineering College, Landran, Punjab, India

Abstract— Welding is a manufacturing process of creating a permanent joint obtained by the fusion of the surface of the parts to be joined together, with or without the application of pressure and a filler material. For the jointing of different materials like alloys or plastics, metal in permanent joining process with the application of heat and/or pressure is called welding. During welding at the interface, the work-pieces to be joined are melted and a permanent joint can be achieved after solidification. To form a weld pool of molten material sometimes a filler material is added, between the materials after solidification which gives a strong bond. On different factors like the metallurgical changes, the weld ability of a material depends that occur during welding, due to rapid solidification changes in hardness in weld zone, with tendency of crack formation and atmospheric oxygen in the joint position there is extent of oxidation due to reaction of materials. In this paper we will study the MIG welding and its Equipments and the Stainless Steel Alloy 202 on which in future we will conducts some experiments and discuss the result in our future publication.

Key words: MIG Welding Machine, Stainless Steel Alloy-202, ER-1100, Hardness, Tensile Strength

I. METAL INERT GAS WELDING (MIG)

Metal inert gas arc welding (MIG) or more appropriately called as gas metal arc welding (GMAW) utilizes a consumable electrode and hence, the term metal appears in the title. There are other gas shielded arc welding processes utilizing the consumable electrodes, such as flux cored arc welding (FCAW) all of which can be termed under MIG. Though gas tungsten arc welding (GTAW) can be used to weld all types of metals, it is more suitable for thin sheets. When thicker sheets are to be welded, the filler metal requirement makes GTAW difficult to use. In this situation, the GMAW comes handy. The schematic diagram of GMAW or MIG welding process is shown in Figure 1. The consumable electrode is in the form of a wire reel which is fed at a constant rate, through the feed rollers.

The welding torch is connected to the gas supply cylinder which provides the necessary inert gas. The electrode and the work-piece are connected to the welding power supply. The power supplies are always of the constant voltage type only. The current from the welding machine is changed by the rate of feeding of the electrode wire. Normally DC arc welding machines are used for GMAW with electrode positive (DCRP). The DCRP increases the metal deposition rate and also provides for a stable arc and smooth electrode metal transfer. With DCSP, the arc becomes highly unstable and also results in a large spatter. But special electrodes having calcium and titanium oxide mixtures as coatings are found to be good for welding steel with DCSP. In the GMAW process, the filler metal is transferred from the electrode to the joint. Depending on the current and voltage used for a given electrode, the metal transfer is done in different ways.

II. EQUIPMENTS OF MIG WELDING

A. Power Source

MIG welding is carried out on DC electrode (welding wire) positive polarity (DCEP). However DCEN is used (for higher burn off rate) with certain self-shielding and gas shield cored wires. DC output power sources are of a transformer-rectifier design, with a flat characteristic (constant voltage power source).

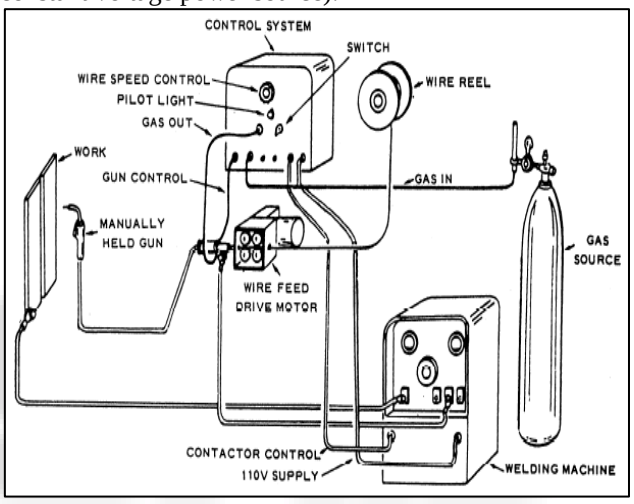

Fig. 1.1: Metal Inert Gas Welding (MIG)

The most common type of power source used for this process is the switched primary transformer rectifier with constant voltage characteristics from both 3-phase 415V and 1- phase 240V input supplies. The output of direct current after full wave rectification from a 3-phase machine is very smooth. To obtain smooth output after full wave rectification with a 1- phase machine, a large capacitor bank across the output is required.

B. Wire-Feed Unit

The wire-feed unit, or sub-assembly where this is mounted in the power source cabinet (known as a composite MIG), provides the controlled supply of welding wire to the point to be welded. According to the welding wire size and Arc voltage provided by the power source, a constant rate of wire speed is required, in MIG welding the power source provides Arc voltage control and the wire feed unit provides welding wire speed control, in MIG this equates to welding current. Most modern wire feed units control the wire feed speed via a DC motor and thyristor control PCB to provide continuous control of Armature volts and hence RPM of motor. The wire feed motor spindle has a feed roller fitted and another pressure roll, adjustable spring mounted to lightly grip the wire and push it up the length of the MIG torch.

C. MIG Torch

This provides the method of delivery from the wire feed unit to the point at which welding is required. The MIG torch can be air cooled or water cooled and most modern air cooled torches have a single cable in which the welding wire slides through a Liner. Gas flows around the outside of this Liner and around the tube the Liner sits in is the power braid and trigger wires. The outer insulation provides a flexible cover. Water cooled MIG torches are similar to the above, but gas hose, liner tube, power lead (including water return pipe), water flow pipe and trigger wires are all separate in an outer sleeve. Most industrial MIG equipment uses a standard European MIG torch connector for easy connection of torch, some low cost smaller units use individual manufacturers fittings. The important areas of maintenance are: Liners are in good condition and correct type and size; Contact tips are lightly fitted, of correct size and good condition.

D. Shielding Gas

This is a complicated area with many various mixtures available, but the primary purpose of the shielding gas in the MIG process is to protect the molten weld metal and heat affected zone from oxidation and other contamination by the atmosphere. The shielding gas should also have a pronounced effect on the following aspects of the welding operation and the resultant weld. Arc Characteristics, Mode of Metal Transfer, Penetration and Weld Head Profile, Speed of Welding, Undercutting Tendency, Cleaning Action, Weld Metal Mechanical Properties. The gases for different material are, Aluminum - Argon, Magnesium – Helium, Copper Alloys: Argon - Helium Mix Steel: CO2 not commonly used today, Ar-CO2 mix is preferred

III. Advantages & Applications

A. Advantages of MIG Welding

1) Welds most metals.
2) Simple technique and very easy to learn and use.
3) Higher deposition, greater speed and a lot more efficient than most other forms of welding.
4) Minimised weld defects.
5) Produces little or no slag.
6) With the correct wire and settings, can be welded out of position.

B. Disadvantages of MIG Welding

1) Sensitivity towards Contaminants.
2) Sensitivity towards Wind.
3) Limited Positions.
4) Lack of Fusion and the equipment is pretty Complex.
5) Portability Problem.
6) Fast Cooling Rates.
7) Time for Metal Preparation.
8) Difficulty in getting into Tight Place

C. Application of MIG Welding

1) Fabrication & Manufacturing

1) Due to increases in speed and efficiency, MIG welding is well suited for Fabrication and Manufacturing.
2) Clean up time is greatly reduced due to little or no slag.

2) Repair & Maintenance

1) Lightweight MIGs can be portable.
2) Welds various types of material.
3) Great for the farming industry with the use of gasless wire which makes it possible to weld outdoors.
4) Single phase domestic power supply MIGs are available.

3) Professionals

1) Panel beaters, body shops, etc
2) Truck repairers.

IV. Metallurgy of a Welded Joint

Metal is heated over the range of temperature up to fusion and followed by cooling ambient temperature. Due to differential heating, the material away from the weld bead will be hot but as the weld bead is approached progressively higher temperatures are obtained, resulting in a complex micro structure. The subsequent heating and cooling results in setting up internal stresses and plastic strain in the weld. Depending upon the slope of temperature gradient three distinct zones as shown in Figure 1.6 can be identified in welded joint which are:

1) Base Metal
2) Heat Affected Zone (HAZ)
3) Weld metal or Fusion zone

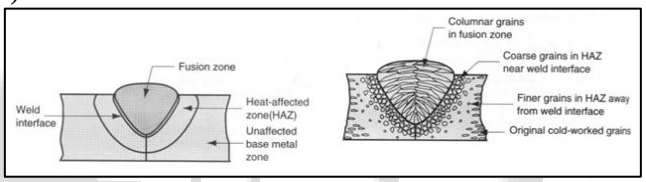

Fig. 1.2: Zones in Welded Joint

A joint produced without a filler metal is called autogenously and its weld zone is composed of re-solidified base metal. A joint made with a filler metal is called weld metal. Weld quality and weld deposition rate both are influenced very much by the various welding parameters and joint geometry. Essentially a welded joint can be produced by various combinations of welding parameters as well as joint geometries. These parameters are the process variables which control the weld deposition rate and weld quality. The weld bead geometry, depth of penetration and overall weld quality depends on the following operating variables.

V. Stainless Steel

The austenitic steel patented in 1912 by engineers Eduard Maurer and Benno Straus currently makes up 70% of the total stainless steel production in the world. Austenitic steel, or 200 and 300 series stainless steel, is steel that has been super-heated to extreme temperatures. This process changes the crystal structure of the steel. While this improves the features of the steel, this process destabilizes the material. So a stabilizing element is required, typically manganese and/or nickel. Stainless steel grade 202 has wide applications in making seamless stainless steel tube for boilers, heat exchangers tubes, super heater tubes, cook wares etc. In arc welding process, due to rapid heating and cooling, the work piece undergoes an uneven expansion and contraction in all directions [2].

This leads to distortion in work piece. Angular distortion or out of plane of distortion is one such defect that makes the work piece distorted in angular directions around the weld interface. Post weld treatment is required to eliminate the distortion so that the work piece is defect free and accepted. Austenitic stainless steel is most commonly used in petrochemical, chemical and power engineering, also in vehicle and aviation industries. [3].Stainless steel is used when both the properties of steel and resistant to corrosion are required. The welding of automotive exhaust gas systems, stainless steel pipes, repairing of chemical industries equipments, etc. are done with the help of gas tungsten inert gas welding (GTAW or commonly known as TIG) [4]. Chrome-manganese austenitic stainless steel grades ("standard 200-series") with well-defined and well-documented technical properties have proved acceptable materials for specific applications for many years. There has recently been a significant increase in the use of new and economical chrome manganese grades (which can be referred to as "new 200-series" grades).

Grade	Chemical Composition (wt %)			
AISI	Cr	Ni	Mn	N
304	18.0 – 20.0	8.0 – 10.5	2.0 max	0.10 max
201	16.0 – 18.0	3.5 – 5.5	5.5 – 7.5	0.25 max
202	17.0 – 19.0	4.0 – 6.0	7.5 – 10.0	0.25 max
205	16.5 – 18.0	1.0 – 1.75	14.0 – 15.5	0.32 – 0.40

Table 1.1: Chemical Composition of Stainless Steel 200-Series Grades

A. Characteristics

- While corrosion resistant, the 200 series has a lower ability than 300 series to protect against pitting corrosion, which occurs in environments that have high moisture and chlorine contents, as well as crevice corrosion, which results in stagnant liquid and high acid environments. This is because, in order to decrease the nickel content, the chromium content must also be reduced, thereby, lowering corrosion resistance.
- Series 200 stainless steels have excellent impact resistance and toughness, even in low (even cryogenic) temperatures. They are generally harder and stronger than 300 series steels, primarily due to their higher nitrogen content, which acts as a strengtheners. Because they are austenitic, both the 200 and 300 series' of stainless steels are not magnetic.
- Although austenitic steels are more expensive than their ferrite counterparts, the 200 series in cheaper to produce than 300 series steels because of their lower nickel content.
- The 200 series, however, suffers from lower formability (ductility) than 300 series grades (although this can be improved with the addition of copper).

B. Applications

Due to its lower corrosion resistance, the range of applications for 200 series stainless steels is narrower than 300 series steels. It is not recommended for use in chemical environments but has found its way into many household items. Some applications for 200 series stainless steel include in:

- Dish Washers and Washing Machines
- Cutlery and Cookware
- In-house Water Tanks
- Indoor and Non-Critical outdoor Architecture
- Food and Beverage equipment
- Automobiles (Structural)
- Automobiles (Decorative)

VI. CONCLUSION

In this paper we discussed about Metal inert gas arc welding (MIG) or more appropriately called as gas metal arc welding (GMAW) utilizes a consumable electrode and hence, the term metal appears in the title. However we also found out that MIG welding is carried out on DC electrode (welding wire) positive polarity (DCEP). However DCEN is used (for higher burn off rate) with certain self shielding and gas shield cored wires. We also discussed about Stainless Steel Alloy 202. The austenitic steel patented in 1912 by engineers Eduard Maurer and Benno Straus currently makes up 70% of the total stainless steel production in the world. In study we found out that due to its lower corrosion resistance, the range of applications for 200 series stainless steels is narrower than 300 series steels. It is not recommended for use in chemical environments but has found its way into many household items.

REFERENCES

[1] Radhakrishnan V.M., "Welding Technology & Design", McGraw Hill, New York (2006).
[2] Velmurugan, V. (2005). Some studies on angular distortion, residual stresses and heat flow of GMAW process. PhD Thesis, Faculty of Mechanical Engineering, Bharathiar University, Coimbatore, India.
[3] Raafal M. Molak, Krystian Paradowski, Measurement of mechanical properties in 316L stainless steel welded joint, Int. J. Pressure vessels an piping, 86 (2009) 43-47.
[4] Lothongkum G, Viyanit E, Bhandhubanyong P. Study on the effects of pulsed TIG welding parameters on delta-ferrite content, shape factor and bead quality in orbital welding
[5] Bharwal S. and Vyas C., International Journal of Advanced Mechanical Engineering. ISSN 2250-3234 Volume 4, Number 6 (2014), pp. 695-700 Weldability Issue of AISI 202 SS (Stainless Steel) Grade with GTAW Process Compared to AISI 304 SS Grade

