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To Study Mechanical behavior by using Variant in Gas Metal Arc Welding

Rishi Dewangan, Naveen Kumar Yadav

Abstract— **The present work deals with the development of a new variant of GMAW process. The new feature in this process is that an additional electrode is fed in the welding arc to melted by the heat of the arc. Thus larger amount of material can be deposited than is possible by conventional welding process. This process will be very suitable for cladding applications. In the present work additional wire of mild steel and stainless steel were fed in the arc produced by (i) SMAW process and (ii) GMAW process. Single layer and multi layers of materials were deposited using this process. Interesting results were obtained in the experiments. The process was successful in controlling the dilutions. Large chucks of stainless steel were seen in the microstructure. It is believed that the weld material deposited by this process will have superior abrasive properties and can be used successfully for cladding applications.**

Index Terms— **GMAW Welding ; dilution**

I. INTRODUCTION

In gas metal arc welding (GMAW) with a constant voltage (CV) power supply, a contact tip in the torch energizes the wire, which is fed towards the work piece at a constant speed. An arc that generates enough heat to fuse both the wire and the work piece is struck between them. The CV power supply allows the welding current to float and, therefore, controls the wire fusion rate and arc length and keeps the process running properly.

In short-circuit GMAW; the wire tip touches the work piece periodically, extinguishing the arc and causing a surge in welding current. During this period, the fused metal is transferred from the electrode to the work piece. The process is relatively unstable and can generate a considerable amount of spatter. Short-circuit welding is still used very often for welding in situations that are different from the down-hand position and to join pieces of small thickness of low carbon steel using shielding gas mixtures rich in carbon dioxide. Despite its successful and increasing use over the last two decades, GMAW tends to be much more influenced by chances in operational variables than other arc welding processes, particularly flux shielded processes such as covered electrode welding (SMAW) and submerged arc welding (SAW). Amongst the several factors that can affect GMAW, one can list the electric welding parameters (current and voltage), electrode stick-out, shielding gas composition, operational conditions of the welding equipment, and several characteristics of the wire, including surface characteristics (presence and type of coating, contamination, roughness ,etc.), geometric characteristics (diameter and localization), mechanical strength, cast and helix.

Rishi Dewangan, Dept. of Mechanical and Automation Engineering, Amity University Rajasthan, Jaipur-303007
Naveen Kumar Yadav, Dept. of Mechanical and Automation Engineering, Amity University Rajasthan, Jaipur-303007

The most frequently used gases or gas mixtures: argon or/and helium in MIG welding and carbon dioxide as well as various mixtures of argon or/and helium with CO_2, O_2, H_2, N_2, NO in MAG welding. These processes allow joining different kinds of steel, aluminium, magnesium, copper and nickel or titanium-based alloys. The transfer mode of the melted metal in the arc depends mainly on nature of the used gas, electrode dimensions and composition, the wire feeding speed and the density of the welding current.

The GMA welding parameters are the most important factors affecting the quality, productivity and cost of welding joint. Weld bead size and shape are important considerations for design and manufacturing engineers in the fabrication industry. In fact, weld geometry directly affects the complexity of weld schedules and thereby the construction and manufacturing costs of steel structures and mechanical devices. Therefore, these parameters affecting the arc and welding bath should be estimated and their changing conditions during process must be known before in order to obtain optimum results; in fact a perfect arc can be achieved when all the parameters are in conformity. These are combined in two groups as first order adjustable and second order adjustable parameters defined before welding process. Former are welding current, arc voltage and welding speed, and later are torch angle, free wire length, nozzle distance, welding direction, position and the flow rate of gas. However, wire electrode diameter and its composition, type of protective gas are the defined parameters before starting welding and cannot be changed during the process. The enough penetration, high heating rate and right welding profile occured the quality of welding joint. These are affected from welding current, arc voltage, welding speed and protective gas parameters. Welding current intensity has the strongest effect on melting capacity, weld seals size and geometry and depth of penetration. It must be well determined in thin parts, because excessive amounts of welding current and a large welding bath cause high penetration depths. In contrast to this, very low welding current causes inadequate penetration and so accumulation of welding metal on base metal. When all parameters are held constant, weld seal area expands with increasing voltage. Relatively low welding speeds cause accumulation of welding metal, large welding bath and so low penetration. The deepest penetration values are obtained in optimum values of welding speed. Air is the most common protective gas used in GMA welding and by mixing with 15–25 wt. % CO_2 gas the depth of penetration and size and geometry of weld seal are reached the desired forms.

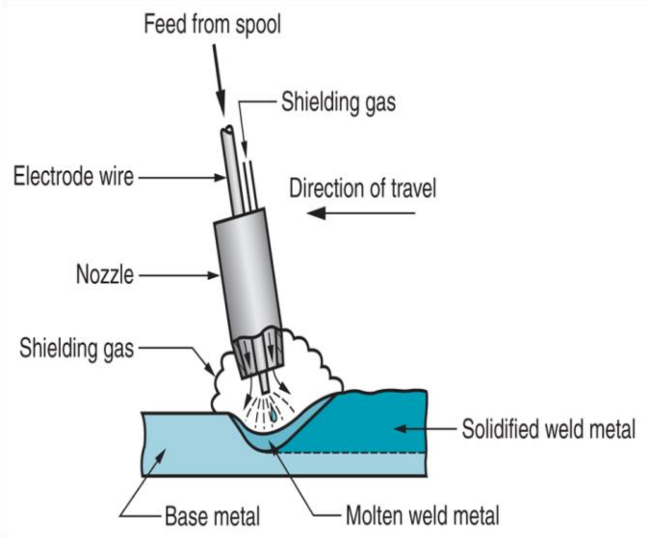

Fig 1:GMAW WELDING PROCESS

II. Experimental Procedure:

The experiment was carried out on thick mild steel plate of size 150x350x6 mm^3. The filler wire (stainless steel) was used as a variant in this study. CO_2 was used as a shielding gas and also constant current power source is used. The distance between the nozzle tips to electrode tip (electrode extension) is maintained as 15 mm. just prior the welding sheet was cleaned with wire brush. The bead on plate welding performed on GMAW process.

After welding process, the specimens were sectioned, polished and etched for structural testing. In the structural process, first we grind all the samples on the grinding belts after grinding of the samples we did the polishing by the emery papers; first we polished the samples on the emery paper of 1000 size. After getting the scratch free surface we polished the samples on 1200 size of emery paper, in this stage we get a more finish or smooth surface. At the end we polished the samples on the 1500 size of emery paper and get a better surface finish and smoothness. Now our samples are prepared for the etching. At last we etched the samples, after etching the areas of different zones can be seen easily. The total dilution area of the weld pool can be seen after etching and then we use these samples for calculating the dilution of weld metal into the base metal.

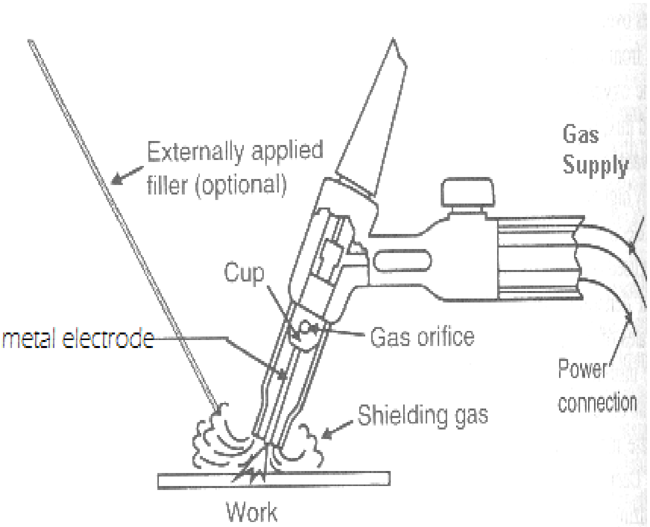

Fig 2:VARIANT IN GMAW PROCESS

TABLE 1: EXPERIMNT RUN VALUES

S. NO.	BASE ELECTRODE	FILLER MATERIAL	CURREN T	WELD SPEED
1	2.5 MM MILD STEEL	1.2 MM STAINLESS STEEL	100 A	20 MM/ MIN
2	3.5 MM MILD STEEL	1.5 MM STAINLESS STEEL	150A	20 MM/ MIN
3	3.5 MM MILD STEEL	1.5 MM MILD STEEL	150A	20 MM/ MIN
4	2.5 MM MILD STEEL	1.2 MM LILD STEEL	100A	20 MM/ MIN
5	3.5 MM MILD STEEL	1.2 MM STAINLESS STEEL	100A	20 MM/ MIN

The welding was performed by ador welding machine with different set of parameter. The photograph of welded position is given below.

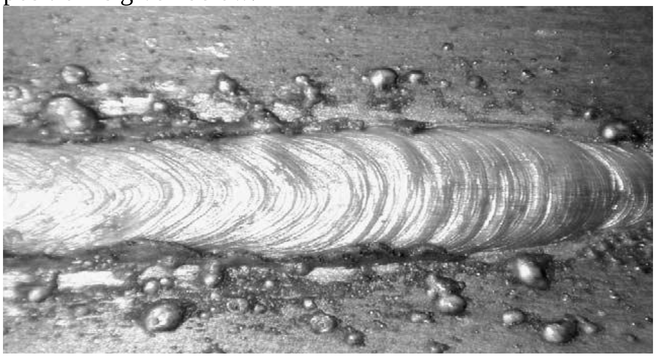

Fig 3: Photograph of the plate position welding experiment

III. Result and Discussion:

3.1 dilution:
Dilution is the percentage of depositing metal into the total weld metal. In the weld bead there is some portion of base metal and some portion of deposited metal. Dilution can be measured by using following Equation-
Filler dilution = (Reinforcement area/Total welding area) X 100 %
where reinforcement area and penetration areas are shown in figure below.
Total area is the summation of these two areas.

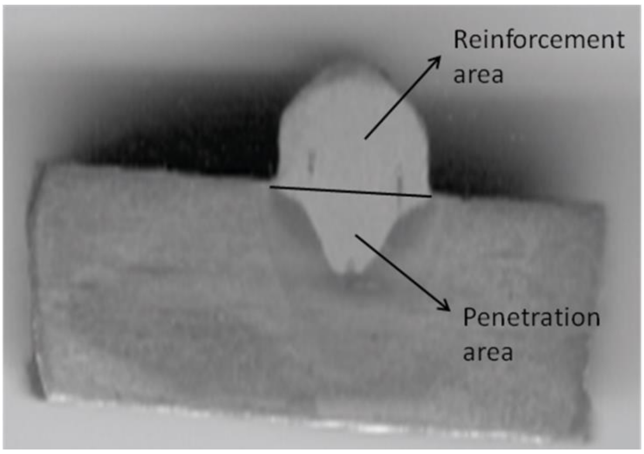

Fig 4- Illustration of reinforcement area and penetration area in GMAW welding

3.1.1.Dilution result

1. for plate 1:
Dilution area of weld bead by using 1.5 mm mild steel filler rod and 3.5 mm mild electrode at 150A current and 20mm\min weld speed is 73.34%.

2. for plate 2
Dilution area of weld bead by using 1.2 mm stainless steel filler rod and 2.5 mm flux coated mild electrode at 100A current and 20mm\min weld speed is 64.33%.

3.2 Microscope result:
The micrograph in different region is typically of what is normally seen fusion welding of mild steel. The micrograph obtains different region whose result is given below:

1. For plate 1:

By the micrograph we seen that metal flowing of mild steel filler in mild steel plate deposited and flowing separately.

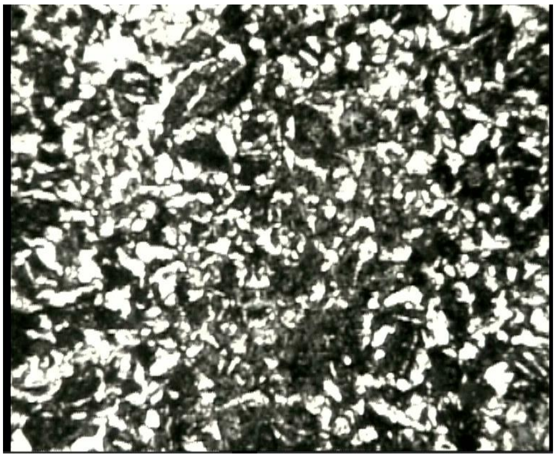

Fig 5: heat affected zone by using mild steel filler and mild steel electrode

Fig6: unaffected zone by using mild steel filler and mild steel electrode

2. For plate 2:

In this weld region we see that some mixing of stainless steel in mild steel occurred, because it may contact with hot mild steel electrode so it can solidify soon as compare with lower region. In this lower region a layer of stainless steel flowing so cladding occur in this region.

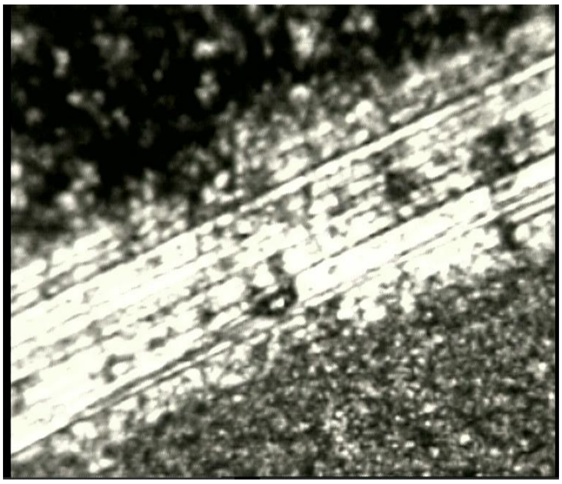

Fig7:weld affected zone by using stainless steel filler and mild steel electrode

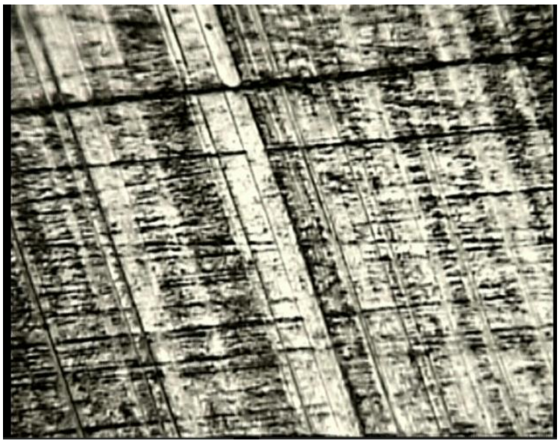

Fig8:un affected zone by using stainless steel filler and mild steel electrode

IV. CONCLUSION:

From the above experiment we obtain some conclusion which is given below:

(i) Variant development was successful and can be used in different application.
(ii) Effective use for controlling dilution.
(iii) Expected that mechanical property of clad layer is expected to be better because large chunks of stainless steel were seen in microstructure.

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