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Some Study Of Submerged Arc Welding – A Review

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Abstract: ***Welding is the process joining two or more similar or dissimilar metal by the application of heat or sometimes pressure. Welding is a fabrication or sculptural process which sole purpose is to join the materials. In current era of technology without welding technique we will reach to a stone age. So welding is one of the most useful fabrication process and it is the backbone of industries like construction industries, railways industries, aircraft industries etc. SAW which is called submerged arc welding process. The main objective of this review paper is to study and understand the various components, equiptments used and the effect of process variables such as welding current, welding speed, electrode, electrode angle etc that direct influences the tensile strength, hardness, bead width, bead reinforcement, depth of penetration etc.***
Keywords: SAW, Welding, Electrode, Hardness, Tensile Strength, Bead Height, Bead Width

I. INTRODUCTION

Submerged Arc Welding was developed in the 1935 by Rothermund and Jones, Kennedy. This welding can be operated as semi-automatic as well as automatic mode. But in general the operation of this welding is performed in automatic mode . Submerged-arc welding method is fixed and extremely adaptable. In this welding process arc is struck between the constantly fed electrode and the workpiece. Flux layer produces protecting gas and slag to protect the weld region. This welding is called Submerged Arc Welding process because the arc can be submerged below the flux layer. In this welding the weld quality is influenced by Submerged Arc Welding processs parameters like welding current, voltage, welding speed, electrode stick out which are closely related to the calculation of weld bead.

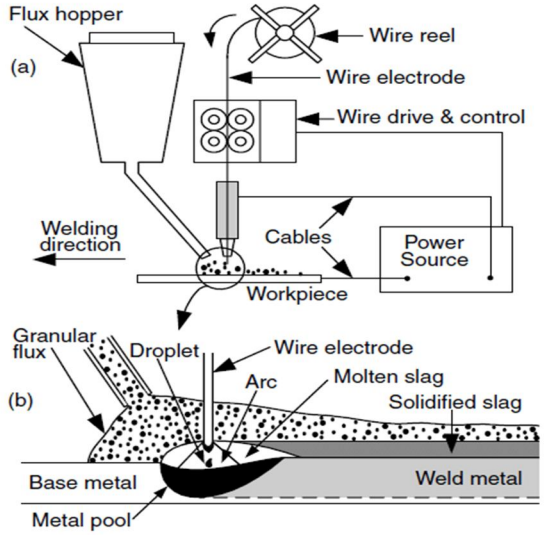

Figure. 1 Diagram Of Submerged Arc Welding Equiptment[13]

A. Working of Submerged Arc Welding

Submerged Arc Welding (SAW) in which the arc is struck between the continuously fed wire and the workpiece. Fluxes are deposit on the joint which is to be welded. In some condition flux act as an insulator. When the arc is struck and due to the heat generated by the arc the flux get soft. After melting of flux then it become highly conductive. Powdered flux blanket creates the protective gas shield and a slag for the weldment. Fluxes are used in place of shielding gas. With the help of the self- adjusting arc principle, then the length of the arc is kept stable. As the arc length reduces, then the arc voltage is increases and this will result in increase of arc current. For better root penetration backing strips are required.

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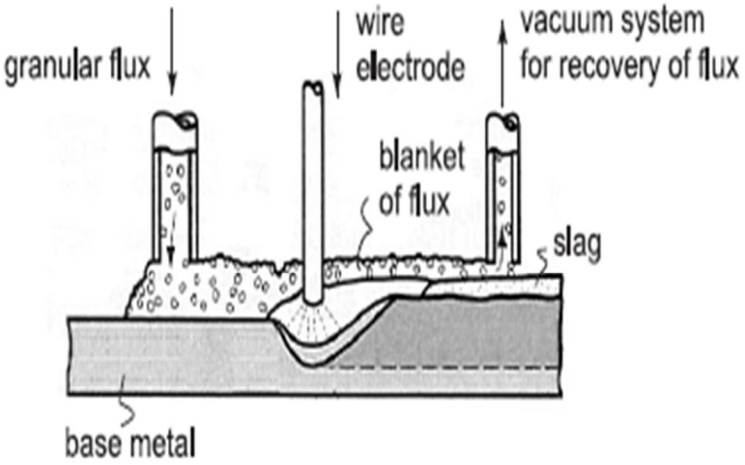

Submerged arc welding operation.

Figure.2 Working Principle Of SAW[12]

B. Equipment's Used in SAW

1) Welding Machine
2) Cable
3) Flux Hopper
4) Granular Flux
5) Electrode Wire Feed Unit
6) Electrode
7) Flux Recovery Unit
8) Wire Spool

C. SAW Process Variables

1) Wire Feed Speed
2) Arc Voltage
3) Travel Speed
4) Electrode Stick Out (ESO) or Contact Tip To Work (CTTW)
5) Polarity and current type (AC or DC)

D. Types Of Flux Used In SAW

1) Fused Fluxe
2) Agglomerated Fluxes
3) Fused Fluxes
4) Mechanically Mixed Fluxes

E. Function Of Flux In SAW

1) To assist arc striking and stability.
2) To form slag that will protect and shape the weld bead.
3) To form a gas shield to protect the molten filler metal being projected across the arc gap.
4) Reduces the fumes and spatter.
5) Provide de-oxidants.
6) To deoxidise the weld pool.
7) In some circumstances, to provide additional alloying elements into the weld pool.

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F. Submerged Arc Welding Methods

1) *Single Wire:* Single wire welding is the most widely used SAW method. DC power source is used. The solid or cored wires of the diameter 2.0-4.0 mm are used. A small diameter produces a higher deposition at the same rate.
2) *Twin Wire:* For twin wire welding, two wires are connected to the same power source. DC power source is used. It offers upto 30% higher deposition rates and can be used at higher currents and speeds. Very high welding speed can be achieved in fillet welding.
3) *Tandem:* In tandem sub-arc welding each of the two wires is connected to its own proper source and fed simultaneously by its own feed unit. Both AC and DC source can be used. The wires are normally large diameter (3.0-5.0 mm) and deposition rates are about twice that of single wire welding.
4) *Tandem Twin:* The ESAB tandem- twin process involves two twin wire heads placed in sequence. Both AC and DC source can be used. With the use of 4x2.5 mm diameter, wires deposition rates up to 38kg/h can be achieved.
5) *Multi Wire:* Up to six wires can be used together, each with their own power source. The lead wire is usually DC+ polarity with the trailing wires being AC. Speeds of up to 2.5m/min can be achieved giving a deposition rate of 90kg/h. This technique is particularly suitable for longitudinal pipe welding.

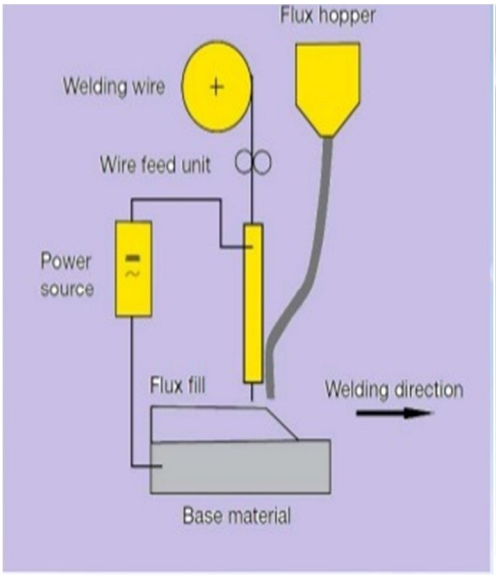

Figure.3.1 Single Wire

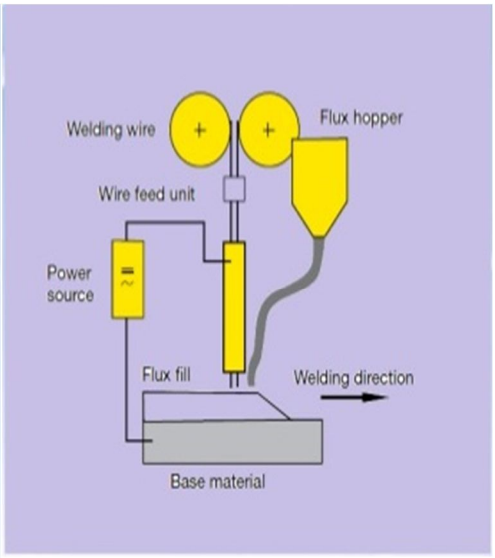

Figure.3.2 Tandem Wire

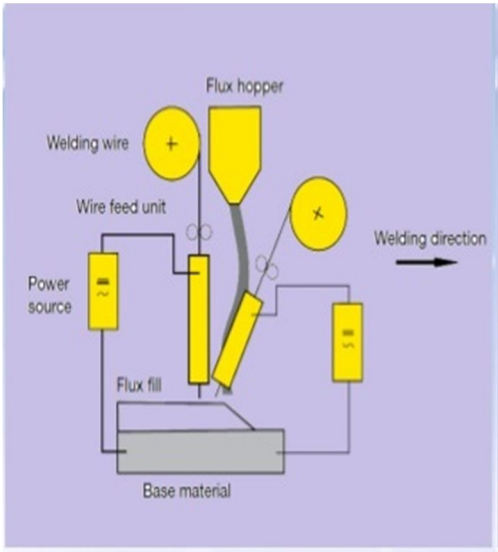

Figure.3.3 Tandem

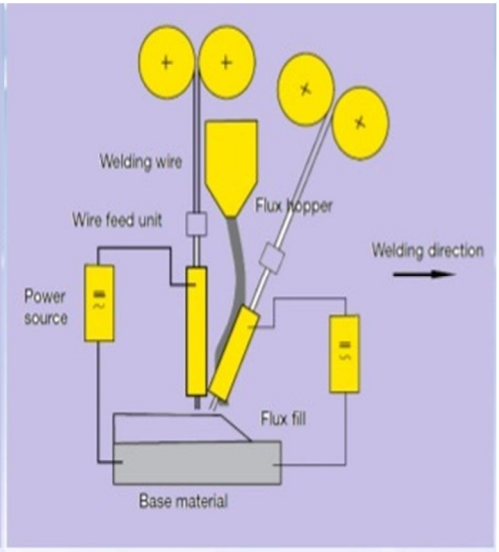

Figure.3.4 Tandem Twin

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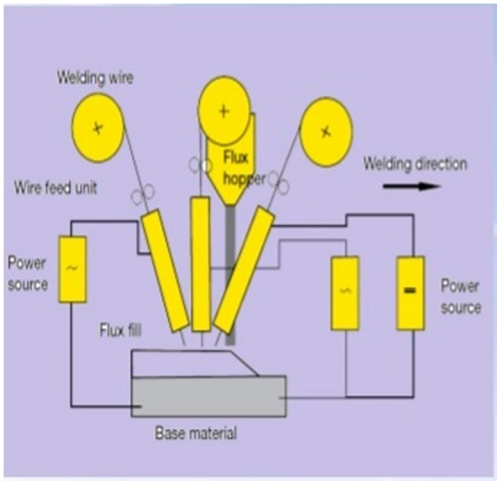

Figure.3.5 Multi Wire

G. Methods that are used to back up the welds in SAW

1) *Backing Strips:* The weld penetrates into and fuse with backing strip, which temporarily or permanently becomes an integralpart of the weldment. The backing strip metal should be such that it does not contaminate the weld metal.

2) *Backing Weld:* One of the two layer of the weld metal are applied on the underside of the seam to support weld metal that will be deposited from the opposite side.

3) *Copper Backing:* Bar grooved or ungrooved, straight or circular is used to support molten weld pool.Such a bar does not fuse and become a permanent part of the weld. Chopper chills molten metal rapidly.

4) *Flux Backing:* For welding on a flux backing a bed of flux is held up to the underside of the workpiece either by rubber hose, at a pressure of about 4 atmosphere, or by the weight of the plate when welding a heavy plate. In welding of thin plates, however, use is made of a flux backing with electromagnetic retainers.

H. Advantages Of SAW

1) Desposition rate is high.
2) Process csn be easily mechanized.
3) Deeper penetration can be easily achieved.
4) Sound welds are produced.
5) Welding of thin steels is very high.
6) Less fume is produced during welding.
7) Edge preparation is not required.
8) Process is suitable for both outdoor and indoor work.
9) No chances of spatter of weld.
10) About 50% flux is recycled, recovered and reused.

I. Disadvantage Of SAW

1) Limited to ferrous and some nickle based alloys.
2) Suitable for 1F, 1G and 2G positions.
3) Limited to thick material.
4) During welding, flux hinder in the view of the welding joint.
5) Flux is subjected to contamination porosity.
6) Required flux handling equiptment.
7) Slag removal take place at regular interval.
8) For proper root penetration backing strips are necessary.
9) Flux and slag residue can present a health and safety concern.

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J. Application Of SAW

1) Used to build up parts and overlays with stainless or wear resistant steels.
2) Manufacturing of ships, heavy structural components of bridges.
3) It is widely used for the repairing of machine parts by depositing cladding and hard-facing beads.
4) Fabrication of pipes, penstocks, pressure vessels, boilers, railroad, structure of railway coaches and locomotives.
5) Automobile, Aviation and nuclear industry.
6) For welding mild steels, medium &high tensile low alloy steels it is most commonly used.
7) Fabrication of pipes.
8) Bridge girders.

Figure.4.1 Welding Of Cylinder

Figure.4.2 Welding Of Pipe

II. LITERATURE REVIEW

A.Bhattacharya et al [1] performed Experimental Investigation for Multi-Response Optimization of Bead Geometry in Submerged Arc Welding using Grey Analysis and concluded that with the use of Taguchi's Orthagonal Array and grey relational analysis to optimize the multiple response like depth of penetration, bead height and bead width in submerged arc welding process.

Sandeep Kumar et al [2] performed Optimization of Submerged Arc Welding Parameters for Joining Disimilar Materials Using Taguchi Method and the author concluded that the decrease in the welding speed, decrease in welding current and the increase in welding speed up to limit will result in decrease in weld bead width. At last the author analyzed that the voltage is most important factor that affect hardness of the weld bead.

M. Sailender et al [3] performed Parametric Design for Purged Submerged Arc Weld Strength Low Carbon Steel and the author concluded that the most significant parameter in case of impact energy is the open circuit voltage and wire feed rate.

A. Sarkar et al [4] performed Optimization of Welding Parameters of Submerged Arc Welding Using Analytical Hierarchy Process (AHP) Based on Taguchi Technique and the author concluded that to optimized the welding process of SAW in different welding parameters by using AHP which is based on Taguchi method , to minimize the uncertainity involved in it for maximizing depth of penetration and minimizing the bead width.

S. Ajay Biswas et al [5] performed Application of Vikor Based Taguchi Method For Multi-Response Optimization: A Case Study In Sumbmerged Arc Welding (SAW) and the author concluded that by using VIKOR based Taguchi method the four bead geometry features like depth of penetration , reinforcement, bead width and dilution has been optimized.

Pranesh B. Bamankar et al [6] performed Study of the Effect of Process Parameters on Depth of Penetration and Bead Width in SAW Process and the author concluded that the with the increase of current the depth of penetration is increases and the bead width linearly increases with arc voltage and current and decreases with welding speed.

Ankita Singh et al [7] performed Optimization Of Bead Geometry Of Submerged Arc Weld Using Fuzzy Based Desirability Function Approach and the author developed a fuzzy based model by using three input variables and one output variable.

J. Deb Barma et al [8] performed Process Parametric Of Optimization Of Submerged Arc Weldingd By Using Utility Based Taguchi Concept and the author concluded that for evaluating the optimum parameter setting taguchi method was efficient.

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Rati Saluja et al [9] performed Modeling And Parametric Optimization Using Factorial Design Approach Of Submerged Arc Bead Geometry For Butt Joint and the author concluded that welding current and arc voltage has considerable factors that affect the bead width while electode stick out and welding speed has minor effect on bead width.

Md. Ismail et al [10] performed Parametric Optimization Of submerged Arc Welding Using L9 Orthogonal Array and the author concluded that the effect of weld current, welding speed and type of flux play a significant role on submerged arc welding in terms of deposition.

III. CONCLUSIONS

This paper give an idea to perform Submerged Arc Welding (SAW) process and from the literature review it is found that various work has been already done on the Submerged Arc Welding (SAW) to study and the optimization of the bead width, bead height, hardness, reinforcement, depth of penetration etc by varying welding process variables like welding current, arc speed, welding speed, electrode stick out etc. This process is widely used for industrial purpose due to easy applicability, high current density , high deposition rate by using more than one wire at the same time.

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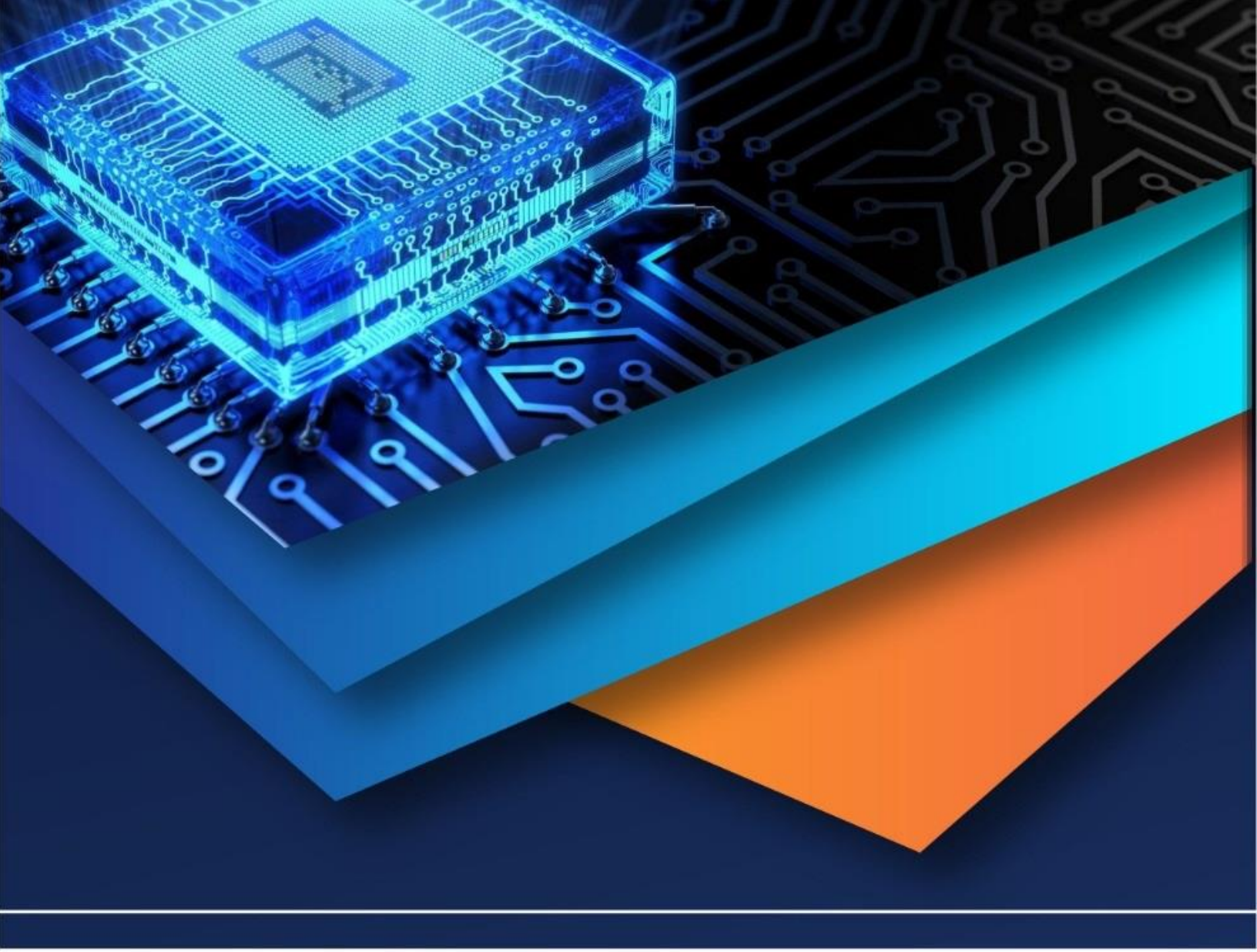

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