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OPTIMIZATION OF SUBMERGED ARC WELDING PARAMETERS FOR JOINING DISSIMILAR MATERIALS: A REVIEW

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ABSTRACT
The main objective of this review paper is optimizing various submerged arc welding parameters including arc voltage, welding current and welding speed for weld bead width and weld bead hardness. Submerged arc welding process is very important component in many industrial organizations. The research on factors controlling weld bead profile in SAW process is essential to high quality welding procedures. Quality is very important element in today's manufacturing world. SAW can be employed for an extremely wide range of work pieces. The method is suitable for butt welding and fillet welding of such applications as structural members in ships, manufacture of pressure vessels, bridge beams, thin sheet shells and so on.

Keywords
Submerged Arc Welding, Butt Welding, Fillet welding, Welding Parameters.

1. INTRODUCTION
Submerged arc welding process is very important component in many industrial organizations. The research on factors controlling weld bead profile in Submerged Arc Welding process is essential to high quality welding procedures. The submerged arc welding parameters are the most important factors affecting quality, productivity and cost of welding joint. Weld bead shape, size and hardness are important considerations for design and manufacturing engineers in fabrication industry. In fact weld geometry directly affects the complexity of weld schedules and thereby the manufacturing costs of steel structures and mechanical devices. Therefore, these parameters affecting the weld bead geometry and hardness 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. The various parameters like welding current, arc voltage, welding speed, type of current, torch angle and the electrode stick out are affecting the weld quality and hardness. SAW can be employed for an extremely wide range of work pieces. The method is suitable for butt welding and fillet welding of such applications as structural members in ships, manufacture of pressure vessels, bridge beams, thin sheet shells and so on. In particularly effective for cladding applications, e.g. when surfacing mild carbon steel with stainless steel materials, or when depositing hard materials on a softer material.

1.1 Control Parameters

1.1.1 Arc Voltage
Arc voltage means the electrical potential difference between the electrode wire tip and the surfaces of the molten weld puddle. Arc voltage is decisive in determining the shape and width of the arc and, to some degree, also in determining its penetration. Too high an arc voltage will produce a wider weld.

1.1.2 Welding Current
It controls the melting rate of the electrode and thereby the weld deposition rate. It also controls the bead width and bead hardness. The current setting depends on the thickness of metal and the type of joint.

1.1.3 Welding Speed
For a given combination of welding current and voltage, increase in welding speed or the speed of the arc travel results in lesser penetration. Welding speed has a great influence on width of weld bead.

1.2 Submerged arc welding methods

1.2.1 Single Wire Welding
Filler wires with diameters from 1.2 mm to 6 mm can be used with welding currents of 120-1500 A. SAW processes have developed from single wire welding to higher productivity processes.

1.2.2 Twin Wire Welding
Twin wires have become increasingly common in the interests of higher productivity. Without very much higher capital costs, it is possible to increase the deposition rate by 40 % in comparison with that of a single wire machine, as a result of higher current density that can be carried out by two filler wires in parallel. As the equipment uses only a single wire feed unit, the welding current will be shared equally between the two wires.

2. LITERATURE REVIEW
2000 Y.S. Tarng, W.H. Yang & S.C. Juang[1] have used Fuzzy Logic in the Taguchi method for the optimization of SAW process. They have used L9 in this study which means 9 runs and levels are 3. They have used mild steel plate of 24 mm thickness, having dimensions 120 mm × 60mm. Through their study they show that the performance characteristics of SAW process such as deposition rate and hardness are improves together by using gray relation.

2001 H.C. Wikle, S. Kottilingam, R.H.Zee[2] through their study by doing experiment on plain carbon steel as test material they showed that variation in the plate gap resulted in depressions where both the weld bead height and width varies significantly.

2005 N. Murugun, V. Gunaraj[3] through their study on prediction and control of weld bead geometry and shape relationships in SAW of pipes they concluded that Arc voltage had a less significant negative effect on penetration and reinforcement but had a positive effect on bead width, penetration size factor and reinforcement form factor.

2006 T. Kannan, N. Murugun[4] concluded that Dilution increases with the rise in welding current and welding speed and decreases with increase in nozzle to plate distance and welding torch angle. weld bead width increases with increase in welding current. Penetration increases with increase in welding current and speed and decreases with increase in nozzle to plate distance.

2007 Kumanan, J Edwin Raja Dhas, & K. Gowthaman[5] have studied the SAW process parameters using Taguchi method and Regression analysis. The test material was mild steel plates of 500×60×6mm dimensions. Using multiple regression analysis they concluded that welding current and arc voltage are parameters that affect the bead width.

2011 Deepak Choudhary, Sandeep Jindal and N.P.Mehta[6] in the present work, an effort was made to investigate the effect of welding parameters on bead geometry. Mathematical models were developed by using 2- level half factorial technique to predict the bead geometry within the range of control parameters for single wire submerged are welding. Current, open circuit voltage, welding speed and nozzle-to-plate distance were taken as welding variables constant. The models were developed from the observed values, with the help of design matrix. It was found that penetration increases significantly with current, decreases with welding speed and remains unaffected by open circuit voltage & nozzle to plate distance. Weld bead width was found to increase with open circuit voltage, decrease with welding speed. The adequacies of the models were tested by use of analysis of variance.

2012 Rati Saluja, K.M. Moeed[7] have applied Factorial design approach for optimizing four submerged arc welding parameters viz. welding current, arc voltage, welding speed and electrode stick out by developing a mathematical model for sound quality bead width, bead penetration and weld reinforcement on butt joint. Response surface methodology (RSM) technique is applied to determine and characterize the cause and effect relationship between true mean responses and input control variables influencing the responses. Welding current and welding speed have major influence on bead penetration whereas electrode stick out has minor effect. Welding speed and electrode stick out had little or negligible effect on weld reinforcement.

2013 Pranesh B. Bamankar, Dr. S.M. Sawant[8] had studied the effect on penetration depth of mild steel by SAW process. Using Taguchi method & considering three factors and three levels, process parameters like welding current, arc voltage and welding speed (Trolley speed) on mild steel of 12 mm thickness The results shows penetration will be at maximum value when welding current and arc voltage are at their maximum possible value and welding speed is at its minimum value.

2014 Pratik umrigar & Sandip Chaudhry[9] analyzed the effects of Plate thickness, Arc voltage and welding speed on Penetration and Bead width. For the experimental design full factorial method (L=m^n) was used. Stainless steel-304 with 5 mm thickness and v-groove joint was selected for experimental welding. The researchers concluded that plate thickness have most significant effect on penetration and bead width.

2015 Farzeen Shahid, Abid Ali Khan & Saqib Hameed[10] were given a brief review on work done on mechanical characterization and mechanical properties of welded joints. The researchers concluded that major problem occurs with dissimilar welding is formation of inter-metallic compounds at the interface which affect the properties and efficiency of the weld. And in order to improve the strength of dissimilar metal weld intermediate layers at the interface can be used.

2015 S. Jindal, S. Walia, R. Goyal & Rajdeep[11] performed Submerged Arc Welding on structural pipe steel (API 5L × 65 grade) to estimate the effect of welding parameters on weld bead geometry. Response surface methodology (RSM) had been used for design of experiments. Mathematical models for bead geometry parameters; bead width, bead height and form factor in terms of welding parameters; welding current, voltage and speed had been formed and checked for adequacy with ANOVA (F-Test). It was found that welding current was the most significant parameter controlling all the responses and arc voltage had increasing effect.

2016 A.M. Moshi, S.R. Bharthi, R. Rajeshkumar and R. Kumar[12] reviewed submerges arc welding process and effects of process parameters on quality of welding because of its inherent benefits such as higher metal deposition rate, good strength of the joint and good surface appearance. The researchers concluded that SAW process is not recommended where a weld deposit is needed that is fully austenitic or is controlled on low ferrite content. However, high quality weld may be produced for applications in which more than 4 % ferrite in the weld deposits are allowable.

3. CONCLUSION

1. It is concluded that Decrease in welding voltage, decrease in welding current and increase in welding speed up to limit will decrease weld bead width.
2. From this study it has been analyzed that welding current is the most significant factor which affect the weld bead width.
3. Increase in welding voltage, increase in welding current and decrease in welding speed up to limit will increase weld bead hardness.
4. That welding voltage is the most significant factor which affect the weld bead hardness.

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