SAW –A REVIEW

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Abstract: In industries widely used welding methods are shield metal arc welding (SMAW), gas metal arc welding (GMAW), gas tungsten arc welding (GTAW) and submerged arc welding (SAW). The SAW process is popular because of high production rate, melting efficiency, ease of automation and low operator skill requirement. This review will be helpful for providing the details for future work. This study shows the different works have been done in the past for improving different properties of welded material. This study also exhibits the effect of different welding process parameters that affect the weld chemistry. Depending upon the requirement the details of past work will we easily obtained for future work with the help of this study.

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1. INTRODUCTION

Submerged arc welding can be employed for an wide range of workpieces. The method is suitable for butt welding and fillet welding of such applications as structural members in ships, manufacture of pressure vessels, bridge beams, and so on. In industries and research organizations most widely used welding methods are shield metal arc welding (SMAW), gas metal arc welding (GMAW), gas tungsten arc welding (GTAW) and submerged arc welding (SAW). The SAW process is often preferred because it offers high production rate, high melting efficiency, ease of automation and low operator skill requirement. It was first used in industries in the mid 1930's as a single-wire welding system (Parmar, 1992). The variables used in the SAW process results in varying heat input in the weldment. The effect of this is the deterioration of the chemical constituents of the weld bead. Hence, the properties of the base metal cannot match those of the weldment to ensure good performance in service, especially in low temperature services.

1.2WELDING PARAMETERS –

1.2.1Welding Current: It controls the melting of the electrode and thereby the weld deposition rate. It controls the depth of penetration and thereby the extent of dilution of the weld metal by the base metal. High current causes excessive reinforcement of weld which is wasteful, and burn-through in the case of thinner plates or in badly fitted joints, which are not provided with proper backing.

1.2.2Arc-Voltage: Arc voltage called welding voltage, means the electrical potential difference between the electrode tip and the surface of the molten weld puddle.

1.2.3Weld Speed: For a given combination of welding current and voltage, increase in the welding speed or the speed of arc travel results in lesser penetration, lesser weld reinforcement and lower heat input per unit length of weld.

2 LITERATURE REVIEW

Dhas et al.-Elaborates the study of welding procedures generation for the submerged arc welding process. Several research works have already been carried out in the field of submerged arc welding for parametric optimization.

Biswas et al. Studied the effect of process parameters on output features of submerged arc weld by using Taguchi method.

Chang et al. applied grey-based Taguchi methods for optimization of submerged arc welding process parameters in hard facing. They considered multiple weld qualities and determined optimal process parameters based on grey relational grade from grey relational analysis proposed by Taguchi.

K. Srinivasulu reddy -In his paper presented optimization & prediction of welding parameters and bead geometry in submerged arc welding. He collected data as per Taguchi‟s Design of Experiments and analysis of variance (ANOVA) and experiment was carried to establish input–output relationships of the process. By this relationship, an attempt was made to minimize weld bead width, a good indicator of bead geometry, using optimization procedures based on the ANN models to determine optimal weld parameters. The optimized values obtained from these techniques were compared with experimental results and presented..

Gunaraj and Murugan -Applied Response Surface Methodology (RSM) for prediction and optimization of weld bead quality in submerged arc welding of pipes by establishing mathematical models.

Tarng et al.-Applied grey based Taguchi method for optimization submerged arc welding process parameters in hard facing.

Datta et al.-Developed statistical models for predicting bead volume of submerged arc butt-weld. Patnaik et al.-Studied the effect of process parameters on output features of submerged arc weld by using Taguchi method. The relationship between control factors and performance outputs was established by means of nonlinear regression analysis, resulting in a valid mathematical model. Finally, Genetic Algorithm (GA) was employed to optimize the welding process with multiple objectives.

Pandey, et al, 1994-Have studied the influence of submerged arc welding (SAW) parameters and flux basicity index on the weld chemistry and transfer of elements such as manganese, silicon, carbon and sulphur. They have used five fluxes and different values of the welding parameters; the welding speed was being kept constant to produce weld bead on a mild-steel plate. The study was mainly aimed at studying whether welding parameters or fluxes were more effective on the element transfer and weld composition. From the study; finally it was concluded that: 1. For controlling the weld-metal composition, welding voltage was more effective than is welding current. 2. The basicity index value of fluxes had a definite relationship with silicon but the same cannot be correlated with the weld-metal manganese, carbon and sulphur contents. 3. The weld-metal composition showed, in general, gain of silicon and loss of carbon, manganese and sulphur elements. The results showed that welding

current and voltage have an appreciable influence on element transfer, as well as on weld composition. (H.L Tsai et al, 1996) has done optimisation of submerged arc welding process parameters in hardfacing. In this they used a neutral network approach for modeling and optimisation of SAW process. i.e. a freeforward neutral network to construct the SAW process model.

Chandel et al, 1997- With the help of their study showed the theoretical predictions of the effect of current, electrode polarity, electrode diameter and electrode extension on the melting rate , bead height, bead width and weld penetration, in submerged arc welding.

Khallaf et al, 1997-Through their study they described cracking behavior during the submerged arc welding of medium carbon steel plates and found that the cracking increases with an increase in the welding current and decreases with an increase in the welding speed or the electrode wire feed rate. It also increases with increases in the plate rolling reduction ratio and with decrease in the plate thickness.

Chandel et al, 1998-Through their study on mild steel plates 350x220x25mm as test material, showed that The impact properties of welds made with powder addition are superior. The weld metal is stronger and tougher than the base metal. (Gunaraj et al, 1999-Studied the effect of controllable process variables on the heat input and the area of the heat-affected zone (HAZ) for bead-on-plate and bead-on joint welding using mathematical models developed for the submerged arc welding of pipes. A comparative study of the area of the heat-effected zone between bead-on plate and bead-on-joint welding was then carried out.

Tarng et al, 2000-Have used fuzzy Logic in the Taguchi Method for the Optimisation of the Submerged Arc Welding Process. They have used L8 in this study which means 9 runs and the levels are 3. They have used a mild steel plate of 24mm. having dimensions 120mm x 60 mm. Through their study they show that the performance characteristics of the Saw process such as deposition rate, dilution and hardness are improved together by using grey-relation. (Vera et al, 2001) The aim of their work is to evaluate the effect of a post weld heat treatment (PWHT) on the microstructure and mechanical properties of the base metal, heat-affected zone (HAZ) and weld metal of a submerged arc welded pressure vessel steel. The material used was ASTM A537 C1 steel.

Wikle et al, 2001- Through their study 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.

Wen et al, 2001- A multi wire SAW process was modeled using a general purpose finite element package for thick wall line pipes. It was shown that the geometric distortion and residual stresses and strains can be minimized through process optimization.

Tarng et al, 2002-Have used grey-based Taguchi methods to determine submerged arc welding process parameters in hardfacing. For Experimentation they deposited a martensitic stainless steel hard facing layer on 30x80x120mm mild steel plate by SAW process. Using grey relation they have done evaluations on dilution rate, hardness and deposition rate, finally done the analysis of variance. From this study they concluded that:- The performance characteristics such as harness, dilution and deposition rate are improved together by using grey relation.

Ana Ma et al, 2003-They have done study of chemical and structural characterization of fluxes for submerged-arc welding was conducted. Three flux formulations were prepared using mineral oxides for agglomerating and sintering processes. A commercial agglomerated and sintered flux was used for comparison. The four fluxes were then analyzed chemically by atomic absorption and X-ray diffraction to determinate the quantity and type of oxides formed. Differential thermal analysis was carried out from 1000 to 1350 0C in order to determine the temperatures for phase transformations and melting of the different compounds formed in the sintering process. From this study they concluded that:- The determination of various phases in fluxes helps to• identify the different type of oxides and radicals formed during sintering of initial materials. This quantification makes it possible to know which anions and cations would be present in the electric arc.

Pandey, 2004 -Proposed a relationship between welding current and direct SAW process parameters using two level half factorial design. Interactive effects of direct parameters were also studied.

Murugan et al, 2005- Through their study on prediction and control of weld bead geometry and shape relationships in submerged arc welding 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. Wire feed rate had a significant positive effect but welding speed had an appreciable negative effect on most of the important bead parameters. Penetration increased by about 1.3mm as wire feed rate was increased from −2 to +2 limit whereas penetration decreased by about 1mm as welding speed was increased from −2 to +2 limit.

Kanjilal et al, 2006-Have studied the effect of flux and welding parameters on chemical composition and mechanical properties of submerged arc weld metal. For experimentation they have used low carbon steel plate of 18mm thickness. The test regarding weld metal composition is done. The behavior of mechanical property was also studied.

Shen et al, 2012 -A series of measurements was carried out on specimens of submerged arc welded plates of ASTM A709 Grade 50 steel. The bead reinforcement, bead width, penetration depth, HAZ size, deposition area and penetration area increased with increasing heat input but the bead contact angle decreased with it. The electrode melting efficiency increased initially and then decreased with increasing heat input but the plate melting efficiency and percentage dilution changed only slightly with it. Cooling time exhibited a very good linear relationship with the total nugget area, heat transfer boundary length, and nugget parameter.

Hari Om et al, 2013-Have shown from their work that HAZ width rises more effectively with wire feed rate. With negative polarity dilution rate decrease more than 20%. HAZ area varies linearly with heat input.

Brijpal Singh et al, 2013-They have done a review study on effect of flux composition on its behavior and bead geometry. With the help of their detailed review they showed that flux constituents has a effect on flux behavior and bead shape geometry. The load carrying capacity of the welded joint does not only depend on microstructure but it is also affected by the physical behavior of the flux, and bead geometry. The main characteristics which are affected by flux constituents are arc stability, slag detachability, capillarity, viscosity and basicity index

CONCLUSION

From the review of relevant literature, it has been found that no systematic work on an integrated approach of studying the effects of various welding process variables (welding current, voltage, welding speed, wire feed rate, nozzle-to-plate distance- all together) on bead geometric descriptors using full factorial technique and predicting the weld bead geometry using Artificial Neural Net work (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) has been found in the literature for Submerged Arc Welding.

Based on this literature review it has been found that a systematic work needs to be carried out to relate the welding parameters with weld bead geometry using Artificial Neural Network (ANN), Adaptive Neuro-Fuzzy Inference System (ANFIS) and Multiple Regression Analysis

(MRA) on Submerged Arc Welding. Thus Mathematical relationships are needed to be developed between the welding process parameters viz. welding current, arc voltage, welding speed, wire-feed-rate, nozzle-to-plate distance and the important weld-bead geometrical variables viz. penetration depth, reinforcement height and weld width of the welded joint using full factorial design technique.

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