DESIGN & FABRICATION OF AUTOMATIC SHIELDED METAL ARC WELDING ON MILD STEEL PLATE

A Review

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Abstract: Shielded Metal Arc Welding (SMAW) is a popular metal fabrication process in construction, shipbuilding operations and metal structure industries. Improving the weld quality is of prime concern. An adaptive sliding mode controller, estimates the bound of uncertainties, and modulates the rate of the electrode feed mechanism that regulates the arc current. The electrode feed-rate mechanism with this controller is driven by an AC servomotor, which can compensate for both the molten part of the electrode and undesirable fluctuations in the arc length during the welding process. The method can be easily applied to any welding system in which the electrode is consumed during the welding process. By maintaining the magnitude of the arc current at the desired value and the stability of the arc length, excellent welding performance is obtained.

Keywords- Shielded Metal Arc Welding, Automatic welding machine, Welding Parameters

I. INTRODUCTION

For a developing industry these operating performed and the parts or components produced should have its minimum possible production cost, then only the industry runs profitably. There are a number of units having used in industries for various purposes. Arc welding is the fusion of two pieces of metal by an electric arc between the pieces being joined – the work pieces – and an electrode that is guided along the joint between the pieces. The electrode is either a rod that simply carries current between the tip and the work, or a rod or wire that melts and supplies filler metal to the joint. The basic arc welding circuit is an alternating current (AC) or direct current (DC) power source connected by a "work" cable to the work piece and by a "hot" cable to an electrode. When the electrode is positioned close to the work piece, an arc is created across the gap between the metal and the hot cable electrode. The conventional SMAW process is performed manually. The electrode supplies the filler–metal as well as acts as the consumable material in the welding process. It requires a well-trained technician to perform such a consumed electrode welding technique. Shielded Metal Arc Welding (SMAW) is a popular metal fabrication process in construction, shipbuilding operations and metal structure industries. SMAW was used for welding stainless steel, high-carbon steel, copper, brass, and aluminum's even it is widely used in industries but there is very less work done on the automation in SMAW ;In our project we will design the optimum welding parameters such as Welding speed, Width of weld bead, Current used in shielded metal arc welding machine and accordingly fabricate the Automatic welding machine for welding the mild steel plates.

2.LITERATURE SURVEY

On the basis on topic of design and fabrication of automatic shielded metal arc welding machine. Different papers published on Elsevier and certain journals involving various experiments on the Optimization of paramaters in shielded metal arc welding,Analysis of shielded metal arc welding.The papers have brought forward in optimization of paramaters in shielded metal arc welding and automation used in shielded metal arc welding..It has become easier to find Automation used in shielded metal arc welding with optimization of parameters.

2.1 Literature Survey on Analysis of Shielded Metal Arc Welding:

Kumar Vikas et al. [1] found that during welding, random variations in current and voltage occur, which cannot be recorded with ordinary ammeter and voltmeter. Acquisition of voltage and current signals while welding is in progress at a very high speed using digital storage oscilloscope (DSO) and subsequent analysis of the stored data can be very useful to understand the arc welding process.

Ravindra Kumar, et al.[2]Shielded metal arc welding (SMAW) was used to weld together ASTM SA210 GrA1(Low Carbon Steel) steel. The oxidation studies were conducted on different regions of shielded metal arc weldment such as base metal, weld metal and heat affected zone (HAZ) specimens after exposure to air at 900 ◦C under cyclic conditions. The thermo-gravimetric technique was used to establish kinetics of oxidation. X-ray diffraction (XRD) and scanning electron microscopy/energy-dispersive analysis (SEM/EDAX) techniques were used to analyze the oxidation products. The base metal oxidized in air indicated the formation of high intensity of $Fe2O3$ (Iron oxide) as reveled by XRD analysis and form a thicker oxide scale on the base metal than that of weld metal at 900 ◦C. The oxidation resistance was found to be maximum in case of HAZ due to the formation of densely inner oxide scale and it was least in case of base metal. The oxidation rate (total weight gain values after 50 cycles of xidation) of different region of the SMAW welded GrA1 boiler tube steel follows the sequence as given below: basemetal > weldmetal > HAZ.Kim I.S.,et al.[3] found based on multiple regressions and a neural network, the mathematical models are derived from extensive experiments with different welding parameters and complex geometrical features. Graphic displays represent the resulting solution on the bead geometry that can be employed to further probe the model. The developed system enables to input the desired weld dimensions and select the optimal welding parameters. Goyal V.K,et al.[4] developed an analytical model assumes the primary heat transfer to weld pool is the initial arc heating considered as continuous heat source (arc heat source) of double ellipsoidal nature followed by deposition of superheated filler metal considered as point heat source of interrupted nature superimposed on the first one. The dissimilar nature of the two heat sources is treated by different analytical techniques to estimate their temperature distribution in weld pool and HAZ at its vicinity. The geometry of the weld pool has been estimated by evaluation of the weld isotherms causing melting of the base metal under the influence of two heat sources acting on the weld pool.

Ghosh P.K et al.[5] carried out an experiment on plate weld deposition of 10 mm thick the arc characteristics and behavior of metal transfer affecting the quality of pulsed current GMA weld is depends upon the pulse parameters and arc voltage primarily due to their influence on arc profile, stability in shielding of arc environment as well as nature of droplets transferred during welding. The arc characteristics defined by its root diameter, projected diameter and length ,stiffness of arc affecting the weld quality. Tong L.G,et al.[6] proposed a physical model represents the fluid and thermal dynamics of the SMAW process are quantitatively described, and the drop short circuit transition process is analyzed. To investigate the effects of material parameters on the fluid and thermal dynamics of the weld pool during SMAW, FR (Fusion Ratio) and FL (Fusion Length) are proposed to describe the pool accurately. The evolution and geometry of a weld pool with V-type grooves during butt SMAW were investigated. The results provide a theoretical basis for improving the welding process and welding quality while avoiding welding defects. Palani P.K,et al.[7] uses different methodologies for Pulsed welding is a controlled method of spray transfer, in which the arc current is maintained at a value high enough to permit spray transfer and for long enough to initiate detachment of a molten droplet. Once the droplet is transferred the current is reduced to a relatively low value to maintain the arc. Parameters of peak current, background current, peak current duration, background current duration, pulsing frequency and load duty cycle; it have a distinct effect on the characteristics such as the stability of the arc, weld quality, bead appearance and weld bead geometry. Improper selection of these pulse parameters may cause weld defects including irregular bead surface, lack of fusion, undercuts, burn-backs and stubbing-in.Vivek Goel,et al.[8] developed an expert system can be used, usually by a welding engineer, to plan for SMAW jobs. This paper presents an expert system to help plan and train shielded metal arc welding (SMAW) operations. It accumulates most of the available information on the SMAW process including edge preparation, electrode selection, economic evaluation, analysis of weld defects and trouble-shooting.

S.M.Tabatabaeipour,et al.[9]studied the ultrasonic testing of two welding processes such as shielded metal arc welding (SMAW) and gas tungsten arc welding (GTAW) and the ultrasonic testing technique used is time-of-flight diffraction (ToFD).The specimens were examined by the ultrasonic ToFD technique under identical conditions. B-scan images obtained from ToFD measurements of the two welds indicate that inspection of the specimen prepared by the SMAW process is easier than the one made by the GTAW process due to higher scattering of waves in the latter

Masaya Shigeta,et al.[10] developed a quantitative evaluation system for arc characteristics such as arc stability and welding spatter generation related to shielded metal arc welding (SMAW) without human sensory evaluation. Factors that correspond to sensory evaluations by welders were investigated based on image processing. For the quantitative evaluation of arc stability, results show that the root mean square and the standard deviation of the arc center fluctuation, correspond to welders' sensory evaluation at AC and DC discharges. For welding spatter generation, a method of counting white pixels in a binarized image evaluates the number and size of welding spatters which closely coincide with welders' sensory evaluations.V.E. Buchanan,et al.[21] found that the abrasive wear behaviour of hypereutectic and hypoeutectic based Fe-Cr-C hardfacings were reported and interpreted in terms of the microstructures.The coatings were deposited onto a grey cast iron substrate by shielded metal arc welding using two commercial hardfacing electrodes. It was found that the hardness of the hypereutectic coating was significantly higher than the hypoeutectic coating. In both cases, optimum hardness was achieved within the first deposited layer. The abrasion tests showed that there was no significance difference in the wear resistance of the hard facings at the higher loads and there was contrasting wear behaviour in the dry and slurry conditions. F. Molleda,et al[22]performed an experiment on mild steel then Spatter results when droplets of liquid metal that have been ejected from the weld pool by the impact of small droplets from the covered electrode solidify and weld to the surface of the base material. The studies shows that spatter and reveals that these small droplets do not oxidise during their short trajectory and they arrive with sufficient heat to weld to the adjacent base material. In this experiment welds were performed on mild steel using covered electrodes (rutile type) to obtain spatter on the adjacent base material. Scanning electron microscopy and X-ray mapping were used to study the above mentioned phenomena.The spatter particle welds to the base material and transfers heat very quickly to it so producing a very thin recrystallised region in the heat affected zone.Min Zeng,et al.[24]In this research paper they adopted a refined method of current wave-form control, and reported a model for GMAW comprising four modules that were inverter power supply,arc load, wire feeder system and waveform control system. SIMULINK tools of MATLAB were implemented to establish this model, and the simulation results were compared with the experiments to comprehen-sively evaluate the influence of the large constant current and the small constant current of arc stage on the welding outcomes. In the short circuit transfer process, the base short-circuit current duration and the peak short-circuit current had great impacts on spatter generation whereas the effect of the current surge rate was relatively small within a certain range. Parameters of waveform control method were obtained and optimized based on this model were confirmed effective and efficient for a high stability of welding process.Pengfei Baia,et al.[26] proposed a sensing method based on arc voltage to sense the weld penetration. A stationary arc was applied to the workpiece for two seconds to mimic the beginning process of welding. The change in arc voltage at peak current period was used to characterize the penetration status.. A penetration control strategy, by seeking the inflection point and comparing the detected with the set point, could control weld penetration at the beginning of pulsed gas metal arc welding.The change in the arc voltage at peak current period reflects the penetration status at the beginning process of pulsed gas metal arc welding.

2.2 Literature Review on Optimization of parameters used in Shielded Metal Arc Welding:

Gurpreet Singh Sidhu,et al.[11]studied to investigate the roll of intermixed weld metal of shielded metal arc welding consumable on weld properties. Intermixing of weld fluxes, change the chemical compositions of electrodes etc are applied for purpose of high weld quality, high productivity, strength and economy in pipeline Fabricators look for welding process which is cost effect and is able to give higher deposition rate better penetration and robust structures. Izzatul Aini Ibrahim,et al.[12] studied, the effects of different parameters on welding penetration, microstructural and hardness measurement in mild steel that having the 6mm thickness of base metal by using the robotic gas metal arc welding are investigated. The variables that used in this study are arc voltage, welding current and welding speed. The penetration, microstructure and hardness were measured for each specimen after the welding process and the effect of it was studied. The value of depth of penetration increased by increasing the value of welding current 90, 150 and 210 A. Welding current,Welding speed and Arc voltage is factor that will determine the penetration. Olga Liskevych,et al.[13] propsed a method for calculating the Heat input and respective thermal efficiency values used for predicting or determining metallurgical aspects resulting from arc welding which are dependent on the conditions such as base material, sample dimensions,welding parameters, environmental conditions, etc, Considering that comprehensive models on heat transfer in welded plates take into account these dimensions and the amount of heat loss from the surfaces is estimated, the input values of the heat delivered to the plate must be free from this heat loss. The determined parameter such as microstructures or bead and HAZ geometries,with the estimation of deformations, residual stresses, cooling rates and mechanical properties.D.S.Nagesh,et al[14] proposed a model based on artificial neural network on shielded metal arc welding suggested that Bead geometry and penetration (depth and area) are important physical characteristics of a weldment. Higher electrode feed rate produced higher bead width making the bead flatter.Current, voltage and arc-travel rate influence the depth of penetration. The other factors that influence the penetration are heat conductivity,arc-length and arc-force.. Back-propagation neural networks are used to associate the welding process variables with the features of the bead geometry and penetration

Brajesh Kumar Singh,et al.[15] does experimentation on welding so Effect of the variations in joint designs on the properties of the weldment was studied. Mild steel plates, IS 2062: E250, were taken as sample for the study using the shielded metal arc welding (SMAW) technique. Main objective was to compare the effects of variations in geometry of butt-joint welding on the mechanical properties of mild steel plate. The welding was carried out on different butt-joint designs, such as, square butt-joint,single V-joint, double V-joint and single J-joint, keeping all other process parameters like current, voltage, welding speed etc. as constant. The mechanical test and the microstructural investigation were carried out to analyse the change in mechanical and microstructural behavior of the weld metal. The results of tests peformed revealed that the Double-V joint was the superior of all other joints,having better mechanical properties than other joints.Single-V was having more width of HAZ was recorded as compared to others.B.S.Praveen Kumar,et al.[16] The focus of this work is to design parameters for shielded metal arc welding to ensure continuous and leak proof joints. To achieve the object an attempt has been made to selected important welding parameters. The selected welding parameters are welding current, welding speed, electrode angle and electrode angle. The selection is purely based on field expert's suggestions, literature Survey and on Scientific reasons. On the selected parameters, trails runs have been conducted The results have indicated that a leak proof joints can be produced in few specific operating conditions. The each parameter was estimated by ANOVA computations.

Xiaolei Jia,et al.[17] invented a new method to predict heat source parameters in the GMAW simulation process by using regression equations, which obtained from a set of welding simulations, was presented.The heat source parameters could then be accurately calculated with those equations and measured values of weldment characteristics together with peak temperature. In regression analysis, the PLSRA(Partial Least Square Analysis)was adopted in prediction of welding heat source parameters owing to its advantage of requiring less simulation data. In this MRA(Multiple regression analysis) mathematical forms simulating the relationships between welding pool characteristics (fusion width W, penetration depth D, peak temperature Tp) and simulated heat source parameters (Q,a, b, cf, cr) were obtained. Alireza Bahrami,et al.[18] studied that selecting the welding parameters appropriately, such as the power supplied to the arc and the translation speed of the arc can reduce the energy consumed per unit length of weld. It is shown that increasing the arc power in conjunction with increasing the travel speed of the arc leads to reduced energy consumption per unit length of weld; this reduction in energy consumption is for equivalent welds, i.e., welds with identical geometric features. The study of temperature distribution in the work-piece reveals that the weld pool maximum temperature is higher when the combinations of higher travel speed and power inputs are applied even though the total heat input and material properties remain constant.Mehmet Eroglu[19] studied the shielded metal arc welding electrodes were produced for making boride coatings and low-carbon steel plates were surfaced with single-pass bead on-plate welds The microstructure of the coating changes with the change of boron content. Increasing the boron content in the coating changes the microstructure from a hypoeutectic to a hypereutectic consisting of primary Fe2B borides and a small quantity of Fe2B-martensite eutectic. is observed for the eutectic and The microhardness of the coating increases with increasing boron content. As the coatings produced by the developed electrodes have high hardness values, these electrodes may be potentially useful for hardfacing to improve the surface properties of agriculture tools, components for mining industry and other equipments for soil.preparation.Mohammad Mousavi Anzehaee,et al[20].proposed a method in which a two-layer architecture with cascade configuration of PI and MPC controllers is implemented to incorporate existing constraints on the process variables, improve transient behavior of the closed-loop responses and reduce interaction level. To provide an appropriate control on the amount of heat and mass transfer to work piece, instead of arc current and arc voltage they had focused on control of the melting rate, heat input, and detaching droplet diameter the computer simulation results it was shown that this choice of outputs facilitates effective reduction of the existing sever interactions between heat and mass transfer to work piece. Arun Kumar Paul[23] has demonstrated that modern welding controllers with the help of sliding mode control are able to converge more diverse domains, quantitative and qualitative,in - electrical, metallurgical compatibility, welding quality,energy and process efficiency, health hazards, operating duty factor, simplicity of set up, process availability, cost etc to a unique optimization function. Conflict-free optimization has been achieved through selective and off-line use of sliding surface using soft-sliding mode control. In these research paper it is brought in to consideration about the adverse effect of the welding on the human health and that it can be brought under control by adopting the sliding mode control technique. Shekhar Srivastava,et al.[27]studied the effect of the various process parameters on welding of IS:2062 mild steel plate using gas metal arc welding process with a copper coated mild steel wire of 0.8 mm diameter. A set of experiments has been performed to collect the data using Box Behnken Design technique of Response Surface Methodology. Based on the recorded data, the mathematical models have been developed. Further an attempt has been made to minimize the bead width and bead height and maximize the depth of penetration using response surface methodology.Bead geometry variables, heat affected zone, bead width, bead height, penetration and area of penetration are greatly influenced by welding process parameter i.e. welding speed, welding current, shielding gas flow rate, voltage, arc travel speed,contact tip – work distance, type of shielding gas etc. and also it plays an important role in determining the mechanical properties of the weld such as tensile strength, hardness etc.

2.3 Literature Review on Automation used in Shielded Metal Arc Welding:

Arun Prakash[28] proposed and tested a vision algorithm using 2D image processing techniques to automate welding was.This presents an automatic welding system assisted by a machine vision system to compute the dimension, position and orientation of the workpieces. By analysing the image taken by the camera, a simple algorithm is developed to detect the dimension, position and orientation of the workpieces. The calculated data is then fed to a controller which controls the welding electrode movement. Use of machine vision system has eliminated the need to pre feed the workpiece data to the robot and hence the system becomes flexible. This algorithm, when implemented in an automatic welding system, makes it simpler and effective in improving the quality of the weld and also increases the welding efficiency. It also reduces the labor intensity with good economic returns.

Wen-Hou Chu,et al.[29] derived a mathematical model of the welding control system and identified the value of the system parameters A fuzzy gain scheduling PID controller modulates the rate of an electrode feed mechanism that regulates arc current. The electrode feed rate mechanism with this controller driven by an AC servomotor can both compensate for the molting part of the electrode and the undesirable fluctuation of the arc length during welding operation. It can also be easily applied to any welding system whose electrode is consumed during the welding process. By maintaining the magnitude of the arc current at the desired value and ensuring the stability of the arc length, excellent welding performance can be obtained.

Dhaval Patel, et al.[30]studied the effect of magnetic field on the weld quality and geometry when the field is applied longitudinal to the electrode travel i.e. the field lines are perpendicular to the electrode travel. The weld quality of the pieces will be checked by conducting different weld test as hardness, tensile strength and impact test.

CONCLUSION

On the basis of different experiments, automation of welding process and effect of magnetic field the following conclusions are derived:

- The automatic welding set-up provides the welding of the mild steel plates with automation by using suitable jigs and fixture arrangement.
- By using Automatic welding machine good weld quality products which is useful in mass production and found the optimum parameters for the SMAW process
- Effect of magnetic field applied transverse to welding direction affects the bead width of joint and increases it.
- Undercuts, spatter etc. welding defects are reduced.

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