EFFECTS OF FILLER RODS ON MECHANICAL PROPERTIES OF DISSIMILAR WELD SS304 AND MS PLATES

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Abstract - This paper describes an investigation on the effect of using two different filler metals to weld two dissimilar metals namely, stainless steel 304 and MS plates with two filler metals Including ER316L and ER70S were selected to weld the two plates Radiography and penetrant tests were performed on the welded metals to ensure the surface and internal soundness. The tensile strength of all the welded samples is found to be in between the tensile strength of the base metals. Micro-hardness test showed that weld has the highest hardness, meanwhile hardness profile of ER316L presented a sharp drop in the stainless- steel side and ER70S weld metal illustrated hardness above the two base metals with fewer variations across the weld metal.

Key Words: TIG Welding, Stainless steel plates, Mild steel plates, Radiography and Penetration test, Micro hardness test.

1. INTRODUCTION

1.1 Welding

Welding is a manufacturing process that joins materials, usually metals, by using high heat to melt and cool the parts together to create a fusion. The welded pieces unite into one entity. Welding differs from low-temperature techniques such as brazing and soldering, which do not melt the base material instead they deposit other material as joining material.

In addition to melting the base metal, filler metal is usually added to the joint to form a pool of molten material (weld puddle). As it cools, the weld configuration (butt, full penetration, fillet, etc.) is stronger than the base metal. Pressure can also be used in combination with heat or alone to create welds. Welding also requires some form of protective shielding to protect the filler metal or molten metal from contamination and oxidation. Welding can use a variety of energy sources including gas flames (chemical), arcs (electrical), lasers, electron beams, friction, and ultrasound.

Welding is often an industrial process, but it can be performedin a variety of environments, including outdoors, underwater, and in space. Welding is a dangerous activity and requires precautions to avoid burns, electric shock, visual impairment, inhalation of toxic gases and fumes, and exposure to intense UV radiation.

1.2 Types of welding

Welding processes can be classified into different types based on electrode, filler material, shielding gas, source energy, etc. Few of the processes are listed below.

1.2.1 Forged Welding

The metal here heated to a malleable state which hammered into the desired form and finally cooled to set in the shape. The process came into mind while a blacksmith working on metal. It is not limited to these professionals only, but forge welding happens to be a choice in the aerospace industry.

Forge Welding

2. LITERATURE SURVEY

Sanjeev Gupta 2016 [1] Performed the experimentto optimizer the condition for performing the welding on Ultra-90 specimen in which he varies the current and voltage while keeping the gas flow rate constant and observed that welding joint not made properly below 50A and 200A since then burning of specimen stated.

Ravinder & S.K. Jarial [2] studied the parametric optimization of Arc welding on stainless steel [202] andmild steel by using Taguchi method and found the control factor which had varying effect on the tensile strength, are voltage having the highest effect and also found the optimum parameter for tensile strength current 80A. Arc voltage 30V.

Dr. Simhachalam et al. [3] carried on the effect of welding process parameters on the mechanical properties of stainless steel -316 [18Cr-8N] welded by TIG welding. The specimen size is 40x15x15mm for experimentation observed that the welding current has a significant effect though filler rod does have some effect similar to current but compared to current it is less significant. MINITABsoftware is used for the prediction of the hardness, impact strength and depth of penetrations.

Javed Kazi et al. [4] represent a review on various welding techniques in international journal of modern engineering research publications in 2015. Their prime focus is on fulfilment of objectives of industrial application of welding with producing better quality product at minimum cost and increases productivity. The attempt is made to understand various welding techniques and to find the best welding technique for steel. Special focuses have been put on TIG and MIG welding. For this study they analysed strength hardness, modulus of rigidity, ductility, breaking point, % clongation etc. at constant voltage onhardness testing machine and UTM.

Naitik s Patel et al. [5] they carried out the features highlighting the TIG as a better prospect for welding then other processes especially for joining of two dissimilar metals with heating therial or applying the pressure or using the filler material for increasing productivity with less time and cost constrain. They madean attempt to understand the effect of TIG welding parameters sha welding current, gas flow rate, welding speed, that are influences on responsive output parameters such as hardness of welding, tensile strength of welding, by using optimization philosophy.

Leroy Gardner [6] comprising tensile test on flat and corner materials. Initial geometric imperfections were generally low in both the hot rolled and cold rolled steels sections, with large imperfections emerging towards the ends of the cold formed members. Current codified slenderness limit was evaluated on the basis of compressive and bending test on hot rolled and cold rolled section.

Jaile mill (2004) [7] self-drilling screw joint for cold rolled steel channel portal. The conclusion of earlier testing by the first author that widely used bolted and plate moments connection is not suitable. They knew joint ofportal frames constructed from thin cold formed channel sections. The order traditionally used joint configuration of

a mitred joint with two bolts is end is ending plates mayneed to be sized conservatively.

Shah Foram Ashok bhai [8] steel consumption is more in industrial shed structure using hot willed steel and cold rolled steel sheets as compared to industrial shed structure using cold formed steel sections. The weight is more in industrial shed which use of hot rolled sheets. The weight of industrial shed with cold formed sections is reduced with 32.03% than industrial shed structure with hot rolled sheets. An attempt is being carried out the comparison between hot rolled and cold milled steel.

D. Devakumar & D. B. Jabaraj [9] the gas tungsten arc welding (GTAW) of sheets 2mm thickness of hot rolled medium and high tensile structural steel (HRS) is carried out to investigation of mechanical properties and composition analysis through energy dispersive analysis of X ray DAX) to find out the hardness test, tensile test, bend test to determine the mechanical properties of the weldments. The increase in the weld zone micro hardness and formation of dendritic delta ferrine microstructure, when compared with HRS parent metal having elongation grained austenite with ferrite and the HRS parent metal having fine grains of ferrite, caused the joint efficiency of the HRS weldments to increase.

Ruangyot Wichienrak & Somchai puajindanetr[10] cold rolled steel industry in type of batch sealing furnace, the mechanical properties of steel sheet have variation by each position. The meters of annealing temperature and time were analysed to work out the source of mechanical properties variation. The mechanicalproperties which were examined i.e., Yield strength, tensile length, 4 elongation and hardness. Increasing the annealing temperature could remarkably case the yield strength, tensile strength and hardness, whereas the elongation model 5982.

Sachita S.Nawale [11] thin sheet steel products areextensively used in building industry. These thin steel sections are cold formed i.e., their manufacturing process involves forming steel sections a cold state (Le. without application of heat) from steel sheets of uniform thickness. The thickness of the cold rolled sheets is usually 1 to 3mm. The method of manufacturing is important as itdifferentiates these products from hot rolled steel sheets. Normally, the yield strength of steel sheets used in coldfrom sections is at least 280N/mm2, although there is a trend to use steels of high strengths, sometimes as low as 230N/mm2.

Chunquan Liu et al [12] study and investigation of mechanical properties of hot rolled and cold rolled steel. In experimental steel, processes by quenching and tempering (Q&T) heat treatment. exhibited excellent mechanical properties of hot rolled (strength of 1050-1130 MPa) and cold rolled steel (strength of 878-1373 MPa). The fracture modes of hot rolled sample. quenched from 650c, and cold rolled sample, quenched from 650e.

Bread Wolter & Gred Dobmann [13] In forming of steel by hot rolled and cold rolled steels a broad range of semi-finished and final products can be produced with a specific, customtailored technological properties. Micro- magnetic techniques, like 3MA have been reached a sophisticated level of industrial standard and are ready to be integrated into the production process of steel manufacturers. Mechanical properties, like tensile, yield strength and hardness as well as residual or structural stress level can be predicted with high accuracy.

Chandel et al [14]. presented 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. They indicated that the melting rate in SAW can be increased by using (1) higher current (ii)straight polarity (iii) a smaller diameter electrode and (iv) longer electrode extension. The percentage difference in melting rate, bead height, bead width and bead penetration has been found to be affected by the current level and polarity used. They have concluded that when a smallerdiameter electrode is used, the increase in the current level does not make a significant effect on the percentage change in the weld bead geometrical parameters.

Chandel and Seow [15], presented the mathematical prediction of the effect of current, polaritywed, electrode diameter and its extension on the melting

rate, bead height, bead width and weld SAW Theyconcluded that for a given current (heat input) the melting rate can be aced by using electrode negative polarity, longer electrode extension, and smaller diameter alsodes. There aretwo other ways to increase the deposition rate without increasing the heat ip these are: (1) using a twin-arc mode and (ii) adding metal powders.

Gansraj and Margan [16], developed analytical models to establish a relationship between process parameters and weld bead volume in SAW of pipes. They also carried out the optimization of weld bead volume using the optimization module available in the MATLAB software

Mostafa and Khajavi [17], described the prediction of weld penetration as influenced by Flux Cured Arc Welding process parameters like welding current, are voltage, nozzletoplate distance. derode-to-work angle and welding speed. The optimization result shows penetration will be I'm when welding current, are voltage, nozzle-to-plate distance and electrode-to-work angle is at their maximum possible value and welding speed is at its minimum value.

Erdal Karadeniz [18] et al., have investigated the effects of various welding parameters on weld in Erdemir 6842 steel of 2.5 mm welded by Robotic Gas Metal Arc Welding Process. The welding current, are voltage and welding speed have been chosen as variable process parameters. The depths of penetration have been measured for each specimen after the welding operations and the of these welding process parameters on penetration have been done

The welding currents in step of 95A, 105A and 115 A, Arc voltages in steps of 22V, 24V and 26 V and welding speeds in steps of 7,10 and 14 mm/s have been usedfor all experiments. has been found that increase in current; substantially increases the depth of penetration while crease in voltage, very slightly increases the penetration. The highest penetration has been served at 10mm/s welding speed.

Cats and Parmar [19], developed mathematical models by using fractional factorial technique pict the weld bead geometry and shape relationship for Submerged Arc Welding of micro nel in the medium thickness range of 10-16 mm. The response factors namely head, weld width, reinforcement, dilution, weld penetration shape factor(WPSF), weld moment form factor (WREF) as affected by wire rate, open circuit voltage, nozzle to- distance, welding speed and work material thickness have been investigated and analyzed

Ravindran and Parmar [20], developed mathematical models by using fractional factorial apes to predict weld bead geometry and shape relations for CO2 voltage, welding current, adding speed, nozzle-to-plate distance and gun angle.

Kamanan, Edwin Dhas and Gowthaman [21], worked on the application of Taguchi Technique ad Regression Analysis to determine the optimal process parameters for SAW. They have carried an experiment on asemi-automatic submerged arc welding machine and thesignals to noise s have been computed to determine the optimum parameters.

Patnaik, Biswas and Mahapatra [22], established a relationship between the controlling factors and performance outputs by means of Non-linear Regression Analysis and developed a valid hematical model and Genetic Algorithm (GA) to optimize the welding parameterand permance output. They have worked on anevolutionary approach to parameter optimization of SAWin the Hard-Facing Process. In SAW a large number of process parameters influence the outputs such as depositionrate, dilution and hardness, which affect the weld quality detired for hard facing.

Patter et al [23] in 1968 have discussed the joining of dissimilar metalo has progressed significantly during the past two decades because of the increasing use of dissimilar-metal nations in the aerospace, nuclear, chemical, and electronics industries. The selection and application of dissimilar metals in structural applications are dictated by the service requirements the structure, as well as the economics of material cost and the ease offabrication.

Schaeffle et al, in 1949 [24] studied the increase the scope and accuracy of Ferrite Number (FN) prediction in stainless steel weld metal and related dissimilar metal joints, a modification of the Welding Research Council1988 diagram (WRC-1 988 diagram) is proposed. The proposed VVRC1992 diagram includes a coefficient for Cuin the Ni equivalent, thereby removing a dency for theWRC-1 988 diagram to overestimate the FN of weld metalswhen the Cu content high. Also, the axes of the WRC-1992 diagram can be extended (as in the Schaeffler diagram) so predict dilution effects in dissimilar metal joints.

Odegard et al. [25] has studied in the year of 2014 about the metallurgical characteristics, taghness and corrosion resistance of dissimilar welds between duplex stainless-steel Alloy 2205 and carbon steel A36 have been evaluated. Both duplex stainless steel ER2209 and Nibased Alloy 625 filler metals were used to join this combination using a multipass, gas tungsten arc welding (GTAW) process.

Kacar et al. in 2004 [26] reported on the microstructure property relationship in dissimilar welds between martensitic and austenitic stainless steel. Both austenitic and duplex stainless-steel electrodes were used to join this combination, using multipass manual metal arc welding process.

W. Provost (1982) [27] explored the impacts of a pressure alleviation warm behavior on the strength of weight container quality steels. The aftereffects of this work depict the impact of post weld warm medicines on thestrength of welded joints in weight vessels quality steels. Uncommon consideration is paid to the base plate thicknessfor which a post weld warm treatment ought to be prescribed.

T.A Lechtenber and J.R. Foulds (1984) [28] explored the impact of pre-warm on the microstructure, hardness and strength of HT-9 weldments. A diminished preheat, affecting a quicker weld metal cooling rate, results in an expanded upper rack vitality and lower pliable

weak progress temperature with no charge in weld metal. SEM examinations show a diminished dendrite separating and bring down inter dendritic isolation with a quickercooling rate.

J.N Clark (1986) [29] researched about the weld fix of low compound downer safe steel castings without

preheat and post-weld warm treatment Extra information on downer pliability of the weld metal were given and talked about reference to the more extended term honesty of fixes.

D.G. Crawford and T.N. Dough (1991) [30] puncher examined about microstructure and strength of lowcarbon steel weld metal. An investigation of the trial information was completed, in view of the preface thatminor stages were the essential locales for fragile break inception, and that effective proliferation or generally of such splits was an element.

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