EXPERIMENTAL ANALYSIS OF CARBON STEEL MATERIAL USING SUBMERGED ARC WELDING PROCESS IN GATE VALVE USED IN PRESSURE VESSEL

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ABSTRACT

Welding plays very important role in fabrication industry and to ensure the quality of fabrication, all the welding shall be defects free. For ensuring the quality of welding joints and finally the integrity of the equipment, various inspection and testing methods are available in today's modern industries to improve the welding quality at the corner joints of the gate valve which is used in pressure vessel by using the different welding process of the SAW, TIG welding were used to made the joints the amount of porosity and distortion were identified by using different NDE examination while using SAW welding the joins the materials which will results more distortion and porosity at the end corners. Then by using the TIG welding to join the material which 80% less porous and distortion. Usually the submerged arc welding is performed for the gate valves used in the pressure vessels but open performing the saw process there are some defects occurring at the gate valves especially at the corners and one such defects that occur at the corner is porosity. In order to overcome this defect we came with the solution of performing Gas tungsten arc welding at each and every joint employed in the gate valves.

KEYWORDS – *Saw – Tig – Welding Defects.*

1.INTRODUCTION

SAW (Submerged Arc Welding) machines normally consist of two or more torches to increase productivity. The performance of conventional SAW depends on the experience of the operators. Error between the measured and the actual values of welding conditions is accumulated as time goes on. Therefore, the weld quality cannot be guaranteed because of the error. Even if a number of welding defects occur, workers are not able to find out the cause of defects because the measured signals show a big difference with the actual values. In this study, a stable measuring system was developed for the welding conditions such as current, voltage, speed so that workers can easily monitor the actual weld ing conditions. If the error between monitored and measured signals occurs, workers are able to easily correct the actual welding conditions through this system. In this way, it increased the reliability of the welding conditions. This system was applied to an actual welding system and showed that the weld quality was stabilized and improved [1]. An automatic double-electrode submerged arc welding (SAW) system included two SAW sub-systems and one movement bogie, and each of the SAW sub-system was consisted of a power supply and a wire feeder. These devices were electrically isolated to prevent electrical and magnetic interference. A 10 coordinate controller was needed to make these devices working coordinately and form a better welding seam. For the purpose of isolation and synchronization, a layer-row-line cubic program structure was introduced. Programs in different rows represented a specific operation of a welding procession, and programs in different layer represented different actions of these devices. Actions were synchronized in rows. A SAW welding procession was the sum of all actions [2]. Harsh environment surface acoustic wave (SAW) sensors are being researched and developed jointly by the University of Maine (UMaine) and Environetix Technologies Corp. for wireless and wired sensor applications, such as those found in gas turbines and power plant combustors. One goal of this work is to extend the operational temperature range of SAW sensors above 1000°C, potentially up to near the melting point of piezoelectric langasite crystals at 1400°C. To achieve stable performance at 1000°C and above, UMaine has developed nanocomposite thin film electrode materials, such as PtRh/HfO 2, and protecting capping layers, such as SiAlON and Al2 O3 . However, these protective top layers, which aid in extending the life of the electrodes, are electrical insulators that prevent direct bonding to the electrodes. The Maine team also found evidence of accelerated thin-film degradation close to theSAW inter digital transducer (IDT) bond pad welds at these extreme temperatures. This paper introduces a high temperature capacitive approach to electrically couple to the IDT, thus allowing electrical access to the SAW device. The capacitive coupling approach also avoids premature failure of the nanocomposite film caused by inter diffusion between the bond wires and the SAW IDT bond pads [3]. A tungsten inert gas welding configuration including the weld pool is modeled. The model originality resides in the numerical and physical coupling between the plasma and the material considering metallic vapors. The necessity to consider one Marangoni coefficient function of the temperature to well describe the poolmotions and the flow inversions is demonstrated by comparison with experimental measurement [4]. Weld pool penetration is a major indicator of weld integrity but it is not directly measurable. The key to solving this issue is to find or create observable phenomena that can be used to derive the penetration. An innovative method has recently been proposed/developed to derive the penetration from the reflection of projected laser from an oscillating weld poolsurface. However, in addition to the penetration, the oscillation, thus the reflection determined by it, also depends on the pulse amplitude of the current, which needs to be adjusted as the control variable to feedback control the penetration as the output. This dependence imposes a constraint on the control algorithm such that the adjustment of the control variable must be relatively slow to minimize additionalsources that affect the oscillation/sensor. This restriction on the control variable adjustment also brings challenges to the identification of the dynamic model of the weld process to be controlled, which has to apply a varying control signal to stimulate the dynamics. To solve these issues, this letter proposes using a low order model to catch the dominant dynamics such that a high speed variation in the controlsignal can be avoided when choosing the model predictive control algorithm [5]. Skilled welders can estimate and control the weld joint penetration, which is primarily measured by the backside bead width, based on weld pool observation. This suggests that an advanced control system could be developed to control the weld joint penetration by emulating the estimation and decisionmaking process of the human welder. In this paper an innovative 3-D vision sensing system is used to measure the characteristic parameters of the weld pool in real-time in gas tungsteTn arc welding. The measured characteristic parameters are used to estimate the backside bead width, using an adaptive neuron-fuzzy inference system (ANFIS) as an emulation of skilled welder. Dynamic experiments are conducted to establish the model that relates the backside bead width to the welding current and speed. The dynamic linear model is first constructed and the modeling result is analyzed. The linear model is then improved by incorporating a nonlinear operating point modeled by an ANFIS. Because the weld pool needs to gradually change, being controlled by a skilled welder, a model predictive control is used to follow a trajectory to reach the desired backside bead width and the control increment is penalized. Because the weld pool is not supposed to change in an extremely large range, the resultant model predictive control is actually linear and an analytical solution is derived. Welding experiments confirm that the developed control system is effective in achieving the desired weld joint penetration under various disturbances and initial conditions [6]. Sensing technology is the key for intelligent robotic welding. Al alloy pulsed Gas Tungsten Arc Welding (GTAW) has been increasingly applied in several industries from aerospace, automobile to ships for light weight manufacturing, wherein vision sensor has shown better performance among others. However, with the disturbance of arc light and surroundings, on-line image feature extraction is still a huge challenge in terms of improving the realtime performance, stability and robustness of robotic welding vision system. In this paper, we proposed an easy methodology to quickly extract several image features for the purpose of detecting the typical welding defects of Al alloy in pulsed GTAW. First, based on the idea of vision attention, the grey levelstatistics have been calculated for three image regions of interested(ROI) both from welding pool and back seam. Then, experience-driven based certain gray interval is chosen to extract its total number of pixel as the main monitoring parameters. Furthermore, the background noise is successfully removed by using the proposed pixel ratio algorithm as well as enhancing the ratio of signal to noise. The test results indicate that the proposed method has the ability of predicting and identifying welding defects of under penetration, surface oxidation, over penetration and burning through, which certainly improves the intelligent level of robotic welding. This paper also provides some guidance for vision-based monitoring of other similar manufacturing process [7]. High speed collecting and managing system of spot welding signal can achieve the A/D conversion and data collection. The data of welding current, electrode voltage as well as welding cycle has been collected. Subsequently, they were processed with data acquisition and memory module, wavelet filtering of digit signal module, U-I curves and energy analyzing module, respectively. Based on the collections of welding current and electrode voltage, a criterion splash occurrence and the defective of loose weld by U-I curves change and acreage were proposed. The results prove that the criterion can decipher the welding splash and defective of loose weld accurately [8]. This paper details the application of Taguchi technique and regression analysis to determine the optimal process parameters for submerged arc welding (SAW). The planned experiments are conducted in the semiautomatic submerged arc welding machine and the signal-to-noise ratios are computed to determine the optimum parameters. The percentage contribution of each factor is validated by analysis of variance (ANOVA) technique. Multiple regression analysis (MRA) is conducted using statistical package for socialscience (SPSS) software and the mathematical model is built to predict the bead geometry for any given welding conditions [9]. A 1 1/2 in isolation gate valve was designed and built to prevent vacuum vessel let-up to atmosphere in the event of ion source component failure. To assure no effect on existing beam geometry, the valve thickness was held to 1 1/8 in. The valve gate consists of two disks separated by a short length of bellows. One disk, moving with the expansion and contraction of the bellows, contains the gasket in its outer face. The other disk contains a leak path from its edge to the interior of the bellows. The shaft is welded to the disk containing t10he leak path and exposes the leak path, through its hollow center, to the exterior of the valve housing. Evacuation of the bellows through the center of the shaft permits linear motion of the valve, by manual push or pull, to closed or open position. Let-up of the bellows' interior to atmosphere holds the valve gate in the position it was placed manually [10]. Summary form only given. Hybrid welding of stainless steels and aluminium alloys was performed with the heat sources of YAG laser and TIG, and YAG laser and MIG respectively. The effects of welding conditions and melt flows on penetration depth, weld bead geometry and porosity formation tendency were investigated with high-speed video observation and X-ray transmission realtime observation methods. The penetration depth was affected not by the arc current but by the laser power in TIG-YAG hybrid welding of stainless steel. On the other hand, the penetration was affected by the arc current in MIG-YAG hybrid welding of aluminium alloys. In both hybrid-welding processes, the beneficial conditions for the production of the deepest penetration were established. Moreover, the target distances between the laser beam and the electrode or wire exerted a great effect on the penetration and its geometry. The great effect of downward melt flows induced by recoil pressure against the keyhole wall and by surface tension and electromagnetic force due to the arc constriction in the molten pool on the penetration depth and geometry were consequently confirmed. Concerning porosity suppression, in YAG-TIG hybrid welding of stainless steel, no porosity formation was attributed to the generation of no bubbles from the tip of a keyhole produced with a laser beam. On the other hand, at high currents in MIG-YAG hybrid welding of aluminum alloys, disappearance of bubbles from the concave molten pool surface played an important role of reduced porosity [11].

2. PROBLEM IDENTIFICATION

A Gate valve made with a material of Carbon Steel employed in Pressure Vessel. There are four plates which are joined with help of SAW. where the inner coating is done with the help of Nickel .After the process of welding there was a `defect and it was porosity in all the four corners so this material has to be reworked and we took sample material for testing and reworking the sample material which has to be reworked undergone SAW at 400 degree Celsius has resulted in distortion .since there was a distortion in sample material we moved to the next solution of applying TIG on the pores formed on the work piece. As the TIG welding applied on the spots of the pores there was a heat transfer which occurred Inside a work material there were some wears in Nickel coating .hence, to overcome this problems we placed the wet cloth at the place of TIG welding where there were pores and is helped to avoid heat transfer .This was successful which is resulted in no pores on the material we also perform the Die penetrant test on the work material in order to prove that there was no pores and that was too successful.

3. PRINCIPLES OF WELDING

3.1 SUBMERGERGED ARC WELDING

Submerged arc welding (SAW) is a common arc welding process. The first patent on the submerged-arc welding (SAW) process was taken out in 1935 and covered an electric arc beneath a bed of granulated flux. Originally developed and patented by Jones, Kennedy and Rothermund, the process requires a continuously fed consumable solid or tubular (metal cored) electrode.] The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under a blanket of granular fusible flux consisting of lime, silica, manganese oxide, calcium fluoride, and other compounds. When molten, the flux becomes conductive, and provides a current path between the electrode and the work. This thick layer of flux completely covers the molten metal thus preventing spatter and sparks as well as suppressing the intense ultraviolet radiation and fumes that are a part of the shielded metal arc welding (SMAW) process. SAW is normally operated in the automatic or mechanized mode, however, semi-automatic (hand-held) SAW guns with pressurized or gravity flux feed delivery are available. The process is normally limited to the flat or horizontal-fillet welding positions (although horizontal groove position welds have been done with a special arrangement to support the flux). Deposition rates approaching 45 kg/h (100 lb/h) have been reported — this compares to ~5 kg/h (10 lb/h) (max) for shielded metal arc welding Although currents ranging from 300 to 2000 A are commonly utilized,] currents of up to 5000 A have also been used (multiple arcs). Single or multiple (2 to 5) electrode wire variations of the process exist. SAW strip-cladding utilizes a flat strip electrode (e.g. 60 mm wide x 0.5 mm thick). DC or AC power can be used, and combinations of DC and AC are common on multiple electrode systems. Constant voltage welding power 20 supplies are most commonly used; however, constant current systems in combination with a voltage sensing wire-feeder are available.

3.2 TUNGSTEN ARC WELDING

Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a nonconsumable tungsten electrode to produce the weld. The weld area and electrode is protected from oxidation or other atmospheric contamination by an inert shielding gas (argon or helium), and a filler metal is normally used, though some welds, known as autogenously welds, do not require it. When helium is used, this is known as heli arc welding. A constant-current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionized gas and metal vapours known as a plasma. GTAW is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminium, magnesium, and copper alloys. The process grants the operator greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, GTAW is comparatively more complex and difficult to master, and furthermore, it is significantly slower than most other welding techniques. A related process, plasma arc welding, uses a slightly different welding torch to create a more focused welding arc and as a result is often automated.

4. CARBON STEEL

Carbon steel is an iron-carbon alloy, which contains up to 2.1 wt.% carbon. For carbon steels, there is no minimum specified content of other alloying elements, however, they often contain manganese. The maximum manganese, silicon and copper content should be less than 1.65 wt.%, 0.6 wt.% and 0.6 wt.%, respectively.

4.1 Types of carbon steel and their properties

Carbon steel can be classified into three categories according to its carbon content: low-carbon steel (or mild-carbon steel), medium-carbon steel and highcarbon steel .

4.2 Production and processing

Carbon steel can be produced from recycled steel, virgin steel or a combination of both. Virgin steel is made by combining iron ore, coke (produced by heating coal in the absence of air) and lime in a blast furnace at around 1650 °C. The molten iron extracted from the iron ore is enriched with carbon from the burning coke. The remaining impurities combine with the lime to form slag, which floats on top of the molten metal where it can be extracted. The resulting molten steel contains roughly 4 wt.% carbon. This carbon content is then reduced to the desired amount in a process called decarburisation. This is achieved by passing oxygen through the melt, which oxidises the carbon in the steel, producing carbon monoxide and carbon dioxide.

5. ACTIVITIES PERFORMED IN THIS EXPERIMENT

STEP 1: the saw process performed in the gate valve die penetration test applied

STEP 2 : Then the fault location in the gate valve are identification

STEP 3: The sample material choosen is carbon steel of grade. 44

STEP 4: Edge preparation is done in sample material.

STEP 5: Using pickling solution cleaning process is done.

STEP 6: SAW is performed at the middle and TIG at the ends. 45

STEP 7: DP test is performed.

STEP 8: Resulted with no defects.

STEP 9: The same procedure is repeated in order to order to obtain defect free gate valve in pressure vessel.

6.WELDING TESTING / NDE EXAMINATION

There are five basic NDT methods used to detect weld defects:

1. Visual Inspection (VT)
2. 2 . Magnetic Particle Testing (MPT)
3. 3. Dye Penetrate Liquid Testing (DPI)
4. 4. Radiographic Testing (RT)
5. 5. Ultrasonic Testing (UT)

6.1 Visual inspection:

Many welding flaws are macroscopic: crater cracking, undercutting, slag inclusion, VI is particularly effective detecting macroscopic flaws, such as poor welds. incomplete penetration welds, and the like. Like wise, VI is also suitable for detecting flaws in composite structures and piping of all types. Essentially, visual inspection should be performed the way that one would inspect a new car prior to delivery, etc. Bad welds or joints, missing fasteners or components, poor fits, wrong dimensions, improper surface finish, delaminations in coatings, large cracks, cavities, dents, inadequate size, wrong parts, lack of code approval stamps and similar proofs of testing.

6.2 Radiography:

Radiography has an advantage over some of the other processes in that the radiography provides a permanent reference for the internal soundness of the object that is radiographed. The x-ray emitted from a source has an ability to penetrate metals as a function of the accelerating voltage in the x-ray emitting 47 tube. If a void present in the object being radiographed, more x-rays will pass in that area and the film under the part in turn will have more exposure than in the non-void areas. The sensitivity of x-rays is nominally 2% of the materials thickness. Thus for a piece of steel with a 25mm thickness, the smallest void that could be detected would be 0.5mm in dimension. For this reason, parts are often radiographed in different planes. A thin crack does not show up unless the x-rays ran parallel to the plane 0 the crack. Gamma radiography is identical to x-ray radiography in function. The difference is the source of the penetrating electromagnetic radiation which is a radioactive materialsuch m Co 60. However this method is less popular because of the hazards of handling radioactive materials.

6.3 Liquid (Dye) penetrant method:

Liquid penetrant inspection (LPI) is one of the most widely used nondestructive evaluation (NDE) methods. Its popularity can be attributed to two main factors, which are its relative ease of use and its flexibility. The technique is based on the ability of a liquid to be drawn into a "clean" surface breaking flaw by capillary action. . This method is an inexpensive and convenient technique for surface defect inspection. The limitations of the liquid penetrant technique include the inability to inspectsubsurface flaws and a loss of resolution on porous materials. Liquid penetrant testing is largely used on nonmagnetic materials for which magnetic particle inspection is not possible. Materials that are commonly inspected using LPI include the following; metals (aluminum, copper, steel, titanium, etc.), glass, many ceramic materials, rubber, plastics. Liquid penetrant inspection is used to inspect of flaws that break the surface of the sample. Some of these flaws are listed below; fatigue cracks, quench cracks grinding cracks, overload and impact fractures, porosity, laps seams, pin holes in welds, lack of fusion or braising along the edge of the bond line 48 Magnetic particles: Magnetic particle inspection is one of the simple, fast and traditional nondestructive testing methods widely used because of its convenience and low cost. This method uses magnetic fields and small magnetic particles, such as iron filings to detect flaws in components. The only requirement from an inspect ability standpoint is that the component being inspected must be made of a ferromagnetic material such iron, nickel, cobalt, or some of their alloys, since these materials are materials that can be magnetized to a level that will allow the inspection to be effective. On the other hand, an enormous volume of structural steels used in engineering is magnetic. In its simplest application, an electromagnet yoke is placed on the surface of the part to be examined, a kerosene-iron filling suspension is poured on the surface and the electromagnet is energized. If there is a discontinuity such as a crack or a flaw on the surface of the part, magnetic flux will be broken and a new south and north pole will form at each edge of the discontinuity. Then just like if iron particles are scattered on a cracked magnet, the particles will be attracted to and cluster at the pole ends of the magnet, the iron particles will also be attracted at the edges of the crack behaving poles of the magnet. This cluster of particles is much easier to see than the actual crack and this is the basis for magnetic particle inspection. For the best sensitivity, the lines of magnetic force should be perpendicular to the defect.

6.4 Ultrasonic Inspection:

Ultrasonic Testing (UT) uses a high frequency sound energy to conduct examinations and make measurements. Ultrasonic inspection can be used for flaw detection I evaluation, dimensional measurements, material characterization, and more. A typical UT inspection system consists of several functional units, such as the pulses/receiver, transducer, and display devices. A pulser/receiver is an electronic device that can produce high voltage electrical pulse. Driven by the 49 pulser, the transducer of various types and shapes generates high frequency ultrasonic energy operating based on the piezoelectricity technology with using quartz, lithium sulfate, or various ceramics. Most inspections are carried out in the frequency rang of 1 to 25MHz. Couplants are used to transmit the ultrasonic waves from the transducer to the test piece; typical couplants are water, oil, glycerin and grease. The sound energy is introduced and propagates through the materials in the form of waves and reflected from the opposing surface. An internal defect such as crack or void interrupts the waves' propagation and reflects back a portion of the ultrasonic wave. The amplitude of the energy and the time required for return indicate the presence and location of any flaws in the workpiece. The ultrasonic inspection method has high penetrating power and sensitivity. It can be used from various directions to inspect flaws in large parts, such as rail road wheels pressure vessels and die blocks. This method requires experienced personnel to properly conduct the inspection and to correctly interpret the results. As a very useful and versatile NDT method, ultrasonic inspection method has the following advantages; sensitivity to both surface and subsurface discontinuities, superior depth of penetration for flaw detection or measurement, ability to single-sided access for pulse-echo technique, high accuracy in determining reflector position and estimating size and shape, minimal part preparation, instantaneous results with electronic equipment, detailed imaging with automated systems, possibility for other uses such as thickness measurements. Its limitations; necessity for an accessible surface to transmit ultrasound, extensive skill and training, requirement for a coupling medium to promote transfer of sound energy into test specimen, limits for roughness, shape irregularity, smallness, thickness or not homogeneity, difficulty to inspect of coarse grained materials due to low sound transmission and high signal noise, necessity for the linear defects to be oriented parallel to the sound beam, necessity for reference standards for both equipment calibration, and characterization of flaws. 50

6.5Procedure:

6.5.1 Liquid penetrate method:

In this method the surfaces to be inspected should be free from any coatings, paint, grease. dirt, dust, etc., therefore, should be cleaned with an appropriate way. Special care should be taken not to give additional damage to the surface to be inspected during the cleaning process. Otherwise, the original nature ofsurface could be disturbed and the results could be erroneous with the additional interferences of the surface features formed during the cleaning process. Surface cleaning can be performed with alcohol. Special chemicals like cleaner-remover can also be applied if needed. In the experiment, only cleaner-remover will be sufficient. Subsequent to surface cleaning, the surface is let to dry for 2 minutes. Commercially available cans of liquid penetrant dyes with different colors are used to reveal the surface defects.

Steps used in the experiment:

1. Clean the surface with alcohol and let surface dry for 5 min.

2. Apply the liquid penetrant spray (red can) to the surface and brush for further penetration. Then, wait for 20 min.

3. Wipe the surface with a clean textile and subsequently apply remover spray (blue can) to remove excess residues on the surface and wait for a few min.

4. Apply the developer spray (yellow can) at a distance of about 30cm from the surface. The developer will absorb the penetrant that infiltrated to the surface features such as cracks, splits, etc., and then reacted with it to form a geometric shape which is the negative of the geometry of the surface features from which the penetrant is sucked.

5. The polymerized material may be collected on a sticky paper for future evaluation and related documentation, if needed.

7. CONCLUSION

Welding distortion and defects were identified on the parent material and it was rectified using alternative welding technology on the sample material then it was applied on the parent material. There was no formation of welding defects on the parent material.

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