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Feasibility Study of Er70s Solidwire for Wire Arc Additive Manufacturing using Mig Welding

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ABSTRACT: Study of weld quality in gas metal arc welding under varied welding parameters Experiments analyses and optimization

This study investigates the influence of varying welding parameters on weld quality in gas metal arc welding (GMAW). Experiments are conducted to analyze the effects of process variables such as current, voltage, travel speed and shielding gas composition on mechanical properties, microstructure and defect formation in the weld joints.

The research employs statistical methods and optimization techniques to identify optimal parameter settings that maximize tensile strength, minimize porosity and improve overall weld integrity. Results provide guidelines for adjusting GMAW parameters to achieve desired weld quality for different material thicknesses and joint configurations.

The work contributes to efficient process control and quality assurance in industrial welding applications.

Keywords: Wire Arc Additive Manufacturing, MIG welding, ER70S solid wire, feasibility study, deposition rate, metallurgical properties, weld bead geometry, mechanical properties, additive manufacturing, process optimization

I. INTRODUCTION

Gas metal arc welding (GMAW) is an arc welding process in which the source of heat is an arc formed between consumable metal electrode and the work piece with an externally supplied gaseous shield of gas either inert such as argon and /or helium .Weld quality mainly depends on features of bead geometry, mechanical-metallurgical characteristics of the weld as well as on various aspects of weld chemistry, and these features are expected to be greatly influenced by various variables such as welding geometry, groove angle, shielding type and mixture, and different input parameters: current, voltage, electrode stick-out, gas flow rate, edge preparation, position of welding, welding speed, nozzle to plate distance etc. Moreover, the cumulative effect of various input parameters determines the extent of joint strength that should meet the functional aspects of the weld in practical field of application. Therefore, preparation of a good quality weld seems to be a challenging job. Dissimilar metal combination between Ferritic stainless steels and Austenitic stainless steels is in demand in certain applications, and, for example, it is commonly employed in $TiCl_4$ reduction retorts, because Austenitic stainless steel has good creep strength and oxidation resistance which are required in the higher temperature regions, while Ferritic stainless steel is preferred to avoid the problem of nickel leaching by molten magnesium

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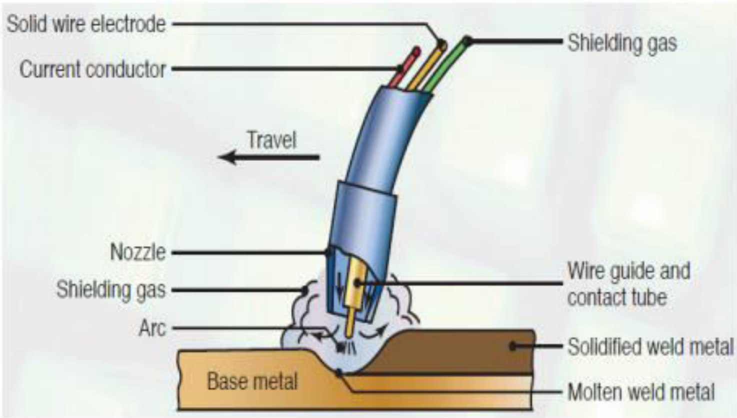

II. EQUIPMENT USED IN GMAW

The basic equipment required for a semi-automatic GMAW system consists of a power source, welding gun, wire feed unit, electrode wire, shielding gas supply system, and a water cooling system, if used. Some basic features of the equipment are discussed here:

a) Power source:
b) b) Welding gun and wire feed unit
c) Shielding gas supply

III. STAINLESS STEELS

Steels are the alloys of iron and carbon in which, the carbon content is in between 0.08 and 2.0 percent. When the carbon percentage is increased beyond 2%, it is called cast iron. Commercial available steels always contain some amounts of other elements. If these elements are accidentally present without any intention, these are called impurities. However, if they are added purposely, they are called alloying elements. Stainless steels are iron-base alloys that contain a minimum of 11- 12% Cr, the amount required to prevent the formation of rust in atmospheres (hence the designation stainless). At this 12 minimum level of chromium, a thin protective self-healing film of Cr_2O_3 forms spontaneously on the outer surface of steel, which acts as a barrier to protect the steel from corrosion by healing itself in the presence of oxygen.

a) Austenitic stainless steels
b) Ferritic stainless steels
c) Martensitic stainless steels
d) Martensitic stainless steels
e) Martensitic stainless steels

IV. WELDING OF STAINLESS STEEL

Most stainless steels are considered to have good weldability, except martensitic stainless steels and may be welded by several welding processes including the arc welding processes, resistance welding, electron and laser beam welding, friction welding and brazing. Generally, welding of martensitic stainless steels is difficult. Austenitic stainless steels are also weldable, comfortably and can be welded by GTAW, GMAW and other processes. The low thermal and electrical conductivity of Austenitic stainless steel is generally beneficial in welding. They have high rate of thermal expansion when welded. The coefficient of thermal expansion for the Austenitic stainless steels is 50% greater than that of carbon steel and this must be considered to minimize distortion.4. Experimental Setup, Results and Bearing Fault Detection

V. INSPECTION AND TESTING OF WELDS

To produce quality in welded joint, it is necessary to keep an eye on what is being done in three different stages in welding:

- Before welding such as cleaning, edge preparation, baking of electrode etc. are to be done to ensure quality weld joints

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- During welding manipulation of heat source, selection of input parameters (gas flow rate, welding current, arc gap, welding speed, welding voltage etc.) affecting the heat input and protection of the weld pool from atmospheric condition needs to be cared for.
- After welding removal of slag peening, post welding treatment are required in many cases.

NON-DESTRUCTIVE TESTS

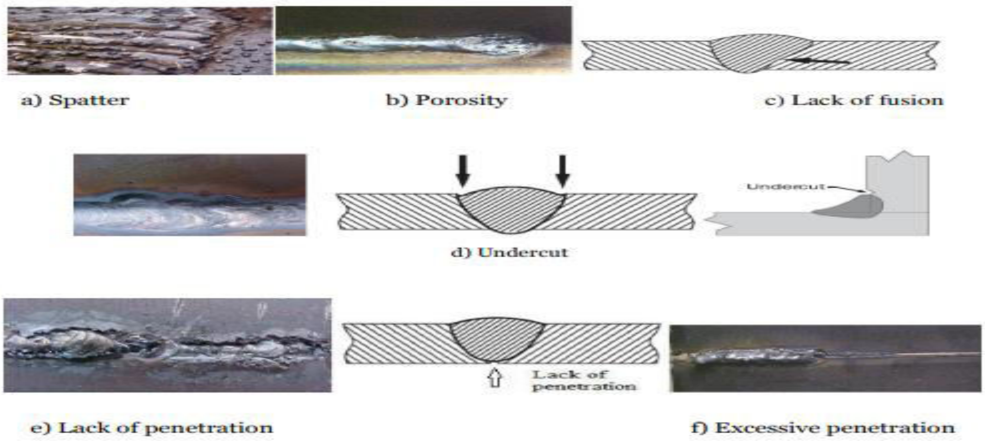
Non-destructive tests as applied to weld are visual, ultrasonic, and radiographic (X-ray). All the non-destructive tests have good potential to check the flaw in weldment.Radiographic inspection: X-ray is used to determine the internal soundness of welds. Radiography is based on the ability of X-rays and gamma rays to pass through metal and other materials opaque to ordinary light, and produce photographic records of the transmitted radiant energy. All materials will absorb known amounts of this radiant energy, and therefore, X-rays and gamma rays can be used to identify discontinuities and inclusions within the opaque 16 material. An X-ray image of the interior of a weld may be viewed on a fluorescent screen as well as on developed film. This makes it possible to inspect parts faster and at a lower cost.

a) DESTRUCTIVE TESTS
1. Tensile test
2. Bend test
3. Hardness test
4. Toughness test
5. Fatigue test

VI. WELDING DEFECTS

A weld defect is any flaw that compromises the usefulness of a weldment. Welding defects can greatly affect weld performance and longevity. According to ASME, cause of welding defects 18 are broken down as follows: 45% poor process conditions, 32% operator error, 12% wrong technique, 8% incorrect consumables, 3% bad weld grooves. General welding defects are given below:

a) Overlap
b) Undercut
c) Cracking
d) Lamellar tearing
e) Porosity
f) Misalignment
g) Spatter
h) Inclusions



VII. SCOPE AND OBJECTIVE OF THE PRESENT WORK

GMAW/MIG has been invented in 1940's; in recent years different new welding processes have come into use but still GMA welding is one of the important welding processes for stainless steel whenever quality and productivity are concerned. Research works have indeed been done in the field of GMA welding of Austenitic stainless steel and Ferritic stainless steel. Several aspects in this context have been investigated. Literature survey, as given above, however,

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indicates that research is still being continued. It suggests there is a need of further extensive research in the area of gas metal arc welding. In so far as gas metal arc welding of Austenitic stainless steel and Ferritic stainless steel is concerned, knowledge-base is not sufficiently rich. More studies are required on various aspects of gas metal arc welding of Austenitic stainless steel and Ferritic stainless steel with the objective of achieving desired quality of weld. In doing so, parametric optimization, mathematical modelling, analysis of weld pool solidification and heat transfer, metallographic characterization, development of ANN or PNN models, analysis of joint performance etc. become important. Extensive investigation relating to all these aspects will lead to create a strong knowledge-base which will help people in practical field to use GMAW in a more predictable way, ensuring desired quality of weld. Further, dissimilar welding is now in demand and is used in some specific areas covering different industries. The complexity and problems exist. This provides scope of extensive research in the area of dissimilar welding. Apart from the present applications and demand of dissimilar welding, it is felt that, development in different aspects on dissimilar welding in different combinations of materials may lead to generate more useful application and demand. Ferritic/austenitic (F/A) joints are a popular dissimilar metal combination used in many applications and these joints have huge demand in industries like petrochemical industries, ship industries, nuclear power plants, pulp and paper, etc. F/A dissimilar joints are based on both technical and economic aspects i.e. these dissimilar joints can provide satisfactory performance with reasonable cost savings. Joining of dissimilar F/A materials is not an easy task; it is considered to be a challenging problem due to differences in thermal conductivities and thermal expansion which may cause crack formation at interface. In dissimilar metal welding, base metal contributes 15% dilution from each metal 49 while the filler metal contributes 70% to the total weld nugget composition. When welding dissimilar metals, good solid solubility is essential for sound weld properties. The trends of welding similar/ dissimilar metals present considerable challenges, still now. Welding of Ferritic and Austenitic stainless steel in general and GMAW welding of such steels in particular, can well be considered as one of the areas where more extensive research may contribute, in a significant way, to the precise control of the welding process for better and acceptable quality of weldment.

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