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Effect of Filler Rod on Microstructure and Mechanical Properties of Bimetallic Weld Joint: A Review

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Abstract- Friction Stir Welding (FSW) technique is a solid state metal joining process. The metal on welding does not melt and recast. Some of the defects commonly encountered in FSW are tunnel defect, kissing bond, cracks, pin holes and pipping defects. The defects occur because of improper metal mixing and lower heat input in the weld nugget zone. Only a literature has focused on the area of filler material and the process parameters on producing a defect free weld with optimal responses. There are different issues which should be tended to while welding the bimetallic metals because of the variety in the properties of the base metal. The coefficient of warm extension, substance organization and mechanical properties influence the weld ability of the joint. For keeping up this issue buttering method is utilized for such joints. It is very hard to choose the consumable cathode for buttering layers, which will fulfill the necessity of attractive mechanical properties and synthetic organization. Carbon relocation is one of the significant issues for buttering layer affidavit.

Keywords- Bimetallic, FSW, Steel , Aluminium.

I. INTRODUCTION

The welding process can be carried out on the same or unequal metal. It is possible to weld metals of various kinds and chemical compositions together. The welding current, unlike welding current, holding time, welding force, etc., can be affected by the inclusion of various mechanical properties during the welding process and in two different metal microstructures.

Metals have a remarkable chemical makeup. Metal chemical composition may differ due to ageing, oxidation, and other circumstances. Since the welded structure can be positioned in potentially hazardous locations, research into wilding's mechanical qualities is critical. There is a risk of intermetallic compound formation, which might have a negative impact on the weld quality. To combine various materials [1] under various conditions, welding is now widely employed in many sorts of industries. It is often considered as a part of design and innovation. [2]

This type of stainless steel is ideal for gas metal arc welding (GMAW). A copper-covered wire with a consistent thickness is used in GMA welding as a joining method. MIG-welding has a number of advantages over traditional welding [2].

There are numerous industries that use hardened steel, such as the compound and petrochemical sectors as well as biomedicine and atomic reactors, because of its high elasticity [3, 4].

One of the welding-boundaries that effects the qualities of the welding connection as well as the shape and infiltration design in welding measurements is the protection of gas stream rate [5, 6]. During the welding process, it is beneficial to take precautionary measures to ensure that the welded junction will be strong, durable, and resistant to erosion [7]. Protecting the gas shields the liquid metal pool from any climatic defilement, as well as settling the bend and promoting uniform metal exchange in welding [8].

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Advancement requires fast creation structures. Welding is a proficient interaction where two materials of the equivalent or diverse design are for all time added together. Diverse structural materials or welding techniques necessitate the use of different welding procedures in many industrial and commercial constructions.

These conditions result in uneven metal welding. An excellent weld is a weld via normal tensile-strengthen & flexibility as the joints for the welded joint does not fail. The main problem with uneven metal welded joints is the formation of intermetallic compounds in the weld zone. These intermetallic compounds should be related to disturbance relating to cracked-sensitivity, ductile-corrosion, & the like. This makes the study of microstructures important for the study of the formation of intermetallic compounds, indicating residual stresses in developed regions.

Due to the reduced temperature, the toughness may undergo a brittle transition, which may later cause weld failure due to such brittleness. To avoid the production of intermetallic compounding, an intermediates layer of nickel/vanadium is utilised. When two metals are melted or filled into a work piece during the welding process, the liquid metal solidifies creating a solid junction. Composite inclusive is one of many methods for incorporating irregular metals into a finished product. Add a third substance between the two metals that are facing each other in order to finish this operation.

The different welding process like resistance-spots welding process , FSW , arc welding , cold-welding ultrasonic-welding , explosive-welding and diffusion-welding etcare a few of the welding processes available for use with uneven metals. Moving the metals together is the key to explosive welding. Metal pieces are accelerated to extremely high speeds with the use of any form of explosive. Welding processes that use explosives.

There are certain advantages to using explosive welding. Attaching it to a large surface is easy, and it has no effect on the metal's actual or perceived performance. Additionally, it is limited to welding simple geometries, creating loudness and huge vibrations as a result of the explosions that take place during the welding process. When using GTAW, or TIG, a non-consumable, non-destructive tungsten terminal is connected to a weld able work piece, and the weld is held in place by an inert gas. As a result, it's commonly employed in the development of train vehicles, automobiles, and synthetics. Because of its high resistance to wear and tear, tempered steel is a crucial component in the manufacturing process. TIG is a welding technique commonly used to join uniformly tempered steel in a variety of configurations.

Hardened steel, the most widely used form of treated steel, has been found to be the material of choice for many projects. Weld depiction, various metal welding, boundary enhancement, measure demonstration, issue investigation, and robotization of the TIG welding procedure are the main areas of investigation.

GTAW welding is a bend welding technique that uses an electric curve to combine energy from a work piece and tungsten terminal. An inert protective gas shields the terminal and weld pool from harmful effects of the weather during welding. To get to the gas weld zone, the shield passes through the gas spout. Unlike other bend welding methods that use anodes like MIG/MAG and MM, TIG welding does not use cathodes like other methods.

As a result of its low weight and consumption resistance, treated steels are frequently applicable in the fabrication of sheet-metaling in automobiles & other transportation vehicles. The term "hardened steel" refers to a collection of metaling-alloys along-with a Cr contents greater than 10.5% & carbon proportion greater than 1.20 percent (as indicated by European standard N10088). As an example, nickel and molybdenum are among the most common components.

II. LITERATURE SURVEY

According to **M. Sireesha et al. (2002) and A.K. Bhaduri et al. (1999) [1-2],** the joint's service life can be prolonged by reducing the cycle warm pressure by increasing the coefficient of warm extension of the composite portion. Using a filler material with a warm extension coefficient (CTE) between carbon steel and treated steel is one way to get there. Due to differences in warm development coefficients, these joints have been shown to induce significant warm anxiety during temperature changes [3].

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According to **Mitchell et al. (1978) and Christoffel et al. [4-5],** carbon moves from high temperatures to low temperatures. As a result, carbon relocation bimetal weld junctions have failed.

In the work **of J. N. Dupont et al.,** for this purpose, they make use of the filler SS 308 L. The carbon content of SS 308L weld filler is limited to a maximum of 0.30% in order to reduce the possibility of carbide precipitation between the particles. Steels like 304, 321 and 347 can be easily welded with the stainless steel 308L. It's a low-temperature application wire, as the name suggests [6].

R. Chhibber et al., (2006) [7], Stainless steel 304 L is utilized for essential evaporator tubes. These prepares are gotten as rectangular squares. Bimetal welded joints are generally utilized in huge hardened a wide range of high-temperature applications for steel and carbon steel transformation frameworks Due to the fact that carbon steel evaporator cylinders and heat exchangers are used in steam power plants, the segments of the heater are exposed to low temperatures. Warmers, for example, are formed of treated steel and work on the final phase of the super radiator, when creep force and drag should be expanded.

A. M. Meyer et al., (2001) [8], The welding of 11-12% chrome steel is a conventional issue in the advancement of tempestuous particles in the warmth influenced zone of ferritic tempered steel. In the event that austenite can be recuperated at high temperatures on the ferrite grain limits, the development of the grains can be interfered. This paper examines the likelihood that the spread of weld metal can expand the carbon or nitrogen substance of the warmth influenced zone, so as far as possible can settle the austenite. In this manner, lessening the margarine will assist with keeping away from/decrease the disappointment related with the remaining pressure of one-20th of the welded joint.

Human Mehdi and his colleagues (2016) Mechanical properties of welded connections were evaluated using grinding mix welding, which is dependent on the combined influences of composite and handling boundaries [9].

Graham Gedge, (2008), for blast-proof buildings, stainless steel is a superb choice because of its high strength, excellent energy retention capabilities, and high flexibility. Using a pressure bend in the plastic reach ensures a level of blockage comparable to carbon steel. It is more self-evident that tempered steel can feel a similar strength to carbon steel at a quick elastic rate, especially 0.2 percent strain in the field in the previous 20 years, than it is for carbon steel. The exploration programmed has looked for direction to build up these stretch rate impacts in austenitic and duplex treated steels just as hardened steel plans in antiknock designs [10].

P.K. Sharma et al There are a variety of uses for SS fabrication's underlying and non-primary segments around the globe. Iron, chromium, nickel, and a variety of molybdenum alloys make up these preparations. The chromium concentration and expansion of molybdenum and nitrogen are the hallmarks of tempered steel's abrasion resistance. Nickel is primarily used to ensure the steel's mechanical characteristics and appropriate microstructure. Adding other alloying components, such as high temperature performance, increased strength, or unusual preparation courses, can enhance unique aspects of hardened steel [11].

Bimetal welded joints are commonly used in large toughened steel and carbon steel in various high temperature applications of energy transformation frameworks, according to Deepak Bhandari et al., (2017). Carbon steel evaporator cylinders and heat exchangers in steam power plants necessitate that the heater's segments be kept at low temperatures in order to save money. When working on the last stages of a super-radiator, parts such as warmers use hardened steel that expands creep force and drag at high temperatures [12].

R. Kacar et al., (2004), [13], Welding between the bimetallic part and the bimetallic of the SS is required in the construction of the apparatus. When soldering using the SS-LAS interface, the bimetallic content is soldered to a minimum depth of 2 mm after removal of the SS cladding. It is used to facilitate welding from LAS to LAS. In the case of SS, a pure austenitic SS steel buffer layer and corrosion resistant SS were used to remove and store the bipolar welded composite. Pure austenite is made using bimetallic welding consumables that are used in the LAS buffer layer to provide the necessary mechanical properties and weld metal for the desired chemicals, welded to corrosion resistant SS consumables made of stainless steel. Bimetal for SS

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welding: Corrosion resistant SS consumables are used for branching of bilateral and SS weld deposits. There is a need for bimetallic welding in compressed water reactor and bubbling water reactor designs, where large areas of low compound steel parts are connected to hardened steel vital channeling frameworks, according to A.K. Bhaduri et.al (1994).

Because the characteristics of the base metals change during welding, some considerations must be made when joining two metals together. Issues related to bimetallic welds are discussed in this study, as well as the significant studies conducted by various analysts. Thermal energy plants commonly use BMWs to join low-compound steels and tempered steels together [14].

M. Sireesha et al., (2000), It was discovered that the hot leg tube of the RPV spout was the cause of thermal breaking in the BMW. Thick-walled, enormously sized hot leg tubes are common in the lingerie industry. Non-welded metal is typically used to join ferritic pressure vessel steel to the hardened steel tube. Using austenitic welds, which include 4-10 volts of delta ferrite and fine dendrites, can induce breakage, strains, and significant impacts [15].

A change material Alloy 800H, which has a coefficient of warm development between the 2-1/4 Cr-1Mo ferritic steel and the Type 316 austenitic treated steel, was shown to greatly reduce the bimetallic joint pressure. A variety of filler metals were compared to Types 309, 312, 347, and 16-8-2, and their relative advantages and disadvantages were highlighted. Type 16-8-2 weld metal was found to be the least gap-sensitive, while Type 347 was shown to be the most vulnerable to hot breaking. In spite of Type 312's modest breakdown, it included a tremendous amount of delta ferrite that may transform to sigma stages when administered at high temperatures [16].

In the steam generators of power plants, austenitic toughened steel and chromium-molybdenum (Cr-Mo) ferritic steel are commonly used in bimetallic evaluations of progress metal joints. Bimetallic junctions using Ni-base weld metals instead of austenitic SS weld metals were discussed by the agents. A new tri-metallic change metal arrangement of austenitic hardened steel (SS 304)/Alloy 800/ferritic steel was proposed by the researchers (2.25Cr-lMo). Similar opinions have been expressed about Inconel 182 and 16-8-2 welding consumables for the type 304 SS/Alloy 800 junction. For welding a junction between SS304 and Alloy 800, the 16-8-2 consumable was shown to be superior to Inconel 182 due to its lower propensity for micro fissuring and lower coefficient of warm extension over the joint. As an additional consideration, the mechanical qualities of the joint at elevated temperatures are only a minor penalty for using 16-8-2 welding consumables [17].

III. RESEARCH GAP

Gas tungsten arc welding has gotten a lot of attention recently, as evidenced by a study of the literature. Micro structural alterations and their impact on mechanical characteristics of the welded material have also been researched by several researchers, who looked at how they affected the mechanical properties of various parameters. Researchers have also used taguchi design of experiments and analysis of variance to improve the tungsten arc welding process. When using ANSYS software, some researchers have tested real-world data against theoretical data generated by the software.

Mild steel and stainless steel have been studied extensively by researchers using various welding processes, however the mechanical properties associated with the weld between Mild steel and stainless steel with filler metal have not yet been documented. In this study, it is proposed to compare the effects of a welded joint made of mild steel and SS202 with two different filler rods.

IV. PROPOSED WORK

1. Base Materials:

Bimetal welded joints are generally utilized in enormous treated steel and carbon steel in numerous high temperature utilizations of energy change frameworks. In steam power plants, the segments of the evaporator are exposed to low temperatures for financial reasons in light of the fact that the essential heater cylinders and warmth exchangers are made of carbon steel.

Different parts, for example, super radiators and creep strength and hostile to oxidation work on it. The material utilized in pressing factor vessel and

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essential heater is Mild steel and treated steel SS 202. These prepares were gotten as rectangular square.

2. Filler Materials:

In this work, SS308L and SS316L filler bar is accustomed to welding mellow steel and treated steel SS202. It is exceptionally alloyed austenitic steel utilized for its great oxidation obstruction, creep opposition and high temperature strength. The lower nickel substance of SS 308L improves protection from Sulfur append at high temperature. It is bendable and extreme and can be promptly created and machined. It is an appropriate wire for application at cryogenic temperatures.

3. Chemical-Composition:

Chemical composition of Mild Steel and Stainless steels are given in table 1 and 2 respectively.

Table 1. Chemical composition of Mild Steel. [13]

Type of Carbon steel	C	Mn	P	S	Si
Mild Steel	0.19	1.2-1.5	0.006	0.002	0.07-0.1

Table 2. Chemical composition of Stainless steel. [13]

Type of Stainless steel	C	Mn	Si	Cr	Ni	P	S
SS202 (base material)	0.03	2.0	1.0	18.0-20.0	8.0-12.0	0.045	0.03
SS308 L (filler material)	0.03	2.0	1.0	19.0-21.0	10.0-12.0	0.045	0.03
SS316 L (filler material)	0.03	2.0	1.0	22.0-24.0	12.0- 15.0	0.045	0.03

4. Mechanical & Physical Properties:

Mechanical and physical properties of Mild steel and stainless steels are given in table 3.

Table 3. Mechanical and physical properties of SS and Mild Steel. [13]

Type of steel	Tensile strength (MPa)	Yield strength (MPa)	Elastic modulus (GPa)	Thermal coeff. (10^{-6}m/m°C)	Density (Mg/m^3)
Mild Steel	450–585	240	200	11.7	7.8
SS202	515	275	207	17.2-18.4	7.8-8.0
308L	618	448-460	190-210	17.2-18.4	7.7-8.03
316L	644	489	190-210	15.0-17.2	7.7-8.03

V. METHODOLOGY

1. Sample Preparation:

To distinguish and assess the microstructure of the material, it is vital to deliberately and appropriately set up the test. The various strides in setting up an example for microstructure assessment include:

- Select a delegate test of the material
- Sample areas to abstain from changing or obliterating constructions of interest
- Mounting the segment without the obliteration of test tests
- Grinding the example surface to get a level example with negligible harm
- Polished the mounted and ground test.

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