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Comprehensive Study of Cast Iron Welding by using Different Electrode, with the Help of Destructive Testing

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Abstract **- The problematic welding characteristics of the cast iron originate majorly from the high carbon content of the material. On welding and cooling, the carbon makes formation of various undesired microstructures possible, reducing the weld ability a great deal in all regions related to welding. For welding cast iron material by using hot welding process according to the preheating temperatures ranges. the lower preheating temperatures are nonsufficient for lowering the cooling rate to the desired values and hence formation of brittle phases as martens tic and carbides are encountered.For these cases generally Ni based electrodes are used. Ni based fillers are weaker than steel alloys and yields higher ductility. Increased ductility suspends crack formation especially in case of martens tic transformation and additionally Nickel bonds with Carbon preventing formation of iron carbide. Despite these superior properties, Ni electrodes provide relatively lower mechanical properties with respect to steel.**

Keywords- **Weld ability, Welding processes, Chemical composition, Cast iron material, Destructive testing, Nickel Alloy Electrode, SMAW, MIG, OAW.**

I. INTRODUCTION

Welding is a permanent joining process used to join different materials like metals, allora plastics, together at their contacting surfaces by application of heat and of pressure Drum welding, the work-pieces to be joined are melted at the interface and her solidification a permanent joint can be achieved. Sometimes a filler material is added to form a weld pool of molten material which after solidification gives a strong bond between the materials. Weld ability of a material depends on different factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position.

Weld ability of cast iron has been found to be very poor due to the heterogeneity of matrix phase and non-wettability of the graphite phase. These phases undergo a series of micro structural changes in the HAZ during weld repairing by fusion welding the project discusses the nature of these changes occurring in the vicinity of the weld zone as well as method of controlling these to get satisfactory weldment.

Preheating must be sustained for a time sufficient to avoid marten site formation and to prevent secondary graphite from developing in the matrix upon annealing for multi pass welding. The effect of preheat is to reduce residual stresses, distortion, prevent cold cracking and reduce the hardness in the HAZ in this study, the HAZ structures and mechanical properties of grey cast iron welds have been examined in the as-cast and fully fertilizing annealing conditions under preheat temperatures.

Ductile cast iron is an important cast material to the designer which combines the advantages of cast iron, such as happiness, case of machining, low melting temperature, good fluidity. good wear resistance properties, high damping capacity, excellent heat resistance properties and those of steel, such as high strength, ductility, toughness, hot workability and hard inability.

In the case of cast iron filler metal, it is reported that the weld cracking due to formation of brittle phase in FZ is highly probable when preheat temperature is lower than 300°C. Nickel bused electrodes offer the highest crack resistance weld mainly because of their desirable mechanical properties and their ability to precipitates the carbon picked up from the base in its free form as graphite.

1.Weldings Used For Cast Iron
SMAW or Stick welding (SMAW)
Oxyacetylene welding (OAW)
Braze welding

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MIG welding
In-house welding

2.Electrode Used For Cast Iron Welding

Nickel base alloy
Copper base alloy
Cast Iron Covered Electrode

3.What Is Destructive Testing?

Destructive weld testing, as the name suggests, involves the physical destruction of the completed weld in order to evaluate its characteristics. This method of testing is used frequently for a number of applications. Some of these applications include welding procedure qualification and welder performance qualification testing, sampling inspection of production welds, research inspection, and failure analysis work. A number of destructive weld testing methods are used to determine weld integrity or performance. Typically they involve sectioning and/or breaking the welded component and evaluating various mechanical and/or physical characteristics. We shall briefly examine some of the more common methods of this type of welding inspection. We shall consider the macro etch test, the fillet weld break test, the transverse tension test, and the guided bend test. We shall consider how they are used, and what types of weld characteristics they are designed to determine. We shall examine their advantages over other inspection methods and their limitations.

II. OBJECTIVES

The objective of our project is to determine and analyze the different welding process under the mechanical properties and microstructure on a same material. To perform the welding techniques and understand importance of welding. Define the problem and defects that occur on the welding. Recognize the type of electrode machines and tools that are used in welding of cast iron material. Also recognize types of welding and steps to perform the welding. To know safety measure when using the welding machine along the welding process. This can help any industry to choose the suitable welding for suitable manufacturing and fabrication. It helps to know the comparison of welding according to their welding speed, with effectiveness, defect free, cost. Other objective of this investigation is as follows:

- To investigate changes in mechanical properties of material by different welding process.
- To investigate the suitable welding process.

III. LITERATURE REVIEW

1. **An investigation of abrasive wear and corrosion behavior of surface repair of gray cast iron by SMAW** Alireza Sadegel, Ahmad Moloodi, Masoud Golestanipour. MeysamMahdayiShahri materials. In this work, improving the abrasion-corrosion behavior of gray cast iron used incentrifugal pumps was studied. These pumps are usually made of gray cast iron (BS:1452Gr220) and are repaired by Shielded Metal Arc Welding (SMAW).Three different typical welding electrodes including Ni electrodes (DINI8563), Carbon Steel electrode (DINI1913), and Hardening electrode (DIN8555) were used to compare the weldability the base metal. Micro structural differences for three types of electrodes were studied and forming of different phases was analyzed. Corrosion and abrasion tests were conducted and related to welding conditions. Experimental results showed that using Ni substrate electrode reduce the unwanted phases (martens tic and carbides). Furthermore, in comparison with the base metal, the abrasion behavior of allweldments was improved. It was also determined that the carbon steel electrode has higher corrosion resistance in zero-resistance ammeter (ZRA) test compared to other electrodes
2. **Weld ability of ferritic ductile cast iron using full factorial design of experiment** Mohsen Askari Paykani, Mehrdad Shayan, Morteza Shamanian The weld ability of a ferritic ductile cast iron was investigated as afunction of different consumables (E7018 and Eni CD under eight different conditions using as cast samples. Preheat was the most effective factor during welding of cast iron. Preheat and cooling conditions are more feasible for E7018 than for Eni-CI. Typical consumables are Fe and NI based electrodes such as E7018, E3081, and Eni-CL. Multipass Welding On Inconel Material with Pulsed Current Gas Tungsten Are Welding Vemanaboina Harinadha*.G.Edisona, Suresh Akellab, L.SanjeevaReddyb. RameshKumar Budducm PCGTAW the heat required to melt the base material is supplied only during the peak current pulses allowing the heat to dissipate into the base material. In the present investigation, an attempt has been made to multi pass weld the Inconel to Inconel material using the PCGTAW; ERNiCrMo-3 filler wire is used for the experimentation. The investigation involves metallurgical and mechanical properties of pulsed current gas tungsten arc welding on Inconel 600. In this work, an attempt has been made to investigate the double v-grooved weld ability; metallurgical and mechanical properties of the PCGTA welded with Inconel 600 similar material, mechanical property relationships of Inconel 600 weldments are discussed in detail.
3. **Effect of preheat on welding of ductile cast iron** EM El-Banna The effect of preheat temperature on the microstructure obtained in the heat-affected zone HAZ and the carbide zone in the weld metal adjacent to HAZ has been studied in multi pass welds for the as-cast and ferritic ductile cast irons. The welding was carried out with manual shielded metal arc welding using ENIFe-CI Giller metal. Ultrasonic, micro hardness distribution,

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tensile and impact tests were conducted to evaluate the quality of welded joints.

4. **Friction welding of ductile cast iron using interlayers** Radoslaw Winiczenko, Mieczyslaw Kaczorowski In this paper, ductile cast iron-austenitic stainless steel, ductile cast iron-pure Amcoiron and ductile cast iron-low carbon steel interlayer's were welded, using the friction welding method. The tensile strength of the joint was determined, using a conventional tensile test machine. Moreover, the hardness across the interface of materials was measured on metallographic specimens. The fracture surface and microstructure of the joints was examined using either light stereoscopic microscopy as well a electron microscopy. In this case, scanning electron microscopy (SEM) and transmission electron microscopy (TEM) were applied. The results of the analysis show that the joint has the tensile strength compared to that of basic material. In case of ductile cast iron, it is possible to reach the tensile strength equals even 700 MPa. It was concluded that the process of friction welding was accompanied with diffusion of Cr. Ni and C atoms across the ductile cast iron-stainless steel interface. This leads to increase in carbon concentration in stainless steel where chromium carbides were formed, the size and distribution of which was dependent on the distance from the interface.
5. **The effect of yield strength mismatch on the fracture behavior of welded nodular cast iron** HakanCetinel, BahadirUyulgan, Tevfik Aksoy In this study, fracture toughness (J-integral) values in cracked welded nodular iron were determined experimentally, and stress-strain analyses were done by the finite element method, for different crack sizes and locations with various strength levels. As a result, the effect of yield strength mismatch on the constraint around crack tip was discussed by means of stress triaxiality (ST) and plastic strain. It was found that ST values increase with crack length. Different regions in the weldment affect the extent of plastic deformation in the material.

IV. RESEARCH METHODOLOGY

Sr. No.	Paper Title	Publication & Year	Authos name	Material & dimension	Welding process	Input Parameter	Output Parameter
1.	Weldability of iron based powder metal materials uding pulsed plasma arc welding process	ELSEVIER, 2018	E.O Correa S.C costa J.N santos	Iron based powder metal material	Plasm arc welding	Weldability Powder metal Alloy Plasma arc welding	Increasing in productivity
2.	Microstructure and wear behavior of Ni based alloy coated on to grey cast iron using a multistep induction cladding process	ELSEVIER, 2018	Jing Yu Bosong Yanchuan Liu	Grey Cast iron	Multistep induction cladding techniques	Ni based alloy coating And chemical composition	A clear boundary was observed between the coating and subtract with a highquality interface and non visible defects or crack
3.	Microstructure evolution during laser cladding fe-cr alloy coating on	ELSEVIER, 2018	Yongjianli Shiyun Dong Shixing, Yan Binshi Xu	Ductile cast iron	Laser technology	Fe based alloy	Microstructure characteristics and phase evolution is obtained

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	ductile cast iron						
4.	Experimental Analysis Of TIG Welded 304 Stainless steel Framesing Artificial Intelligence Tool.	IJPAM, 2017	I.j. Rohit, R. Ajithraj and M. Dev Anand	304 Stainless Steel	TIG	Welding Currently, Voltage, Speed, Gas flow rate	Vickers hardness and tensile strength.
5.	Multipass welding on inconel material with pulsed current gas tungsten arc welding	ELSEVIER, 2017	Vemanaboina Harinadh, G.Edison, Suresh Akella ,Ramesh Kumar Buddu	Standard double V groove butt	Tig welding	ERNiCrMo-3 is used for gas metal arc welding and gas tungsten arc welding of Inconel 600 alloy	Successfully multi pass Weldments of Inconel 600 could be obtained from PCGTAW technique

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VI. CONCLUSION

The SMAW welding is more suitable for welding of cast iron. Best results are obtained when welding with low current and the lowest practical heat inputs. The Nickel Alloy Electrode is most suitable for cast iron welding. The different parameters of cast iron material before welding & after welding successfully checked by Destructive Testing.

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