Micro structure evaluation and running performance of submerged arc welding flux using bauxite ore

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Abstract:

This research work deals with the microstructure and running performance of submerged arc welding to evaluation the mechanical behavior of weld bead by using bauxite ore flux. Here bauxite ore was used for development of submerged arc welding flux because it contents some industrial compound (Al_2O_3-60-70%, Fe_2O_3-10-20%, TiO_2-1-3%, SiO_2-10-15%, Cao+MgO-1-3%)which is also important ingredient for flux material. Agglomeration technique was used for developed of flux with some alloying ingredient like TiO_2, MnO, CaF_2 and Fe_2O_3. Four types of flux were developed and bead on plate welding technique used for this research work. Running performance, slag detachability and bead appearance of weld material is found to optimum quality. Transverse section of optimized bead was checked for microstructure examination and found a very good amount of acicular ferrite which improves toughness and tensile strength. From the experiment work it is found that flux composition number 4 and number 1 showed some amount of widemann stattan and blocky ferrite which increases the brittleness property in the bead. So overall from the microstructure evaluation flux composition number 4 found the best from other compositions.

Keywords — **Submerged arc welding, microstructure, running performance, bauxite ore**

I. INTRODUCTION

Submerged arc welding(SAW) are plying a very important role in varying types of arc welding processes. In the Submerged arc welding techniques flux plays an important role in deciding the welding bead characteristic and it also decrease the cost near about fifty percentage of the total welding cost. According to American Welding Society, flux is a material used to prevent, dissolve or facilitate removal of oxides and other undesirable substances[10]. Fluxes used in SAW are granular, fusible, minerals containing oxides of manganese, silicon, titanium, aluminum, calcium, zirconium, magnesium and other compounds such as calcium fluoride[11]. TiO_2-containing flux increases the yield and ultimate tensile strengths and Vickers hardness with a decrease in the titanium content. The increase in titanium content in fluxes also improved the toughness and ductility of the welds[1]. The yield and ultimate tensile strengths of welds for TiO_2 containing fluxes increase with the formation of acicular ferrite. This has the importance in the selection of flux composition in order to improve the mechanical properties of steel welds[4]. The maximum impact strength can be achieved by 8% CaF_2 and 2% FeMn composition and maximum hardness can be achieved at 5% CaF_2 and NiO compositions [2]. The temperature of electric arc causes the dissociation of oxides and these remains as ions in the plasma. Most of the oxides are melted, but oxides with high melting points such as MgO, CaO and ZrO_2 are not melted[3]. In submerged arc welding, current and voltage influence the weld-metal composition and the element transfer behavior for the elements, viz manganese, silicon, carbon and sulphur. For controlling the weld-metal composition, welding voltage is more effective than is welding current[5]. The penetration will be at maximum value when welding current and arc voltage are at their maximum possible value and welding speed is at its minimum value[6]. The use of Al_2O_3 nano-particles led to decrease the bulk density and improve the cold crushing strength properties at the drying temperature (110◦C). The use of Al_2O_3 nano-particles led to formation of platy and needle shape phases which improved the densification and cold crushing strength of the castable compositions at the sintering temperature (1550◦C)[7]. There is no corrosion on the surface of electrode with electrolyte recycling on desulfurization from bauxite water slurry electrolysis [8]. The oxidation of Si Caggregate affects the microstructure and properties of bauxite–SiC refractories. The active oxidation of Si Caggregates produces large interstices between Si Caggregate sand matrixes of bauxite–SiC specimens [9].

In this research work the bauxite ore was used as a flux with varying composition with TiO_2, MnO_2, CaO and CaF_2 to analysis the microstructure of the welding bead and running performance of submerged arc welding and to evaluation the mechanical behaviour of weld bead using bauxite ore as a flux material.

II. EXPERIMENTATION:

In the experimental work the first step was flux preparation using bauxite ore. The bauxite ore was collected from the extraction of alumina from Bhilai steel plant, Bhilai (India). This ore was firstly crushed upto 60-120 micron and then it is mixed with the with varying percentage of Titanium oxide (TiO2), calcium oxide (CaO), calcium fluoride (CaF2), manganese dioxide (MnO2) with binding agent of water glass. In this composition one more ingredient of Iron Oxide(Fe2O3) were used to increase the flux deposition rate on the bead. The entire additives were mixed together with different composition as shown in Table 1.

Flux Composition no.	Bauxite ore (gm)	TiO_2 (gm)	MnO_2 (gm)	CaO (gm)	CaF_2 (gm)	Fe_2O_3 (gm)	Water glass (gm)
1	450	225	150	150	75	10	450
2	450	225	150	150	75	20	450
3	450	150	225	150	75	10	450
4	450	150	225	150	75	20	450

Table 1: Element composition table

In the preparation of flux composition the agglomeration method was used. This method consists of processes like mixing, baking and crushing for development of various flux compositions. After mixing of all additives in the buxite core, this mixture was backed in the muffle furnace for 2 hours at 800^oC to remove moisture content from the mixture. After that this mixture is again crushed in a course granular particle forms. Now this prepared mixture is known as a flux that was used in a submerged arc welding as shown in fig. 1.

Fig. 1 Developed flux by using bauxite ore

III. RESULTS AND DISCUSSION

There are four types of experimental work carried out by varying the composition of flux that named as flux composition number 1, 2, 3 and 4 as shown in Table 1.

A. *Running performance*

To measure the running performance of weld bead, the bead on plate method was used by using different flux compositions numbers 1, 2, 3 and 4. The running performance results found as shown in table 2.

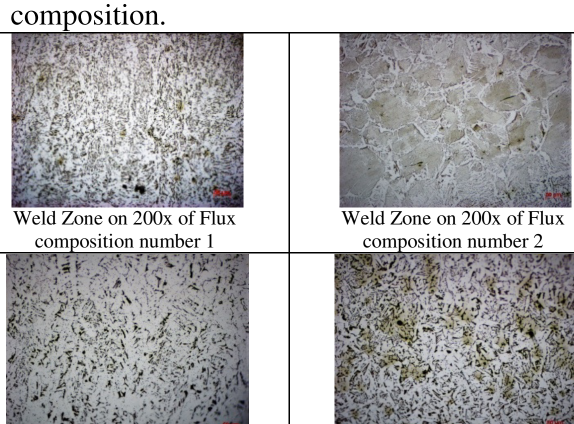
Table 2: Running performance

Flux Composition Number	Slag detachability	Bead appearance	Remark
1	Good	Acceptable	Some Porosity present
2	Better	Best	Defect free bead profile, viscosity is acceptable
3	Good	Good	Some defects and porosity present
4	Best	Best	Almost Defect free bead profile, viscosity is also good

As shown in table 2 that there is slag detachability and bead appearance were evaluated to find the running performance of bead. From the results it is found that flux composition number 4 is the best flux among the others compositions because of its very less defects, good bead profile and better viscosity. From the results it is also found that flux composition number 1 shows acceptable bead appearances and some porosity so in the comparison of above flux number 1 could be acceptable but not good. This result shows a good idea about the flux behavior on the mild steel substrate and its usefulness.

B. ***Microstructure Evaluation:***

In the evaluation of change in bead composition after submerged arc welding in the presence of various flux compositions, the microscopic picture was taken at 200x zoom of weld bead to evaluate the results of change in bead composition.



Weld Zone on 200x of Flux composition number 1

Weld Zone on 200x of Flux composition number 2

Weld Zone on 200x of Flux composition number 3

Weld Zone on 200x of Flux composition number 4

Fig.1 Optical microscopic results

From the above microstructure it is found that flux composition number 1 have scattered cementite (Fe_3C) structure and combination of pearlite and cementite structure which is responsible to reduce ductility and less contribute to tensile strength. Flux composition number 2 has blocky ferrite structure which reduces the ductility but contribute to enhancement of toughness property. Flux composition number 3 is the combination of widemann staten ferrite and acicular ferrite which enhances the toughness property of welding bead. Flux composition number 4 shows maximum needle like structure which is acicular ferrite that is enhance the tensile strength and fractural toughness and minimize weld decay.

IV. CONCLUSION

The flux is successfully developed by using bauxite ore and other ingredient to find the running performance of weld bead and to study the change in mechanical property of weld bead through microstructure study. From the test results it is found that running performance of the bead was good for the flux composition number 4 and for the flux composition number 1 it is acceptable condition. From the microstructure study it is found that flux composition number 4 provide the best weld results comparison to other flux compositions.

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