# To Study the Mechanical Behavior of properties on change in concentration of Aluminates of metal cored welding electrode

Ravikant[1], Deepak Malik[2]

[1]M. Tech scholar, Rohtak Institute of Management and Technology
[2]Assistant professor in Mechanical Department, Rohtak Institute of Management and Technology

**ABSTRACT**

**Welding is a fabrication process that joins material, usually metals or thermoplastics, by using coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material(weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat or by itself, to produce the weld. An electrode is an electrical conductor used to make contact with a non-metallic part of a circuit (e.g. a semiconductor, an electrolyte or a vacuum). The word was coined by Michael Faraday from the Greek word electron (meaning amber, from which the word electricity is derived) and hodos, a way. In my present work in electrode coating flux composition concentration would be varied at different levels. We will change the composition of aluminite in flux composition by keeping whole flux composition fixed. By using this method we will perform several operations like tensile strength ,arc stability , smoke level , micro-hardness , chemical composition, weld bead geometry etc. and can study the actual mechanical behavior of welded specimen i.e. 16% aluminite, 47% aluminite , and 65% aluminite. Microstructure also studied before and after welding of every specimen with varying composition of aluminite in flux for checking the grain structure and it reveals how variations in aluminite affect the micro-behaviour.**

**Keywords: Arc Welding, Electrode flux, Grain Structure, mechanical properties.**

## 1. INTRODUCTION

In solid state welding the surfaces to be joined are brought into close proximity by: Heating the surfaces without causing melting and applying normal pressure Providing relative motion between the two surfaces and applying light normal pressure .Applying high pressure without heating In these processes the materials remain in solid state and welding is achieved through the application of heat and pressure, or high pressure only due. In Electric Arc Welding a sustained arc provides the heat required for melting the parent as well as filler material. The workpiece and the electrode are connected to the two materials of the power source. The arc is started by momentarily touching the electrode on to the workpiece and then withdrawing it to a short distance (a few mm) from the workpiece.

### SHIELDED ARC WELDING

Consumable electrodes usually have a coating on its outer surface which on melting release gases like hydrogen or carbon dioxide to form a protective covering around the molten pool. The electrode coating also reacts to from slag which is a liquid, lighter than the molten metal. An electrode in an electrochemical cell is referred to as either an anode or a cathode. The anode is now defined as the electrode at which electron leave the cells and oxidation occurs, and the cathode as the electrode at which electron enter the cell and reduction occurs. Each electrode may become the anode or cathode as depends on the direction of the current through the cell. A bipolar electrode is an electrode that functions as the anode of one cell and cathode of another cell.

In arc welding an electrode is used to conduct current through a workpiece to fuse two pieces together. Depending upon the process, the electrode is either consumable, in case of gas metal arc welding shielded metal arc welding or non-consumables such as in gas tungsten arc welding for a direct current system the weld rod or stick may be a cathode for a filling type weld or an anode for other welding process. For an alternating current arc welder the welding electrode would not be considered an anode or cathode.

The diameter of electrodes usually varies between 3.15 to 12.50 mm with the intermediate standard diameters being 4.00, 5.00, 6.30, 8.00 and 10.00 mm. The length of these electrodes varies between 350 to 450 mm with bare portion ranging between 20 to 30 mm wherefrom it is held in an electrode holder.

The welding electrode is coated in a metal mixture called flux, which gives off gases as it decomposes to prevent weld contamination, introduces deoxidizers to purify the weld, causes weld-protecting slag to form, improves the arc stability, and provides alloying elements to improve the weld quality. The choice of electrode for SMAW depends on a number of factors, including the weld material, welding position and the desired weld properties. Electrodes can be divided into three groups—those designed to melt quickly are called "fast-fill" electrodes, those designed to solidify quickly are called "fast-freeze" electrodes, and intermediate electrodes go by the name "fill-freeze" or "fast-follow" electrodes. Fast-fill electrodes are designed to melt quickly so that the welding speed can be maximized, while fast-freeze electrodes supply filler metal that solidifies quickly, making welding in a variety of positions possible by preventing the weld pool from shifting significantly before solidifying.

## ELECTRODE COATINGS

The ingredients that are commonly used in coatings are liquids and solids. The liquids are generally sodium silicate or potassium silicate. The solids are powdered or granulated materials that may be found free in nature, and need only concentration and grindings to the proper particle size. Other solid materials used are produced as a result of chemical reactions such as alloy or other complex synthetic compounds. Particle size is an important factor: coarse as fine sand, or as minute as sub-sieve size. Physical structure may be crystalline or amorphous.

## FUNCTIONS

To shield the weld metal from the oxygen and nitrogen of the air as it is being transferred across the arc, and while it is in the molten state. For stabilization of the arc. A variety of elements can be added to weld metal by including them in coating composition. To protect molten metal from deleterious effect. To provide a slag blanket on the weld so as to reduce its rate of cooling. Electrode coating materials are: rutile, aluminite, low carbon, ferromanganese, flurospar, mica cellulose ,china clay, calcite, quartz, telcom powder.

## WELDING FLUXES

1. That portion of the flux which melts floats as a liquid blanket over the malten metal, protects it from the deleterious effect of surrounding atmosphere thereby reduces the pickup of oxygen and nitrogen.
2. It acts as a good insulator and concentrates head within a relatively small welding zone, thus it improves the fusion of the molten metal from the welding electrode and the parent material.
3. The weld metal is not only clean but it is also more dense and excellent physical properties.

## OPERATIONAL PROPERTIES: MANUAL WELDING:

The operational behavior of the six electrodes was studied using an AC 350-A power supply set to AC, alternating current.

**Table 1: Welding Parameters for the Test Specimen**

| Parameters | 16% aluminite | 47% aluminite | 65 %aluminite |
|---|---|---|---|
| Current (A) | 145 | 145 | 145 |
| Voltage (V) | 25 | 25 | 25 |
| Welding speed (mm/sec) | 3.6 | 3.3 | 2.9 |
| Heat input (KJ/mm | 1.2 | 1.2 | 1.1 |

The weld beads with various composition of aluminite coating were laid on the test plates (480mm*150mm*10mm). The power supply was varied as described in 4.2. After completion of all welds on plates, the weld bead geometry measurements were taken. The plates of dimension 480mmx150mmx10mm were machined on Shaper and V groove angleof 600 and root face of depth 2mm was cut using shaper. These plates were then cleaned with acetone and then welded using the electrodes developed by varying aluminite composition.

## TEST ON WORKPIECE: MECHANICAL TESTING:

The mechanical testing is used to determine the hardness of a material to deformation. Several such tests micro hardness testing, tensile strength testing, micro structure testing and chemical composition testing.

## MICRO HARDNESS TESTING

Micro-indentation hardness testing (or micro hardness testing) is a method for measuring the hardness of a material on a microscopic scale. The Vickers test is often easier to use than other hardness tests since the required calculations are independent of the size of the indenter, and the indenter can be used for all materials irrespective of hardness. The basic principle, as with all common measures of hardness, is to observe the questioned material's ability to resist plastic deformation from a standard source. The Vickers test can be used for all metalsand has one of the widest scales among hardness tests. The unit of hardness given by the test is known as the Vickers Pyramid Number (HV) orDiamond Pyramid Hardness (DPH). In the present work micro hardness measurements were covered out in all weld regions of the test specimens of size 1 0mmx10mmx55mm, cut from the weld coupon. These specimen werepolished and mounted on micro hardness tester,250gm load was applied and reading were taken.

## MICROSTRUCTURAL TESTING

Microstructure is defined as the structure of a prepared surface or thin foil of material as revealed by a microscope above 25× magnification. The microstructure of a material (which can be broadly classified into metallic, polymeric, ceramic and composite) can strongly influence physical properties such as strength, toughness, ductility, hardness, corrosion, resistance, high/low temperature behavior, wear resistance. The specimen is examined in the as polished condition in the weld metal regions. Mild steel specimen and weld samples were polished then etched with 2% nital before testing. The metallographic study was carried out on transverse cross sections of the all weld- metal test assemblies.

## CHEMICAL COMPOSITION TESTING

Chemical composition analysis is available for a wide range of applications and sample types with detection down to trace and ultra-trace range. After welding with electrodes of varying composition we carried out the chemical composition test of the specimens. In the chemical composition testing we evaluate the results of all three i.e. 16 % aluminite, 47 % aluminite, 65 % aluminite types of electrode of welding. And also studied the chemical composition testing of mild steel before welding. The most common testing machine used in tensile testing is the universal testing machine. This type of machine has two crossheads ; one is adjusted for the length of the specimen and the other is driven to apply tension to the test specimen. There are two types: hydraulic powered and electromagnetically powered machines

## TENSILE TEST

This is carried out by gripping the end of the specimen in a tensile testing machine and applying and increasing pull on to the specimen till it fractures. During the test, the tensile load as well as the elongation of a previously marked gauge length in the specimen is measured with the help of load dial of the machine and extensometere, the two pieces respectively. After fracture of the broken specimen are placed as if fixed together and the distance between two gauge marks and the area at the place of fracture are noted. V groove on two plates were cut and after doing welding in V groove of 2 plates by three electrodes then tensile weldment specimen is to be cut from these plates for tensile testing.

## WELD BEAD GEOMETRY


**Figure 1: weld Specimen used for testing**

## OPERATIONAL PROPERTIES

All operational properties measured are given in Table 5.1.ln general, the arc produced by all electrodes was observed to be stable for welding. The arc stability was found to be better in all type of electrodes welding. The slag produced by 16% and 65% aluminite electrodes was thicker than that of 47% aluminite electrodes.The slag detachability is good for welding for all electrodes. The slag for all electrodes presented porosity but it was more prominent in especially with 47% aluminite electrodes.

**Table 2. Observation of arc stability, smoke level ,slag detachability ,porosity**

| coating | Arc stability | Smoke Level | Slag Detachability | Porosity |
|---|---|---|---|---|
| 16%Aluminite | Good | Medium | Good | Present |
| 47%Aluminite | Excellent | Low | Good | Present |
| 65%Aluminite | Medium | High | Medium | Present |

**Table 3 . Composition of weld bead**

**Experimental data:**

| Elements | 16% aluminite | 47 % aluminite | 65% aluminite |
|---|---|---|---|
| Carbon | 0.400 | 0.033 | 0.200 |
| Silicon | 0.200 | 0.200 | 0.033 |
| Manganese | 0.570 | 0.400 | 0.200 |
| Phosphorus | 0.033 | 0.570 | 0.400 |
| Sulphur | 0.043 | 0.043 | 0.043 |
| Chromium | 0.170 | 0.168 | 0.165 |
| Molybdenum | 0.012 | 0.014 | 0.19 |
| Nickel | 0.050 | 0.050 | 0.050 |
| Aluminite | 0.016 | 0.018 | 0.017 |
| Arsenic | 0.00 | 0.00 | 0.00 |
| Boron | 0.00 | 0.00 | 0.00 |
| Cobalt | 0.00 | 0.00 | 0.00 |
| Copper | 0.0142 | 0.0142 | 0.0143 |
| Niobium | 0.00 | 0.00 | 0.00 |
| Lead | 0.00 | 0.00 | 0.00 |
| Tin | 0.015 | 0.017 | 0.013 |
| Titanium | 0.00 | 0.00 | 0.00 |
| Tungesten | 0.00 | 0.00 | 0.00 |
| Vanadium | 0.00 | 0.00 | 0.00 |
| Iron | 98.33 | 98.33 | 98.43 |

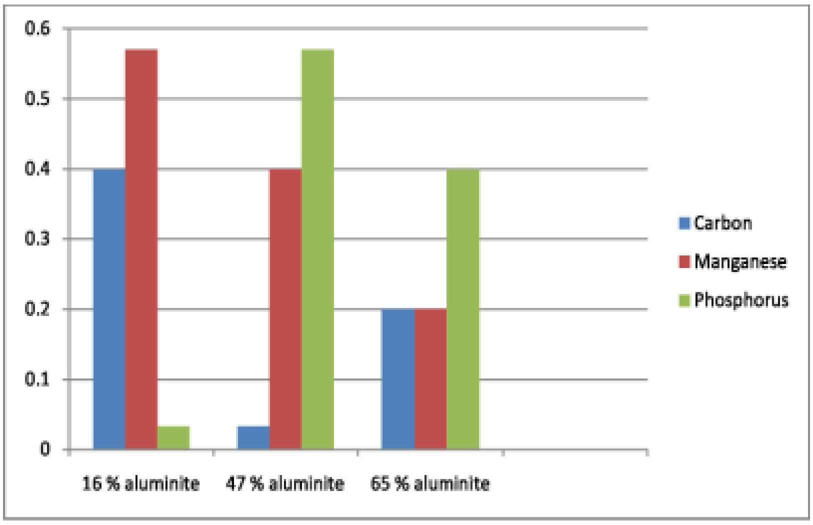


**Figure 2: Composition of carbon, phosphorus and manganese.**

**Table 4: Micro hardness measurements**

| Coating | Hardness at Weld bead | At 9mm from weld bead | | At 12 mm From weld bead | |
|---|---|---|---|---|---|
| | | L | R | L | R |
| 16% Aluminite | 170 | 167.5 | 167.7 | 166.5 | 166.4 |
| 47%Aluminite | 167 | 165.5 | 165.3 | 163.7 | 164 |
| 65%Aluminite | 142 | 139.9 | 140.3 | 140.7 | 140.5 |

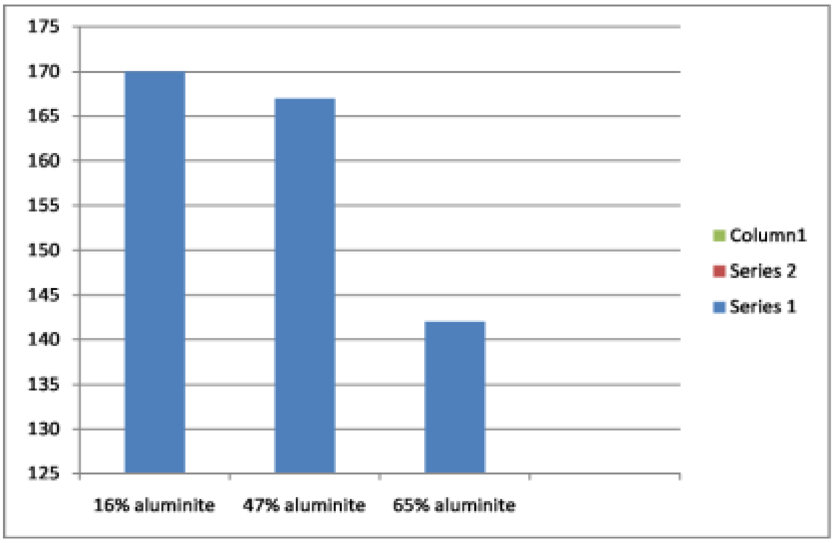


**Figure 3: graph of micro hardness vs %of aluminite at weld bead**

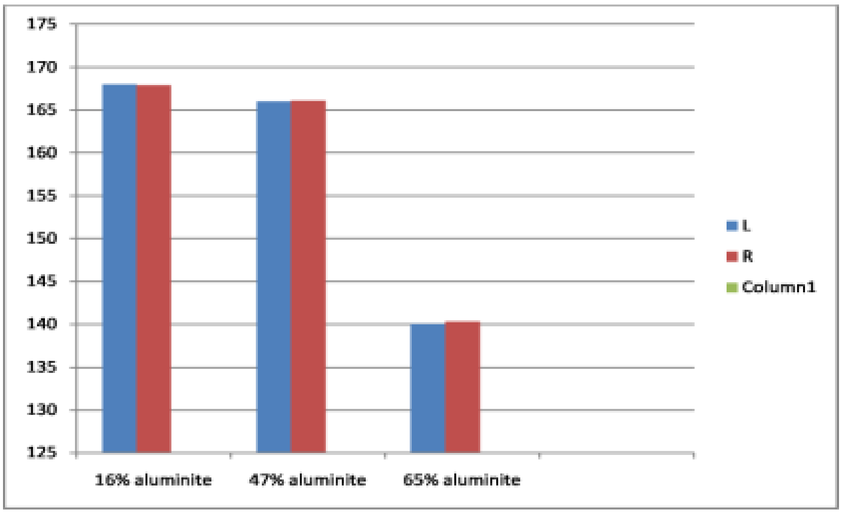


**Figure 4: microhardness at 3mm from weld bead in left and right**

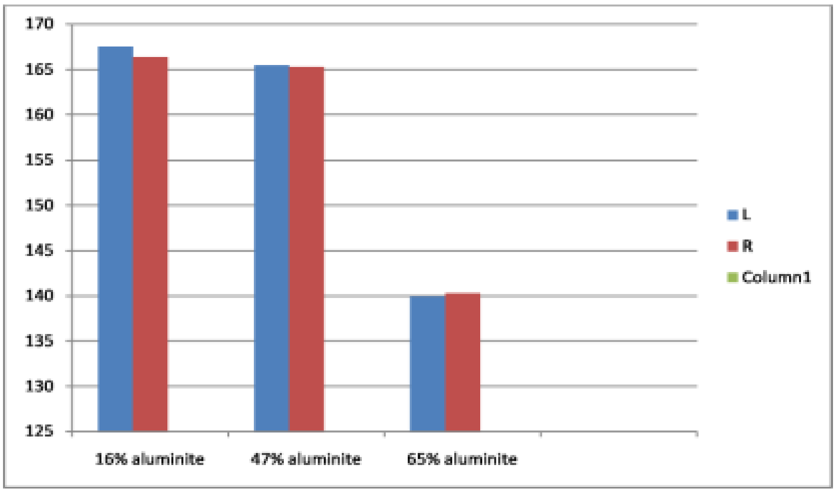


**Figure 5: Micro Hardness at 9mm from weld bead in left and right.**

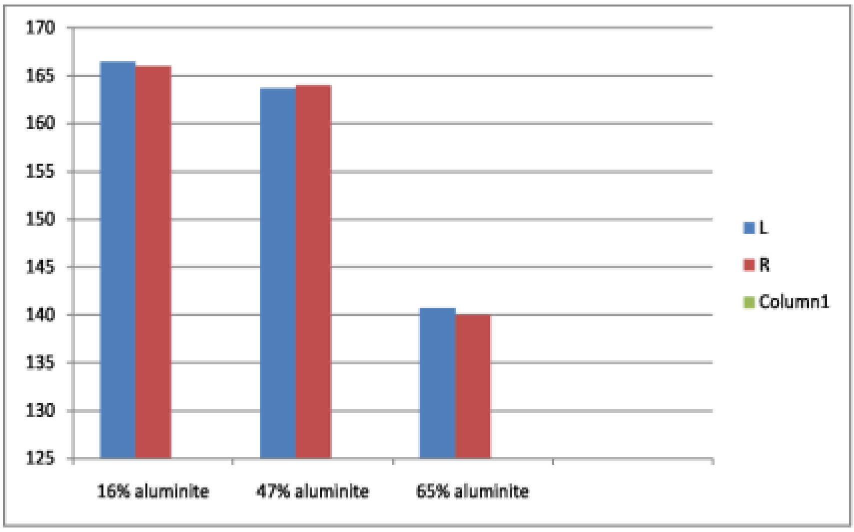


**Figure 6: Micro hardness at 6mm from weld bead in left and right**

Tensile testing of various specimen i.e. 16 % aluminite ,47 % aluminite and 65 % aluminite taken into consideration. Electrodes having 16 % aluminite have tensile strength of 247 $N/mm^2$ .and electrodes having 65 % of aluminite have tensile strength of 249 $N/mm^2$, electrodes having 47 % of aluminite have tensile strength of 303 $N/mm^2$. Thus by this data we c an say that electrodes having 47 % aluminite have best tensile strength and elongation.

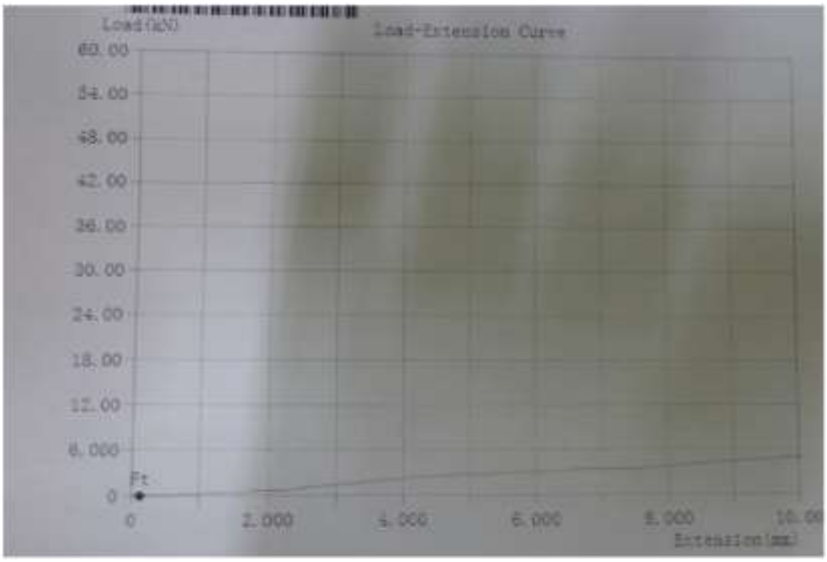


**Figure 4:** Tensile strength graph of 65 % aluminite

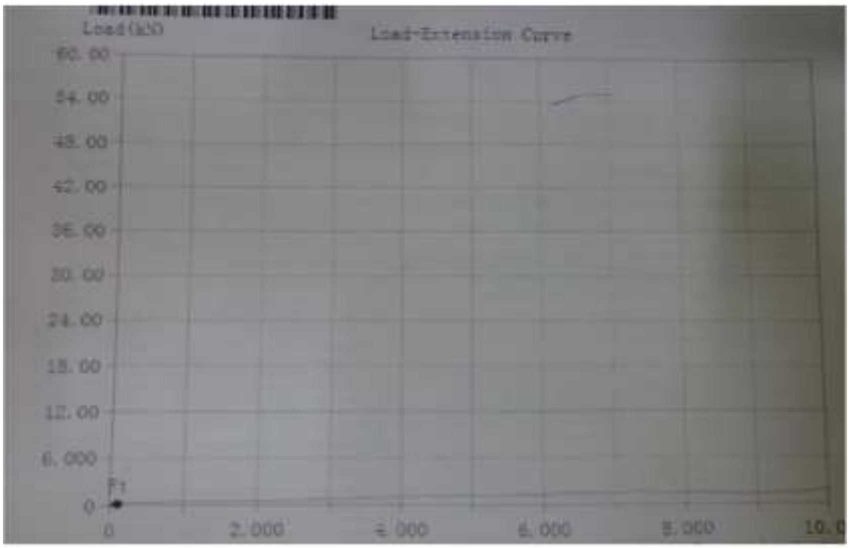


**Figure 5: Tensile strength graph of 16 % aluminte**

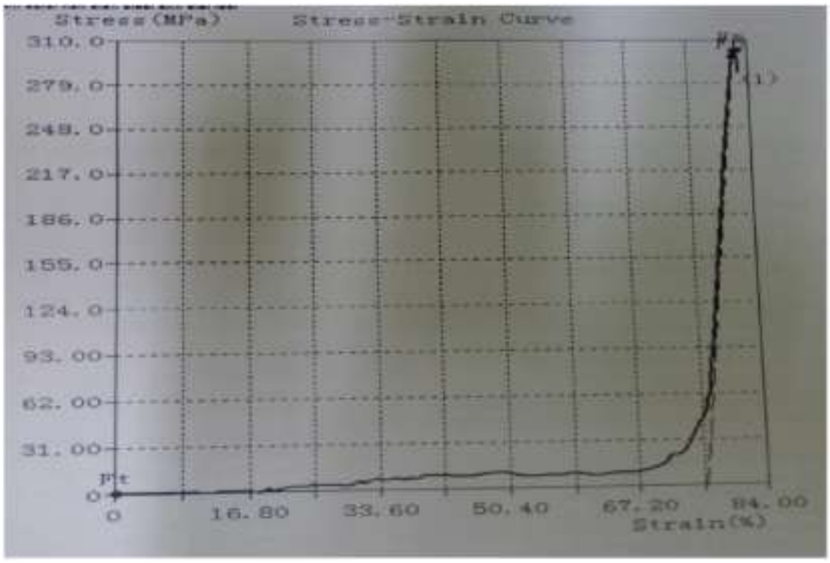


**Figure 6. Stress vs strain curve for tensile strength**

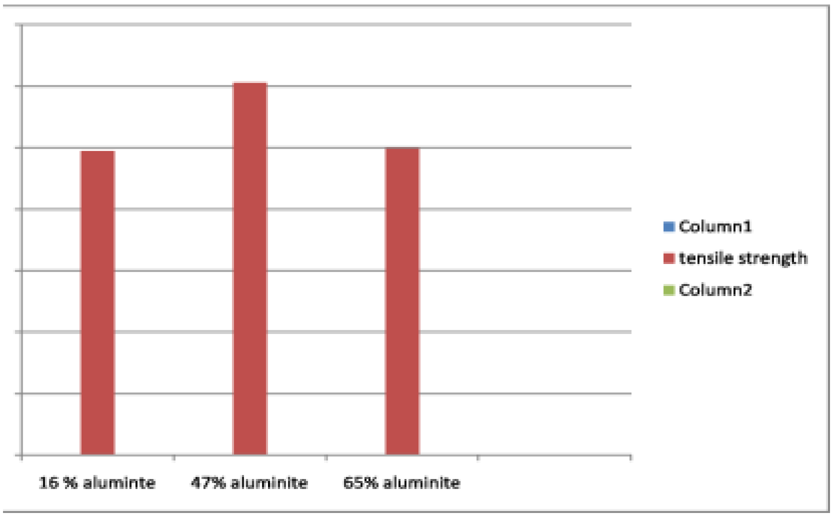


**Figure: 7 Comparison of tensile strength**

**SSMOKE TEST RESULTS**

All the three electrodes are tested for smoke level produced during the welding process. This smoke test result obtained from all of the three electrodes, but in case of 47 % aluminite smoke level observed to be very less as compared to both of the other electrode.

| Composition | 16% aluminite | 47% aluminite | 65% aluminite |
|---|---|---|---|
| Smoke level | 1 | 0.75 | 1.25 |

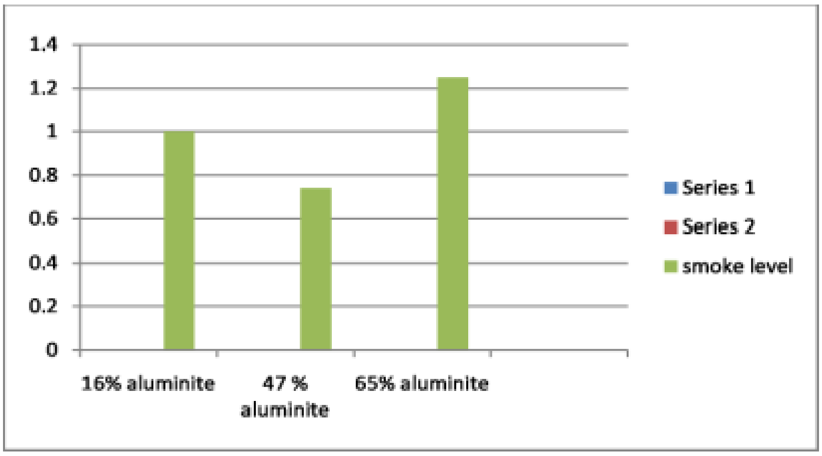


**Figure 8 Smoke Level Vs Percentage of aluminite**

**CONCLUSIONS:**

This study examined the effects of adding aluminite contents and increasing the content to flux cored welding electrodes. The important results obtained are as follows:

1. aluminite coating electrode. So we can say that if we weld from 16 % aluminite coating composition electrode metal will be hard as compare to other two.
2. As we increase the contents of aluminite composition of carbon increases in chemical composition results.
3. In case of microstructure results we obtain very fine grain structure in case of 16% alumninte and 47 % alumninte as compare to the 65 % alumninte coating electrode.
4. Weld beads obtained by 47 % alumninte coating electrode found to be very good as compare to others. Electrode having 47 % alumninte coating having high tensile strength than other two.

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