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Extraction of Value Added Product From Waste Aluminium Dross

[1] Meet Rajeshkumar La lakiya, [2] Pranab Das
[1][2] Department of Mechanical Engineering, Christ University Faculty of Engineering, Bengaluru, INDIA

Abstract:-- **It is reported that the aluminium dross generated in aluminium industry is about 5 million tons in the world, but only half can be processed to recover aluminium from aluminium dross. India is expanding its aluminium scrap recycling industry, whose production capacity is at least 1.2 million tons per year. Aluminium production capacity in India is more than 1 million tons per year. In the next five years, India aluminium scrap recycling capacity and primary aluminium production capacity will be doubled. For primary aluminium industry, the aluminium loss is about 1-2%, which is more than 15,000.00 tons aluminium loss each year in the form of dross. Application of dross in ceramic industry is a novel and useful concept because dross contains more than 50% alumina. In the present work alumina was recovered from dross by both acid leaching (sulphuric acid and hydrochloric acid) and alkali addition (sodium hydroxide). The precursor materials were calcined at temperatures ranging between 900-1000°C resulting in the production of different varieties of alumina. Dependent on different acid addition, the generated alumina showed variable morphology under SEM studies. In a separate study the dross was chemically treated to remove undesirable impurities and its application as refractory lining material in furnaces is being investigated.**

Keywords:— **alumina, aluminium dross, hydrochloric acid, sulphuric acid**

I. INTRODUCTION

The worldwide aluminium industry produces nearly five million tons of furnace waste each year. Known as dross, the residual waste material is produced from any process in which aluminium is melted, and is left behind after conventional recycling has been carried out. Aluminium waste are chemically active and when exposed to water can react and emit toxic and potentially explosive gases [1]. Traditionally, it is disposed of in landfill, but tighter regulation and spiraling costs are forcing the industry to consider alternatives. One such solution, which could dramatically reduce landfilling is to convert into a value added product such as aluminium oxide for application in ceramic industry. Aluminium dross is a complex oxide material containing Al2O3, SiO2, Na2O, Fe2O3, and other compounds [2]. Aluminium nitrides and carbides are also expected to be present in the aluminium dross [3]. Drosses are classified according to their metal content; typically, white dross has higher metal aluminium content than black dross [4]. Drosses obtained from primarily melting operations consist primarily of aluminium oxide while drosses from secondary smelting operations typically contain a mixture of aluminium/alloy oxides and slag [5]. Typically, 15-25 kg of dross is generated per metric ton of molten aluminium [6]. The objective of this paper is to get a value added product from an industrial waste namely aluminium industry. In aluminum industry dross which is a waste comes out on the surface of molten aluminium associated with other various chemical elements. In this article an attempt has been made to produce a value added product namely alumina which finds extensive application as a high temperature ceramic material. However, production of alumina can be done by both acid and alkali treatment. In this article attempt has been made to show the different properties of alumina achieved due to acid and alkali treatment.

II. EXPERIMENTAL

II.I. Collection Of Aluminium Dross

Aluminium dross samples were collected from Minerals Processing Industry located in Peenya, Bengaluru. Samples collected from industry were fine in size and passing below

100 mesh. The aluminium dross received from an aluminium industry had the following composition (given in percentages); Silica- 11.07, Iron oxide- 2.89, aluminium oxide- 65.35, calcium oxide- 1.39, Magnesium oxide- 0.52 and Loss on Ignition- 7.72

II.II. Extraction Of Alumina

500 g of the dross powder (as received) was subjected to acid treatment having varying concentration (1(acid): 10(water)) up to a maximum of 1(acid): 1(water). The different acids used were laboratory grade sulphuric and hydrochloric acid. The amount of solution was kept fixed as 1 litre. Room temperature

leaching was carried out overnight and the percentage of retained solid was measured after filtration through a WHATMAN filter paper. A maximum of 30% leached amount was observed with the varying concentrations of acid and water. The individual filtrates with the different acids were subjected to ammonia treatment at constant pH in the range of 6-7 when precipitate of aluminium hydroxide started appearing. The solution was kept overnight for complete precipitation. The precipitate was separated from the solution after filtration and the solid aluminium hydroxide was dried at 100 degrees centigrade in a hot air oven. Subsequently, they were calcined between 900°C to a maximum of 1000°C to get Aluminium Oxide.

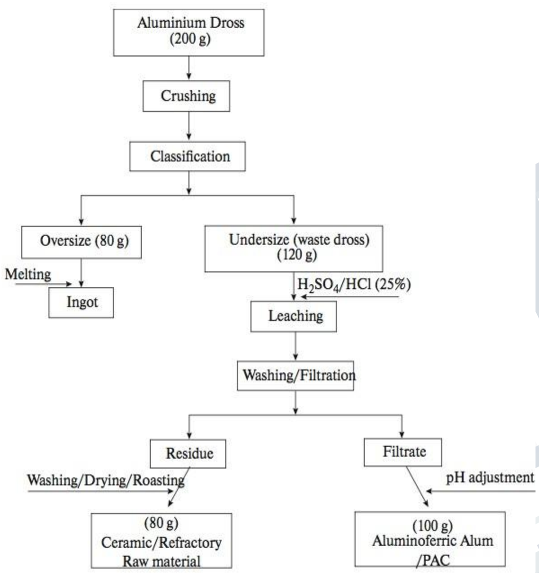

Fig. 1. Experimental process flow chart for extraction of aluminium dross [1].

Possible chemical reactions that can occur during production of alumina are shown as follows [2]:

$Al_2O_3 + 6HCl = 2AlCl_3 + 3H_2O$;

$2Al + 6HCl = 2AlCl_3 + 3H_2\uparrow$; $Fe_2O_3 +$

$6HCl = 2FeCl_3 + 3H_2O$; $CaCO_3 + 2HCl$

$= CaCl_2 + CO_2 + H_2O$; $AlCl_3 +$

$3NH_4OH = Al(OH)_3 + 3NH_4Cl$;

$Al(OH)_3 + NaOH = NaAlO_2 + 2H_2O$;

$NaAlO_2 + H_2O + NH_4Cl = Al(OH)_3 + NaCl + NH_3$;

$2Al(OH)_3 = Al_2O_3 + 3H_2O$.

II.III. X ray diffraction analysis

XRD analysis were conducted using a diffractometer (GEOL, JAPAN) to identify the phases. The pattern was recorded with Cu Kα radiation with voltage of 40 kV. Scanning angle was 2θ = 10° to 70° with scanning speed of 1°/min. The diffraction pattern was analyzed according to the powder diffraction file of the JCPDS - International Centre for Diffraction data.

XRD Pattern via Acid Route:

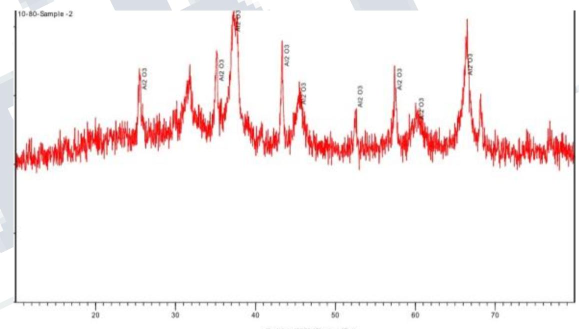

Fig. 2. XRD of alumina prepared with sulphuric acid

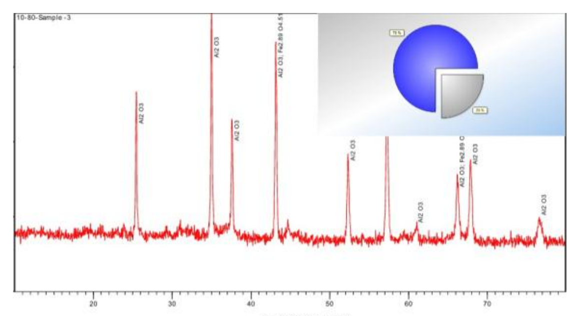

Fig. 3. XRD of alumina prepared with hydrochloric acid

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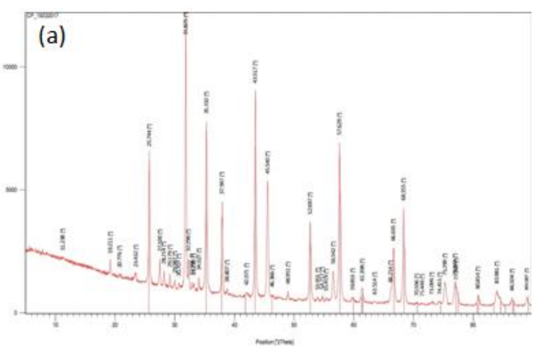

XRD Pattern via Alkali Route:

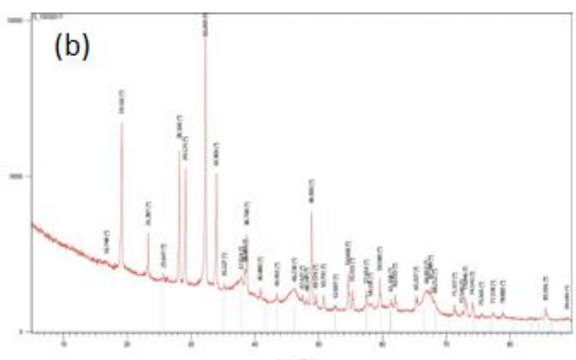

Fig. 4. (a,b) XRD of alumina prepared with sodium hydroxide (alkali addition)

II.IV. SEM STUDIES

Information on morphology and texture of alumina powders by both acid dissolution and alkali dissolution are given below under SEM studies. The images of aluminium oxide obtained after calcination of aluminium hydroxide at 900°C and the morphology of the powders is shown in the SEM analysis. It will be observed that the powders obtained from sulphate root are spongy, porous and are spherical in nature. It is also observed that size does not vary much even after higher temperature calcination indicating that these are nano sized alumina powders. The alumina powder obtained from chloride root is however longitudinal in nature and the particle size is more compared to the alumina obtained from sulphate root.

SEM Study via Acid Route:

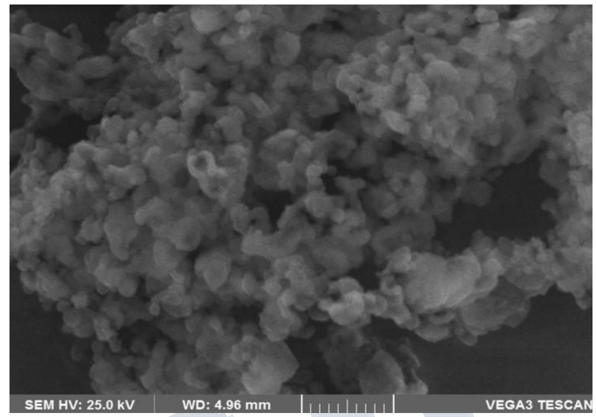

Fig. 5. SEM study of alumina sample prepared from sulphuric acid (note the porous structure of alumina)

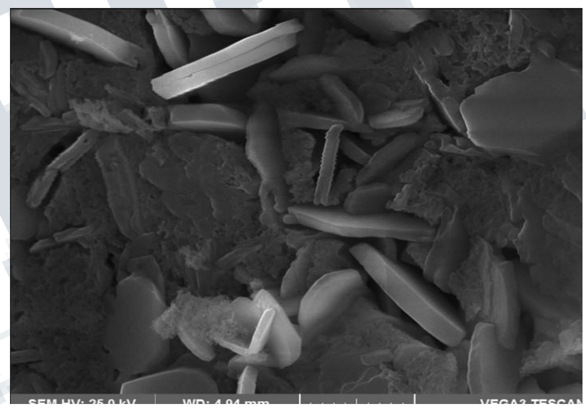

Fig. 6. SEM study of alumina prepared from hydrochloric acid (note the lath like morphology)

SEM Study via Alkali Route:

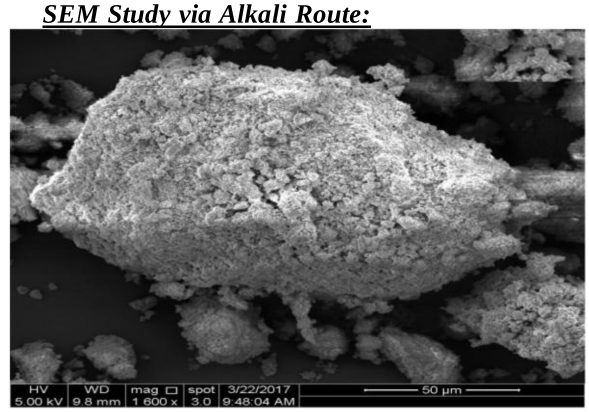

Fig. 7. SEM study of alumina prepared from sulphuric acid (magnification: 1600X)

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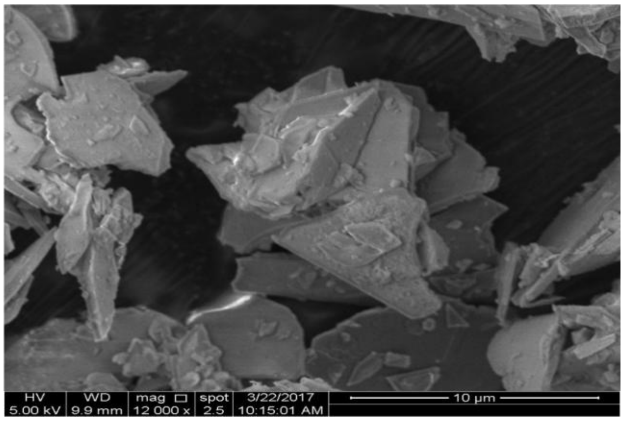

Fig. 8. SEM study of alumina prepared from hydrochloric acid (magnification: 1200X)

Fig. 9. SEM study of alumina prepared from sulphuric acid (magnification: 24000X)

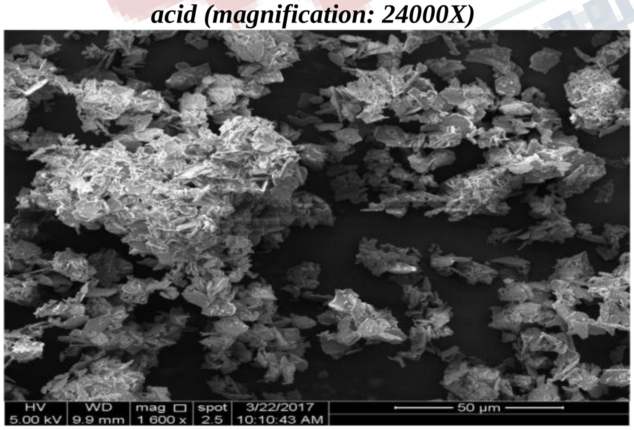

Fig. 10. SEM study of alumina prepared from hydrochloric acid (magnification: 1600X)

III. CONCLUSION

Dependent on different acid addition, the generated alumina showed variable morphology under SEM studies. The Alumina received after calcination of sulphate derived precursor was almost nano crystalline in nature and SEM studies indicated they are porous in nature. The chloride derived alumina on the contrary was denser with sharp peaks of aluminium oxide and the SEM studies indicated they had an acicular morphology. The purity of alumina was expected to be more than 97%. XRD analysis showed formation of alumina in all the samples without having any other peaks. Further work is on progress to know the difference in behaviour of their physic-chemical properties. Moreover, alumina extracted from dross also helps reducing environmental hazards produced by aluminium industries in India.

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