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THE RECYCLING OF BAYER ELECTROFILTER FINES FOR DIVERSE APPLICATIONS

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Abstract

Aluminum is the second most used metal after iron due to its singular properties that makes its alloys useful in many applications. Despite of its great importance, the obtaining processes (Bayer_Hall-Heroult tandem) produce an important environmental impact. Generated waste and pollutants should be minimized and treated.

The laboratory of Metallurgy of the Escuela de Minas de Oviedo is investigating the uses of industry wastes from alumina/aluminum industry since over 30 years. This paper presents one of the research lines followed for the recycling of electrostatic filter fines from alumina calcination furnace to produce industrial quality aluminum sulfate, alums and abrasives.

Keywords:

Electro-filter Fines, Bayer, Alumina, Metallurgical waste, Recycling.

INTRODUCTION

The Bayer process for obtaining aluminum oxide (alumina) uses bauxite, a rock with aluminum hydrates, as raw material. The process involves several steps: pressure digestion of bauxite ore in a hot pressurized aqueous soda solution, followed by precipitation of the aluminum hydrate from the clean aluminate solution and finally calcining the hydrate to alumina [1-2].

Electro-filter fines are a residue generated in considerable amounts (between 5-8% of the final alumina product) in the last stage of the Bayer Process, during the aluminum hydroxide calcination. The residue is a mixture of different aluminas and hydrates that have not completed their calcinations process. Due to its small particle size, the dust leaves the fluid bed calciner by its upper part and is collected in the electro filter device, avoiding to be in the final alumina product, that will be in that case of bad quality for electrolytic cell solution [2]. Electro filter fines, composed of alpha alumina, gibbsite and transition aluminas [3], can be treated with sulfuric acid passing most of the aluminum into an aqueous solution; the remaining residue should be mainly undissolved alpha alumina.

Electro filter fines, with an annual output of 80.000-100.000 tons for a 1.2 millions tons alumina plant, have been tested for some different applications: Calcined fines with residual aluminas, has been recycled to the digesters, for redissolution, with not very much success. Also they were used as row material for α alumina production used in refractory industry, after a 1400ºC treatment. So they are in many cases stored indefinitely in the red mud pool as another waste. It is therefore evident the need of the treatment of this fines for a better raw materials economy (sustainability), also avoiding an environmental problem.

The laboratory of Metallurgy of the Escuela de Minas de Oviedo, has been studying alternatives to this outside storage, trying to find viable alternatives to the residue. In this context, this paper presents an alternative for treating this waste generated, yielding products with market value.

EXPERIMENTAL

A. - Materials

The electrofilter fines used for this study were produced in the Spanish plant of San Ciprián. This waste, which is a heterogeneous product containing aluminum trihydrate, transition aluminas and α alumina, has to be managed. The analysis of a sample of the product presents a composition of

about 90% of aluminum oxide, 16% of which is α alumina and the rest is gibbsite and different transition aluminas.

Table 1. Chemical Analysis of dry electrofilter fines

Component (wt %)								
Na_2O	K_2O	MgO	Fe_2O_3	Al_2O_3	CaO	MO	MOI	LOI
0.50	0.21	0.06	0.19	89	0.03	2.25	8 .0	1.95

MO (moistoure) MOI (moisture on ignition 300ºC), LOI (loss on ignition 300-1200ºC).

B-Methodogy

The whole utilization of the Bayer electro-filter dust produced to obtain different commercial products takes place at different stages. Figure 1 shows a flow-diagram of the manufacturing process for three products: aluminum sulfate, abrasive and alum.

Methods for obtaining aluminum sulfate solution with commercial specifications, from different residues from aluminum industry, have been developed successfully in the Cátedra of Metallurgy, several years ago [3-7] . For their production, and after analyzing the original waste, an acid leaching at 90 °C is made as follows.(1):

$$Al_2O_3 . n\ H2O + 3\ H_2SO_4 \rightarrow Al_2(SO_4)_3 + (3 + n)\ H_2O \quad (1)$$

The mixture is stirred to get the dissolution of the aluminum trihydrate. As an example, the production of 1000 ml of commercial characteristics aluminum sulfate solution uses 875 g of sulfuric acid (24%Wt) and 375 g of the initial sample. This product has as its main field of use as coagulant for drinking water treatment. This process is not good for fines because only most of residual hydroxide is attacked, it means low aluminum recovery.

Another possibility is a sulfuric acid dry treatment at high temperature in oven, so that transition alumina could be attacked [5] Starting with 80 g of initial sample and 320 g of sulfuric acid (90%W), the mixture treated at 300ºC in oven for half an hour, is subsequently leached with 800 ml of water, producing about 1000 ml commercial solution, plus 13 g of alpha alumina, that could be used as abrasive because its fineness (less than 5 µm).

The solution produced is used for potassium alum production with a high yielding (90%) [9], using the stoichiometric amount of caustic reactive, as in reaction (2).

$$Al_2(SO_4)_3 + H_2SO_4 + 2\ KOH + 22\ H_2O \rightarrow$$
$$2\ AlK(SO_4)_2 . 12\ H_2O \quad (2)$$

Finally, it can be associated the two different attacks for producing aluminum sulfate, alum, and abrasive alumina. The flow-sheet for this tandem process is described in the Fig. 1.

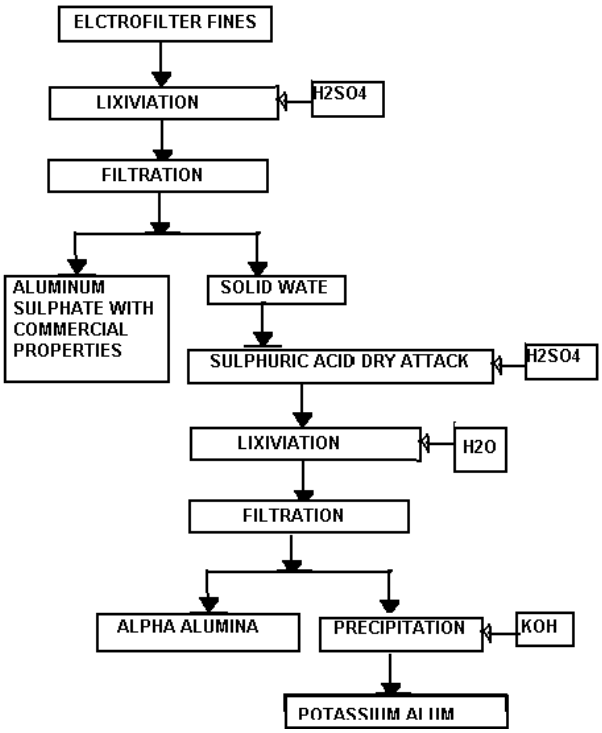

Figure 1. Flow diagrame of the process

CONCLUSIONS

The aim of the companies management board is in general, and particularly in aluminium industries, to minimize the amount of waste being sent for disposal. With the treatments outlined above, products with added-value were obtained from Bayer electrofilter fines, using very simple techniques and cheap reagents, thus getting a correct environmental management of waste generated in the Aluminium industry. In this case no secondary wastes are left.

REFERENCES

[1] Dean, H. What is alum?. Journal for Weavers, Spinners and Dyers, (2005) 213, pp 10 -11.
[2].- Sancho J.P., Verdeja L.F., Ballester A., 2000. Metalurgia Extractiva Vol 2. Madrid Ed. Síntesis. 181–190.
[3].- M.P. García, J.M. Ayala and J.P. Sancho, The use of Bayer alumina fines for other industrial purpose (1993), Light Met. (1991), pp. 195–201.
[4].- J.P. Sancho, La Metalurgia del Aluminio, Aluminium Verlag., Dusseldorf (1992), pp. 63–65.
[5].- J.P. Sancho Martínez, J. Ayala Espina, M.P. García Coque, B. Fernández Pérez and D. Costales Alonso, The sulphuric acid leaching of Bayer electrofilter fines: a practical kinetical approach, J. Met. (2006), pp. 58–63 August 2006.
[6].- J.P. Sancho, M.P. Garcia, M-F Garcia, J. Ayala y L.F. Verdeja - The posible use of Bayer process cyclone fines for manufacture of abrasives.. Rev Metal. Madrid 38 (2002) 433 – 442.
[7] J.P. Sancho Martínez; J. Ayala Espina.; M.P .García Coque.; B. Fernández Pérez. Leaching behaviour of a Bayer electrofilter fines in sulphuric acid. Hydrometallurgy (2008)
[8] J.M.M. Paixao, J.C. Amarak, Memoria L.E, Freitas L.R. Sulphation of Carajás manganese ore. Hydrometallurgy (1995) 39 , pp 215 – 222.
[9] H. Lin Sheng and C. Lo Mu, Synthesis if aluminium sulphate from waste aluminium processing solution by crystallization. Journal of Hazardous Materials. (1998) 63, 2-3, pp 211 – 222