

# ALIEN PROPERTY CUSTODIAN

## PROCESSES FOR EXTRACTING ALUMINIUM FROM COAL MINE PRODUCTS

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The invention relates to a process for extracting aluminium from coal mine products.

It has been proposed to prepare alumina a. o from silica and aluminium containing ash obtained by burning waste materials from coal mines, washing and flotation plants. For this purpose the slags after being ground are treated with strong hydrochloric acid and the residium is removed by filtration; the solution is evaporated and the residium heated till the aluminium chloride and iron chloride are converted into the corresponding hydroxides; the solid mass is washed with water to remove the soluble chlorides; then the silica still present is converted into water glass with the aid of sodium or potassium carbonate and removed; the alumina is dissolved from the residium by means of caustic soda and this solution is treated to recover the alumina.

In an improved process the waste materials before being burnt are mixed with about 2.5% of calcium hydroxide or a corresponding quantity of another calcium compound or with about 7% of barium hydroxide or a corresponding quantity of other barium, strontium or magnesium compounds, calculated on the ash contents of the materials to be burnt. On account of the action of these admixtures the slags can be treated with hydrochloric acid at normal pressure and boiling temperature; when treating slags formed without admixtures it is necessary to work in autoclaves. By this improved method, when using calcium compounds, 80-85%, and when using other earth alkaline compounds, up to 60% of the aluminium compound contained in the ash pass into solution, whereas this percentage amounts to only 20 for the ash from the waste materials without addition. In the improved process the solution obtained is worked up in the same manner as described before.

It has also been proposed to treat the ash from coal or lignite burnt without any admixture with nitric acid. This process, however, has a serious disadvantage over the treatment with hydrochloric acid in as far as substantially less of the aluminium contents of the slags passes into solution; investigations with slags of various origin have invariably shown recoveries below 10%.

One of the objects of the invention is to extract a high percentage of the aluminium compounds from coal mine products.

Another object is to improve the filtration capacity of the mass resulting from the treatment with acid.

Other advantages obtained in the process ac-

ording to the invention will be clear as its description proceeds.

According to the invention coal mine products containing aluminium compounds, such as coal sludge, intermediate product and stones from the washing plant or mixtures thereof are mixed with earth alkaline compounds inclusive magnesium compounds, then burnt and extracted with nitric acid.

Whereas nitric acid when used to treat slags obtained without an addition of earth alkaline compounds only allows to dissolve about 8% of the aluminium contents, this percentage is increased to about 88 or even higher when the same acid is applied to slags remaining after the burning of coal mine products admixed with earth alkaline compounds. This high figure is unexpected, as when attacking "prepared" slags with strong hydrochloric acid the recovery is somewhat less than that obtained with nitric acid according to the invention, although according to literature hydrochloric acid dissolves already up to about 20% of the aluminium contents from "unprepared" slags, where nitric acid dissolves up to about 8%.

Further the silica obtained when using nitric acid can be filtered off more easily than when working with hydrochloric acid. Moreover, after a magnetic separation, which will be described below, less iron passes into solution than when using hydrochloric acid.

Still other advantages are connected with the use of nitric acid instead of hydrochloric acid. In the first place it is possible to work in metal apparatuses, which cannot be used when extracting with hydrochloric acid. Further several of the nitrates obtained, for example those of calcium and of the alkaline metals, are valuable by-products, as they can be used as fertilizers.

It suffices to treat the slags with nitric acid under normal pressure. The strength of the acid can vary materially; excellent results have been achieved for example with nitric acid of about 20%. The slags are preferably ground before being treated with the acid.

On account of the use of nitric acid instead of hydrochloric acid it has often been found preferable to increase the amount of the earth alkaline compounds over that stated in the third paragraph of this specification. In general one uses more than 7% and preferably about 10%, calculated as oxide on the ash contents of the material to be burnt; a calcium compound is preferred. To elucidate this the following experiments are given. As a starting material coal

5  
10  
15  
20  
25  
30  
35  
40  
45  
50  
55

sludge with 21.3% ash was used; the slags were treated with nitric acid of about 25% at boiling temperature for about one hour.

Kg sludge	Addition	Recovery of alumina
		<i>Per cent</i>
470.....	6.2 kg CaO as a powder.....	36,8
475.....	7.8 kg CaO as a powder.....	67,1
465.....	9.1 kg CaO as a powder.....	75,7
470.....	9.3 kg CaO as milk of lime.....	88,2
485.....	11.8 kg CaO as milk of lime.....	94,8

Though the use of a calcium compound is preferred, also other earth alkaline compounds or mixtures of such compounds or minerals containing same can be used, for example magnesium carbonate, barium sulphate, dolomite, magnesite, etc. If it is intended to use the nitrates obtained as a by product as fertilizers the application of barium compounds has to be avoided with a view to their toxicant character to plants.

To avoid unnecessary losses of nitric acid care should be taken to reduce the contents of combustible materials in the slags as much as possible. Losses of nitric acid are also due to iron-containing compounds in the slags. These losses are chiefly caused by a far going reduction of higher nitrogen oxides. So it is preferred to remove said substances as much as possible before the slags are treated with the nitric acid. Slags formed by well burning coal mine products are obtained as coarse cinders, among which are smaller particles containing a higher percentage of combustible material. So, according

to the invention it is preferred to remove the fine particles, e.g. by sieving, before treating the slags with nitric acid, for example through a sieve with openings of  $\frac{1}{2} \times \frac{1}{2}$  cm. Moreover, with a view to iron and iron-compounds, especially ferrous compounds, the slags to be treated with acid are preferably subjected to a magnetic separation. The results of this separation is elucidated with the aid of some analyses.

	Starting material (ground)	Magnetic portion	Non-magnetic portion
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
15 SiO <sub>2</sub> .....	40,8	37,6	44,2
Fe <sub>2</sub> O <sub>3</sub> .....	7,9	29,7	4,4
Al <sub>2</sub> O <sub>3</sub> .....	32,3	25,4	34,8
CaO.....	11,2	11,0	13,0

In this case the magnetic portion amounted to 7% of the total starting material.

If desired stronger and less strong magnetic fractions may be separated.

The working up of the solution obtained by the treatment of the slags with nitric acid into alumina or other aluminium compounds may be achieved in various ways. An important thing herein is the separation of the aluminium from the iron compounds; this may be performed, for example, with the aid of their different behaviour towards caustic alkalies. So it is possible to precipitate both the aluminium and the iron from the solution as hydroxides and to dissolve the aluminium hydroxide with caustic soda from the precipitate.

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