PATENT SPECIFICATION

700,216

Date of Application and filing Complete Specification: Aug. 30, 1951.

No. 20484/51.

Application made in United States of America on Sept. 21, 1950.

Complete Specification Published: Nov. 25, 1953.

Index at acceptance:—Class 1(3), D1, D1—G(1 : 50).

COMPLETE SPECIFICATION

Improvements in or relating to Process for Extracting Alumina Values from Alumina Bearing Ores

We, ALUMINIUM LABORATORIES LIMITED, a corporation organised under the laws of the Dominion of Canada, of 1800 Sun Life Building, Montreal 2, Canada (Assignees of WILLIAM ADDISON JAMES), do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in the art of treating alumina bearing ores for recovering alumina values therefrom, particularly to the Bayer and like processes, in which recovery of alumina from bauxite and similar alumina bearing materials is achieved by digestion of the ore with caustic liquor the major portion of the alumina values being thereby dissolved by the liquor and the major portion of the unwanted ore constituents remaining undissolved so as to be separable from the liquor. More specifically, the invention relates to such procedure wherein the nature of the ore under treatment has occasioned difficulty in the separation stage after digestion, i.e. the filtration of the alumina-containing solution from the insoluble material.

In procedure of the Bayer type for the treatment of alumina bearing ores, the selected ore, e.g. bauxite, is usually digested with a caustic liquor, which in commercial operation, for example, is normally a spent aluminate liquor recycled from previous digestion and alumina-precipitation stages; by the digestion step, alumina values are extracted from the ore and thus re-establish a relatively substantial concentration of dissolved alumina in the liquor. Efficient operation has required that the digestion processes be carried out at temperatures well above that of the normal boiling point of the solution (i.e. the boiling point at atmospheric pressure) and thus at pressures far in excess of atmospheric pressure. Following the digestion of the ore by the caustic liquor, the next step has been to cool the resultant slurry by flashing, that is, rapidly decreasing the digestion pressure, in one or several stages, to effectuate a rapid water evaporation therefrom with accompanying decreases in temperature. For example, the digester is subjected to sudden release of pressure (as by opening it suddenly) one or more times, so that with the usual ebullition the slurry cools down promptly to or near the normal boiling point. After flashing, the alumina bearing liquid is separated from the unwanted and undissolved ore constituents, designated "red mud," suspended therein. Although other methods, such as sedimentation, followed by decantation, or combinations of methods, have sometimes been proposed, it has generally been found that for commercial operations, which are usually of large magnitude, filtration is the most economic and efficient procedure for effecting the separation of the alumina bearing liquid, i.e. aluminate solution, from the unwanted and undissolved red mud suspended in it. Thus in common practice, the slurry from the digesters (after it has been flashed) is conducted to filter presses or the like, from which the alumina-rich liquor is removed for subsequent processing to precipitate alumina, while the red mud remains as the usual cake on the filter cloth.

Special difficulties have been found to arise, however, in attempts to separate the digested liquor from the red mud in the case of certain types of ore, particularly the ores known as "Jamaica" bauxites (i.e. bauxite mined in Jamaica, B.W.I) or materials of like character, as explained below. The primary difficulty is in the achievement of an efficient rate of separation, or conversely, in obtaining, as by filtration or otherwise, a satisfactory yield of essentially clear and uncontaminated aluminate solution within an economically short time. Thus the filtration rates of the slurries formed from ores of this type, after digestion and treatment by the normal commercial operations as set forth above, have been found to be very slow as compared to the filtration for other ores, for example, the ores known to the

industry as "Demerara" and "Arkansas" bauxites, i.e. bauxite mined in British Guiana, and certain material found in the United States especially in Arkansas. For this extreme slowness in the rate of filtration for the "Jamaica" bauxites, which may seriously impede the normal schedule of plant operations and which in any event greatly impairs the utility of such ores in an economic sense, no remedy has heretofore been found.

The present invention has for a chief object the provision, for recovering alumina values, of improved digestion and filtration procedures in which the difficulties outlined above are at least much reduced, and, in some cases, largely overcome. Another object is to provide, for the purposes indicated, methods for improving the filtration rates of particular alumina bearing slurries.

We have discovered that the undue slowness of the filtration rates for the "Jamaica" bauxites is apparently caused, at least to a chief extent, by the rapid filling of the interstices of the filter cloth, and also, or alternatively, by the building up of a dense, close packed cake on the filter cloth; such difficulty or difficulties seem to result from the extremely finely subdivided nature of the solids forming the red mud as contained in the slurry supplied by the customary procedure. We have further discovered, however, that this difficulty is unexpectedly overcome by transferring the slurry from the digester to the separation step while maintaining it in a relatively undisturbed state, e.g. specifically by conducting the slurry from the digestion stage directly to the filters without flashing, and preferably at a high temperature, or alternatively after the slurry has been gradually cooled down. Extensive tests have shown that the rate of separation of the desired alumina-bearing solution is then greatly increased and the stated difficulties are largely overcome, an essential feature of the process being the avoidance of flashing (or more particularly, the prevention of any sudden change in pressure or temperature), as by filtering the slurry at digestion pressure and temperature or by slowly reducing the temperature of the slurry, while maintaining the slurry confined against sudden reductions in digestion pressures, prior to filtration.

That is to say, we have found that flashing the digested slurry formed from "Jamaica" bauxite produces, in some way not yet fully understood, a suspended red mud formed of particles that are extremely finely subdivided in nature as compared to the particles resulting from the flashing of slurries formed of "Arkansas" or "Demerara" bauxites, and the filtration rates for separations thereof may be substantially increased by avoiding the flashing of the digested slurry. From microscopic investigation, it is now believed that the Jamaica bauxite has, so to speak, a residual skeletal structure that is substantially disintegrated by the flashing operation, i.e. presumably by the relatively violent agitation or other disturbance of the nature of ebullition, which accompanies a sudden reduction in digester pressure. On the other hand, the residual skeletal structures of bauxites heretofore commonly used, such as Demerara and Arkansas bauxites, do not appear to exhibit this susceptibility or characteristic. So far as we know, moreover, this significant difference in the nature of the red mud particles from the two types of ore has not been observed or recognized heretofore.

It may be explained that by residual skeletal structure is meant the structure of the undissolved components or constituents left behind (and usually constituted in particles of relatively appreciable size) after dissolution of alumina values by digestion with caustic liquor, the original ore being itself customarily characterized (at least as supplied to the digester) by a moderate but not excessive fineness of particle size, i.e. in that for economy of grinding cost and for ease of handling, the bauxite is usually crushed to no more than a fineness which affords extraction of nearly all of the alumina. For convenience of definition herein, the ore to which the invention is peculiarly applicable may be denoted as having a residual skeletal structure which can be substantially disintegrated by flashing (meaning flashing after digestion), and will be understood to mean Jamaica bauxite or other ore like it, i.e. that exhibits a behaviour identical to Jamaica bauxite and presently interpreted as due to the special particulate structure of its caustic-insoluble content.

A further feature of our discovery is that elevated filtration temperatures lead to an unusually large increase in filtration rate when applied to slurries of the type described above. The effect of such operation, i.e. filtering the slurry at a temperature well above its normal boiling point, and most conveniently at the temperature of digestion is quite pronounced when utilizing bauxite of the Jamaica type in marked distinction from other kinds of ore such as Demerara bauxite, which do not yield the readily disintegrated structure of the red mud particles.

With reference to commercial operations the advantages of the invention may be advantageously utilized by directly filtering the digested slurry at digester pressure and temperature and subsequently cooling the resultant red mud filter cake and alumina bearing filtrate. For instance, in such operation the slurry is led, while confining it under pressure and without flashing or blowing out, from the digester directly to the filters. There the slurry is filtered, at a suitable pressure of the sort usually found convenient for filtration, while at the same time it maintains a temperature well above the normal boiling point, such temperature decreasing somewhat as the opera-

tion continues. When this procedure is followed, greatly improved filtration rates are obtained for Jamaica or like bauxites having a residual skeletal structure, i.e. red mud structure, of the readily disintegrable sort defined above.

The improved process may also be practiced with advantage for Jamaica and like bauxites of the stated, special type, by slowly reducing the temperature of the slurry, in or from the digester, while maintaining the slurry confined against sudden reductions in pressure, until the temperature reaches or approaches that of the boiling point of the liquid at atmospheric pressure. Conveniently, the digester is provided with internal or other cooling coils or with a suitable jacket, through which cold water or other coolant is circulated so that the temperature of the slurry is brought down slowly to the desired point, while the digester is kept closed and violent disturbance of the slurry is avoided. So reduced in temperature, the slurry is then conducted to the filters, and there treated in the usual manner, e.g. for filtration under pressure as customary in the Bayer process. It will be understood that during the slow cooling operation in the slurry and prior to its advance under pressure against the filter cloths, it is immaterial whether the digester is open to the atmosphere, providing of course that the cooling has been carried to a point where no violent disturbance of the liquid can result from release of pressure over it or in it.

As will now be apparent, a notable feature of the invention is that it may be applied to advantage and without radical modification of equipment to the Bayer process as commercially practiced at the present time.

As presenting one specific example of our process the following table of data (Table I) resulting from small scale tests is presented. In each of the tabulated tests a slurry was made up by digesting a bauxite charge (of the selected bauxite) calculated to give an alumina concentration of 45 grams per litre in a 100 grams per litre NaOH solution, the latter being the caustic liquor used for digestion. The slurry was filtered on a 1 square inch vertical filter at a pressure of 50 psi (pounds per square inch). The digestions were carried out in a manner representative of standard practice, e.g. at temperatures of 150° C. for about 10 minutes. In the test where flashing was avoided yet filtration was effected below 100° C., the slurry was cooled down slowly in the digester, while keeping it closed. In each test, the volume of filtrate was measured at 5 minute intervals up to an hour, but the total volume, at the end of the hour, was found to be amply significant.

TABLE I.

Bauxite Source	Number of Tests	Digester Slurry Flashed	Filtration Temperature ° C.	Cumulative Filtrate Volume, ml, in 60 minutes, Average
Jamaica	2	Yes	85	61.6
Jamaica	1	No	85	204.5
Demerara	8	Yes	85	340

As will be seen, the yield of aluminate solution in a given time was tremendously increased, in operation with Jamaica bauxite, by the present process where flashing was avoided and the digester charge was cooled down slowly.

As another and more complete specific example of our process, a further table of data (Table II) for a pilot plant scale tests is presented. In these tests portions of the selected bauxites were digested with plant spent liquor, the bauxite charge being calculated to increase the alumina concentration by 45 grams per litre in the 50 litres of spent liquor that were used for each test. The spent liquor was the usual caustic liquor (sodium hydroxide—sodium carbonate—sodium aluminate solution) used for digestion in the Bayer process, being taken directly from the recycled supply in the commercial plant where the tests were carried out. In each case, digestion was done in a steam jacketed autoclase for 10 minutes at about 290° F. A filter cell was connected to the bottom of the autoclave and contained a vertical round filter leaf of 37 square inches area.

The volume of filtrate was measured at regular and suitably frequent intervals up to an hour. Where necessary, the filtrate was cooled by passing it through a condenser. The autoclave was arranged so that for the tests with flashing, the charge could be cooled by flashing into a receiver from which the slurry was then drained back into the autoclave. For the lower temperature filtrations without flashing, the charge was cooled by passing cold water through the jacket of the autoclave. Where filtration was effected at high temperature, the filter was arranged to receive the slurry from the digester (i.e. the autoclave) without sudden release of pressure, except that in the tests indicated as involving high temperature filtration after flashing, the digester was flashed (to provide a sudden, large release of pressure) and then closed while the contents were reheated to the stated temperature before filtration.

TABLE II

Bauxite Source	Jamaica				Demerara			
Flashed	Yes		No		Yes		No	
Filter Temp. Average °F.	212	258	227	266	228	267	233	272
Range °F.	242—194	297—233	246—216	304—235	248—214	296—236	249—222	293—255
Filter Pressure Average (p.s.i.)	87	81	88	86	87	84	82	83
Range (p.s.i.)	91—79	86—50	96—70	100—79	95—79	89—73	86—79	92—71
No. of Runs	2	2	2	2	5	4	2	4
Time of Filtration — Minutes	Average Cumulative Volume of Filtrate, Liters							
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1.7	2.3	2.6	3.3	4.1	4.6	3.4	4.5
10	2.7	3.6	4.3	5.5	7.0	8.1	6.0	8.0
20	4.1	5.7	7.5	9.2	12.0	13.8	10.8	13.6
30	5.6	7.7	10.3	12.8	16.3	18.4	15.2	18.2
40	6.8	9.4	12.8	15.5	20.3	22.3	19.2	22.4
50	7.9	10.8	15.1	18.4	23.9	25.7	22.7	26.0
60	8.8	12.1	17.2	21.1	27.4	28.9	26.2	29.7

In the operations representing the improved procedure of the invention, i.e. the treatment of Jamaica bauxite without flashing the digester charge, the data Table II clearly demonstrate the great extent to which the filtration was expedited at both low and high temperatures. As will be apparent, the unusual advantage of the method is especially marked, by comparison with the relatively insignificant effect of similar modifications in the treatment of slurries derived from Demerara bauxite; indeed in the latter tests, the substitution of slow cooling for flashing appeared even to delay the filtration somewhat. By the results of the above and other tests, the present process has been shown to afford unique and very material improvement in the efficiency of liquid separation for digester slurries derived from the Jamaica type of bauxite.

What we claim is:—

1. A process for extracting alumina values from Jamaica bauxite and from ores having a like skeletal structure by digestion with caustic solution at elevated temperature and pressure to form a slurry of dissolved alumina and insoluble particles suspended therein, said insoluble particles constituting the undissolved portion of the ore, characterized by the fact that, without sudden reduction of the temperature or pressure of digestion, said slurry is subjected to a separation treatment such as filtration or sedementation.

2. A process according to claim 1 characterized by the fact that the temperature of said slurry is slowly reduced and the cooled slurry is subjected to said separation treatment.

3. A process according to claim 1, wherein said slurry is filtered without substantially decreasing the temperature or pressure thereof.

4. A process for extracting alumina values from ores substantially as hereinbefore described.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1953.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

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No. of Runs	2	2	2	2	5	4	2	4
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20	4.1	5.7	7.5	9.2	12.0	13.8	10.8	13.6
30	5.6	7.7	10.3	12.8	16.3	18.4	15.2	18.2
40	6.8	9.4	12.8	15.5	20.3	22.3	19.2	22.4
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