

SPECIFICATION

Preparing aluminium hydroxide

This invention relates to a process for the manufacture of coarse aluminium hydroxide, for example via the Bayer process in which bauxite is digested with an aqueous sodium aluminate liquor, so that the aluminium oxide contained in the bauxite goes into solution. The aluminium hydroxide can be crystallised by seeding the filtered, super-saturated sodium aluminate solution with finely divided aluminium hydroxide. This invention is particularly suitable for the production of coarse aluminium hydroxide which contains a maximum of about 15% by weight of particles which are less than 45 μm in size.

Nowadays, two processes for the manufacture of aluminium oxide by Bayer process find large scale application, one being usual in European plants and the other being practised in America. The European process employs a high Na_2O concentration, up to 140 g/l, for the crystallisation. In order that good productivity may be obtained at this high concentration, a large amount of seed hydroxide, for example, at least 200 to 250 g/l $\text{Al}(\text{OH})_3$ of liquor, is used at a low temperature, for example, 55°C or less. Up to 80 g/l of fine aluminium hydroxide can be obtained. As long as this fine hydroxide is calcined at a high temperature, there is little dust. However, the dry scrubbing of waste gas demands an oxide with a BET-surface area of between 30 and 60 m^2/g which can only be obtained by weak calcination of the aluminium hydroxide. However, weak calcination of the fine aluminium hydroxide produced in the European process gives an oxide with a strong tendency to dustiness which is not generally commercially acceptable.

The process practised in America is designed to produce a coarser hydroxide than the European process. The weak calcination which is then used gives an oxide with little tendency to dustiness. In order to manufacture a coarse hydrate, the caustic liquor concentration is normally less than 110 g/l Na_2O in the American process. The starting temperature is high, for example 70°C, and the amount of seed material low, for example 50 to 120 g/l $\text{Al}(\text{OH})_3$. If too low a starting temperature for the crystallisation is chosen and the amount of seed hydroxide too high, then a fine product is obtained. The conditions in the American process for the production of a coarse product are opposed to good liquor productivity. The lower liquor productivity of this process is evident in that, at best, about 55 g/l of aluminium oxide are produced, whereas a productivity of up to 80 g/l can be achieved in the European process. Expressed in other terms, 18 to 20 m^3 of liquor are required for the production of one tonne of aluminium oxide in the American process compared to only about 13 m^3 in the European process.

The European process could be adapted, using features of the American process, to the production of a calcined aluminium oxide with a BET-surface area of 30 to 60 m^2/g , but its productivity would fall by about 30 to 40%, with a corresponding rise in heat consumption. Conversely, an improvement in the productivity of the American-type plant would mean an increase in capacity, accompanied by a reduction in the specific heat consumption.

There have been many proposals for achieving the desired aim of a coarse product with high productivity. U.S. Patent Specification No. 2,657,978 discloses a modification of the American process, the seed material being added in two stages. In the first stage, only sufficient seed is added to promote strong coarsening. This is then followed by a second addition, to achieve good productivity. By fixing the caustic concentration at about 85 g/l Na_2O , a productivity of about 48 g/l Al_2O_3 , based on the liquor to be crystallised, can be achieved. This may be compared with a productivity of about 45 g/l for the unmodified process with a single seed addition, when the reaction time in both cases is 35 hours. The increase in productivity by the modification is thus about 6.5%.

French Patent Specification No. 1,391,596 discloses a two-stage process having two crystallisation routes. With a crystallisation time of 30 to 40 hours, the process can give a productivity increase of 6.4% over, and a coarser product than that obtained in, the normal one-stage American process. Although no absolute figures as to the productivity are given, they would not appear greatly to exceed those achieved by the process of U.S. Patent Specification No. 2,657,978. In one of the two crystallisation routes, fine seed is added under conditions which allow agglomeration to occur; in the other route, coarse hydroxide is added in an amount and under conditions such that growth of the crystals results. Following the separation of the coarse hydroxide and the coarse seed, the partially exhausted aluminate liquor from both routes is treated with further fine seed in the second stage of the process, in order to exhaust the aluminate liquor still further and to raise the productivity of the precipitated aluminium hydroxide. The main feature of this process is a coarse, abrasion-resistant product which is obtained with improved productivity.

U.S. Patent Specification No. 3,486,850 discloses a modification of the American process in which greater productivity is obtained by intermediate cooling during the crystallisation, while maintaining the production of a coarse product. This must be conducted in a narrowly defined temperature range, in order not to obtain too fine a product. In one example of this process, a productivity of 51 g/l Al_2O_3 is given, with a crystallisation time of approximately 40 hours.

In Light Metals 1978, Vol 2 (Proceedings of sessions of 107th AIME Annual Meeting, Denver, Colorado, U.S.A.) page 95, the conversion of a European process alumina plant to the American process is described. The process is substantially the same as that in French Patent Specification No.

1,391,596. The productivity is 56.3 g/l Al_2O_3 , with a reaction time of between 40 and 50 hours. This publication refers to other processes which, although giving a coarse product, exhibit lower productivity than the particular process described above.

It is thus clear that various methods are known in which aluminium hydroxide seed material is added to an alkaline aluminate solution super-saturated, with respect to the ratio between the aluminium hydroxide and aluminate in the solution under equilibrium conditions, with aluminium hydroxide. According to the present invention, coarse particles of aluminium hydroxide, no more than 15% by weight of the particles being less than 45μ in size, are produced by a process in which the seed material is added in two stages. In the first stage, conducted at a temperature of from 66 to 77°C, there are from 7 to 25 grams of super-saturated Al_2O_3 per square meter of the surface area of the seed material. There is an interval of at least two hours between the first and second stages. In the second stage, conducted at a temperature lower than the first stage, the total amount of seed material added is at least 130 grams $\text{Al}(\text{OH})_3$ per liter of aluminate liquor.

The individual steps of the novel process are more or less well known. However, the novel process can achieve results which the individual steps cannot.

The invention will now be described by way of example with reference to Figure 1 of the accompanying drawings, which is a schematic representation of apparatus suitable for carrying out the invention. The apparatus is basically of the American process type, with suitable modifications.

Figure 1 shows two crystallisation tanks arranged in series. A tank 1 is supplied through pipe 2 with sodium aluminate liquor super-saturated with aluminium oxide and through pipe 3 with a measured amount of a fine seed suspension. The temperature, amount of seed and the molar ratio of the components are adjusted to the characteristics of the seed material and the conditions of operation so that the desired degree of agglomeration of the fine seed material occurs in tank 1. The equilibrium of the fine seed may be maintained, if necessary, by the addition of a certain amount of coarse seed through pipe 8—8'.

The agglomeration proceeds at a suitable rate at from 66 to 77°C. It is usually considerably advanced after 2 hours and is often practically complete after 6 hours. The suspension is then passed through a cooling device 4 and then delivered, by means of a pump 5, to the tank 6. In the tank 6, the suspension is seeded with sufficient coarser seed through pipe 8 so that the crystallisation proceeds to completion with a larger seed surface area and/or a high degree of super-saturation (obtained by the cooling). The cooling can be caused by indirect contact with the surroundings through the uninsulated walls of the crystallisation tank or tanks, instead of by using the cooler 4.

The supply of seed to the tank 6 is from a secondary thickener 16 through pipe 8 and, if necessary, a small excess of fine seed from a tertiary thickener 19 through pipe 3—3'. This second crystallisation stage allows the seed hydroxide to grow further and, according to the degree of super-saturation of the aluminate liquor, results in the formation of fine particles of hydroxide by secondary nucleation and by mechanical detachment of fine crystals. Owing to the relatively high amount of secondary seed, the secondary nucleation effect is held within bounds.

The suspension is then pumped, by means of a pump 7, through pipe 9 to a primary thickener 10 in which the thickened material (the product hydroxide) is discharged through pipe 11 and pumped, by means of a pump 12, to a filtration plant 13. From the filtration plant, the hydroxide filter cake is passed to a calcining kiln (not shown).

The overflow of the primary thickener 10 is passed through pipe 14 to the secondary thickener 16. The thickened material (coarse seed hydroxide) is discharged through pipe 8 and pumped, by means of a pump 17, to the tank 6. The overflow of the secondary thickener is passed through pipe 18 to the tertiary thickener 19. The thickened material from the tertiary thickener (fine seed material) is discharged through pipe 3 and pumped, by means of pump 20, to the tank 1. The overflow of the tertiary thickener 19 consists of clarified, decomposed aluminate liquor which is recirculated to a fresh digestion operation. An optional plant 21 permits conventional washing of the fine seed, in order to reduce the content of organic substances, particularly sodium oxalate.

An optional pipe 15 may be provided to return the product hydroxide from the primary thickener 10 in the event that the nature of the product hydroxide needs to be adjusted.

In continuous operation of the process according to the invention, more than one crystallisation vessel, connected in series, is usually used in place of the one illustrated tank 1, and more than one crystallisation vessel, connected in series, is usually used in place of the one illustrated tank 6.

With sufficient air cooling, the cooling device 4 may be omitted. Alternatively, it may be replaced or augmented by internal cooling in the tanks using, for example, cooling coils or jackets.

The fine seed washing plant 21 may be omitted if the fine seed is of sufficient purity, i.e. if there is little contamination of the fine seed with organic substances. The type, properties and amounts of such organic substances determine the necessity for washing the fine seed.

Figure 2 of the accompanying drawings is a graph of the percentage degree of agglomeration as a function of the ratio of the super-saturation of the liquor (in grams Al_2O_3 per litre of liquor) to the surface area of the seed material used (in square meters per litre of liquor). The super-saturation of the liquor is determined using, for example, thermotitration, and the specific surface area by, for example, the well-

known Fisher Sub-Sieve Sizer.

The percentage degree of agglomeration may be expressed as

$$(I-A)100/I$$

wherein I is the percentage of the seed less than 45 μm in size and A is the percentage of the agglomerated product less than 45 μm in size.

The results shown in Figure 2 are obtained in a temperature range of from 66 to 77°C and a range of liquor concentrations of from 70 to 150 g/l Na₂O caustic. Agglomeration may occur outside these ranges, but then the results which can be achieved by using the process of the invention are only partially attained.

The degrees of agglomeration represented in Figure 2 are attained after a residence time of 6 hours in tank 1. Good degrees of agglomeration are also attained after residence times shorter than 6 hours, as can be seen from Figure 3 (a graph of the degree of agglomeration as a function of the resident time) with different seed surface areas (square meters of seed per litre of liquor) where temperature, aluminate liquor concentration (g/l Na₂O) and degree of super-saturation are substantially the same. It will be seen that, after only 2 to 3 hours, approximately 50% of the total degree of agglomeration can be attained. Further, Figure 3 shows that, after a residence time of approximately 6 hours, it is possible to attain something approximating to the maximum degree of agglomeration. (Some of this knowledge was obtained using batches of 600 m³ of super-saturated aluminate liquor). The knowledge obtained from the result shown in Figures 2 and 3 and described above is used in conducting the first stage of the process of the invention, e.g. for conducting the agglomeration in tank 1. In this first stage, the fine seed hydroxide grows coarser by agglomeration, so that a sufficiently coarse product can be obtained at the end of the complete crystallisation cycle.

Experimental work has shown that the necessary degree of agglomeration is attained when the amount of fine seed in the first stage is such that the relationship of the super-saturation of the aluminate liquor used (g/l Al₂O₃) to the surface area of this fine seed (m²/l) is from 7 to 25, and preferably from 7 to 16, g/m².

It is advantageous if the duration of this first stage is as short as possible. However, it should be sufficiently long to achieve the necessary coarsening, so that as long as possible a residence time is available for the second stage of the process. According to the invention, this second stage is conducted under conditions which are conventional in European plants and which can lead to high productivity, i.e. at relatively low temperatures and using large amounts of seed.

Experiments have shown that the temperature in the second stage must be lower than in the first, and will therefore usually be lower than 66°C. The temperature may be lowered continuously or in one or more successive steps. The final temperature depends on a number of factors, among which are the duration and degree of crystallisation, and the amount of fine particles formed. The final temperature can be, for example, about 40°C.

The amount of seed which is added in the second stage is less critical than the amount added in the first stage. However, it must be sufficiently large that the desired final properties are obtained, and that secondary nucleation is held within bounds. Experiments have demonstrated that the amount of seed added in the second stage must be sufficiently large that the total amount of seed (primary and secondary additions) is at least 130 g/l Al(OH)₃. Generally, not more than 400 g/l is added. It has been observed that it is advantageous if the seed added in the second stage is added all at once. However, it may be added portion-wise without deviating from the scope of this invention.

As mentioned above, not only does the seed grow during the second stage, but also fine particles of hydroxide are formed by secondary nucleation and by mechanical detachment of fine crystals, these circumstances occurring owing to the renewed increased super-saturation of the aluminate liquor and the continuous agitation of the suspension. However, this formation of fine hydroxide particles is of no significant disadvantage in this invention, in contrast to known processes. Accordingly, even if a large number of fine particles are formed in the first stage, they may be processed in the given agglomeration conditions, as will be apparent from Figures 2 and 3. The conditions in the second stage may therefore be chosen to achieve maximum liquor productivity, the formation of fine particles being tolerated.

In the invention, up to 80 g/l of aluminium oxide may be achieved. This is equivalent to the productivity of known European type processes but the aluminium hydroxide which is produced is coarser, containing between 4 and 6% by weight fewer particles which are less than 45 μm in size.

The productivity of the process of the invention is dependent on the caustic concentration of the original liquor. In order to attain high productivity, the caustic concentration in the liquor which is used at the start of the process is preferably at least 100, and more preferably at least 120, g/l Na₂O.

European plants are not usually provided with means for separating the product and secondary and tertiary hydroxides. In converting a conventional European plant to operate in accordance with this invention, appropriate devices are necessary, but these need not be gravity separators as in the American process; any suitable known separator is suitable.

American plants are furnished with suitable separation apparatus, as described with reference to Figure 1. An American plant can be converted to conduct a process of this invention by introducing an

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agglomeration phase and a second seeding stage, and it may also be necessary to raise the caustic liquor concentration and to introduce cooling after the agglomeration.

The suspension withdrawn from the final crystallisation device can sometimes exhibit too high a solids content for satisfactory separation in the primary thickener. It may therefore sometimes be desirable to dilute this suspension, for example with the clear liquid which is obtained in the overflow from the final, e.g. tertiary, thickener.

The following Examples illustrate the invention.

EXAMPLE 1

1000 l of super-saturated Bayer aluminate solution from a production plant, with an initial concentration of 120.2 g/l Na_2O caustic and 142.3 g/l Al_2O_3 , were placed in a vessel of 1.5 m³ capacity provided with air agitation means. This aluminate liquor exhibited a super-saturation of 69.9 g/l Al_2O_3 at 71°C. After the addition of 50 kg $\text{Al}(\text{OH})_3$ primary seed material (60.8% by weight less than 45 µm in size) the reaction mass was adjusted to a starting temperature of 71°C according to a temperature profile adapted from large-scale industrial operations.

The primary seed exhibited a specific surface area of 0.1148 square metres per gram, so that about 5.75 m²/l of seed of aluminate liquor was employed. The relationship of the super-saturation (g/l Al_2O_3) to the seed surface area (m²/l) was about 12.1 g/m².

After six hours, 156 kg of secondary seed (16.4% by weight less than 45 µm in size) were added to the reaction mass which was then rapidly cooled by 7.5 degrees C. The crystallisation was allowed to proceed for a further 6 hours, following which a second intermediate cooling of 7.5 C degrees was undertaken. The crystallisation was then allowed to proceed for a further 33 hours. The final temperature was 50°C. The resultant suspension was filtered, and the aluminium hydroxide so obtained was washed and dried.

The dried filter cake, consisting of seed material and precipitated aluminium hydroxide, contained 14.9% by weight of particles less than 45 µm in size. By subtraction of the weight of the seed from the total weight of the dried filter cake, and conversion to an Al_2O_3 basis, a yield of 71.1 kg Al_2O_3 was obtained. This corresponds to a specific yield of 71.1 g Al_2O_3 per litre of liquor to be decomposed.

The test results of this Example, reproduced in the Table following Example 6, are average values of two parallel tests.

30 EXAMPLE 2

Following the procedure described in Example 1, a Bayer aluminate liquor of higher starting concentration (124.6 g/l Na_2O caustic and 146.4 g/l Al_2O_3) and a liquor super-saturation of 70.2 g/l Al_2O_3 was used. Primary seed of the same quality and amount as in Example 1 was added. The secondary seed was considerably finer than in Example 1 (156 kg with 24.9% by weight less than 45 µm in size) but all other parameters were the same as in Example 1. The dried filter cake consisting of seed material and precipitated aluminium hydroxide, contained 20.1% by weight of particles less than 45 µm in size. 72.3 g Al_2O_3 were obtained per litre of the original liquor. These values are averaged from three parallel tests.

EXAMPLE 3

A Bayer aluminate liquor with a concentration of 120.3 grams Na_2O caustic per litre and 142.4 grams Al_2O_3 per litre was used. The reaction mass was mechanically agitated. The primary seed contained 54.3% by weight less than 40 µm in size, its specific surface area being 0.1148 m²/g. The secondary seed contained 23.5% by weight less than 40 µm. The amount of the primary seed was 50 kg, that of the secondary seed 156 kg. The super-saturation of the aluminate liquor amounted to 69.9 g/l Al_2O_3 , so that the ratio of the super-saturation to the surface area of the primary seed was 12.1 g/m². The temperature profile cooling only was carried out, of 15 C degrees, before the addition of the secondary seed. The final temperature was 49°C. The working-up and evaluation was performed in the same manner as described in Example 1.

The dried filter cake, consisting of seed and precipitated aluminium hydroxide, contained 18.9% by weight of particles less than 40 µm in size. The specific yield was 72.1 grams Al_2O_3 per litre of original aluminate liquor.

EXAMPLE 4

An aluminate liquor containing 111.7 g/l Na_2O caustic and 130.5 g/l Al_2O_3 and a super-saturation of 65.6 g/l Al_2O_3 at 71°C was used. The amounts and qualities of the primary and secondary seed were identical to those in Example 2, so that the super-saturation to primary seed surface area ratio was 11.4 g/m². The same temperature profile as in Example 3 was chosen and, as in Example 3, the final temperature was 49°C. The dried filter cake, consisting of seed material and precipitated aluminium hydroxide, contained 19.5% by weight of particles less than 45 µm in size. The specific yield was 67.8 grams of Al_2O_3 per litre of original aluminate liquor.

EXAMPLE 5

Using the procedure of Example 1, a Bayer aluminate liquor with a starting concentration of 130.6 g/l Na₂O and 163.2 g/l Al₂O₃, and a super-saturation of 80.6 g/l Al₂O₃ at 70°C was seeded with 125 kg of primary seed (38.6% by weight less than 45 µm in size). The starting temperature was 70°C.

The primary seed had a specific surface area of 0.0885 m²/g, so that a surface area of about 11 m²/l was available. The ratio of super-saturation to the seed surface area was about 7.3 g/m².

After 6 hours, the reaction mass was cooled by 7.5 C degrees and 105 kilograms of coarser secondary seed (14.1% by weight less than 45 µm in size) were added. The crystallisation was carried out for a further 64 hours, second and third intermediate cooling steps, each of 7.5 C degrees, being carried out after 3 and 6 hours of the 64 hour period. The final temperature was 41°C. The resultant suspension was filtered and the aluminium hydroxide so obtained was washed and dried. The dried filter cake consisted of seed material and precipitated aluminium hydroxide, and contained 18.6% by weight of particles less than 45 µm in size. By subtraction of the seed hydroxide weight from the total weight of the dried filter cake, and on conversion to an Al₂O₃ basis, a yield of 83.0 kg Al₂O₃ was obtained. This corresponds to a specific yield of 83.0 grams of Al₂O₃ per litre of the original aluminate liquor.

EXAMPLE 6

A similar procedure to that in Example 5 was used. The Bayer aluminate liquor had a starting concentration of 136.8 g/l Na₂O caustic and 174.5 g/l Al₂O₃. The super-saturation of the liquor was 84.6 g/l Al₂O₃ at the starting temperature, 70°C. 125 kg of primary seed (38.6% by weight less than 45 µm in size) were used.

The primary seed had a specific surface area of 0.0885 m²/g, so that a surface area of 11 m²/l was available. The ratio of the super-saturation to the seed surface area was about 7.7 g/m².

After six hours, the reaction mass was cooled by 7.5 C degrees and 105 kilograms of coarser secondary seed (14.1% by weight less than 45 µm in size) were added. Crystallisation was conducted for a further 94 hours, second and third intermediate cooling steps, each of 7.5 C degrees, being carried out after 3 and 6 hours of the 94 hour period. The final temperature was 41°C. The resultant suspension was filtered, and the aluminium hydroxide so obtained was washed and dried. The dried filter cake consisted of seed material and precipitated aluminium hydroxide, and contained 16.5% by weight of particles less than 45 µm in size. By subtraction of the seed hydroxide weight from the total weight of the dried filter cake, and on conversion to an Al₂O₃ basis, a yield of 91.7 kg of Al₂O₃ was obtained. This corresponds to a specific yield of 91.7 grams of Al₂O₃ per litre of the original aluminate liquor.

The following table presents the results obtained in the above Examples. The term "fine proportion" refers to the proportion of particles less than 45 µm in size (in Examples 1, 2, 4, 5 and 6) or less than 40 µm in size (in Example 3).

Example	YIELD Al ₂ O ₃ g/l	FINE PROPORTION						
		SEED MATERIAL					PRODUCT	
		PRIMARY		SECONDARY		Σ	seeded plus precipitated material	
		Al(OH) ₃		Al(OH) ₃		Al(OH) ₃	Al(OH) ₃	
		%	g/l	%	g/l	g/l	%	g/l
1	71.1	60.8	30.4	16.4	25.6	56.0	14.9	46.9
2	72.3	60.8	30.4	24.9	38.3	69.2	20.1	63.6
3	72.1	54.2	27.1	23.5	36.7	63.8	18.9	59.8
4	67.8	60.8	30.4	24.9	38.8	69.2	19.5	60.4
5	83.0	38.6	48.2	14.1	14.8	63.0	18.6	66.3
6	91.7	38.6	48.2	14.1	14.8	63.0	16.5	61.0

The Table shows that, after the return of primary and secondary seed hydroxides of the same amount and similar constitution to those used, a product hydroxide with a very low fine proportion can

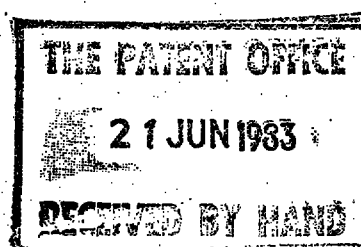
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be produced, for example 3 to 5% by weight of particles less than $45\text{ }\mu\text{m}$ in size, as is required for the production of sandy aluminium oxide. Further, the productivity of the aluminate liquor is extremely high.

CLAIMS

1. A process for producing coarse particles of aluminium hydroxide, no more than 15% by weight of the particles being less than $45\text{ }\mu\text{m}$ in size, which comprises adding aluminium hydroxide seed material, in two stages, to an alkaline aluminate solution super-saturated, with respect to the ratio between the aluminium hydroxide and aluminate in the solution under equilibrium conditions, with aluminium hydroxide; in which first stage there are from 7 to 25 grams of super-saturated Al_2O_3 per square meter of the surface area of the seed material, the first stage being conducted at a temperature of from 66 to 77°C ; in which there is an interval of at least two hours between the first and second stages of addition; and in which second stage the total amount of seed material added is at least 130 grams $\text{Al}(\text{OH})_3$ per litre of aluminate liquor, the second stage being conducted at a temperature lower than the first. 5
2. A process according to claim 1, in which, in the first stage, there are from 7 to 16 grams of super-saturated Al_2O_3 per square meter of the surface area of the seed material. 10
3. A process according to claim 1 or claim 2, in which the interval between the first and second stages of the addition is about 6 hours. 15
4. A process according to any preceding claim, in which the solution contains at least 100 g/l Na_2O . 20
5. A process according to claim 4, in which the solution contains at least 120 g/l Na_2O . 20
6. A process according to any preceding claim, in which, between the first and second stages, the temperature is reduced step-wise. 20
7. A process according to claim 1, substantially as herein described with reference to Figure 1 of the accompanying drawings. 25
8. A process according to claim 1, substantially as described in any of Examples 1 to 4.
9. A process according to claim 1, substantially as described in Example 5 or Example 6. 25

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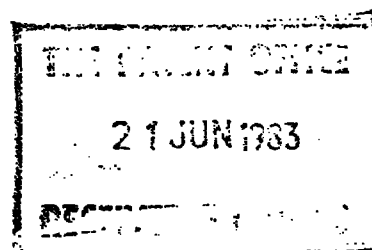




be produced, for example 3 to 5% by weight of particles less than $45\text{ }\mu\text{m}$ in size, as is required for the production of sandy aluminium oxide. Further, the productivity of the aluminate liquor is extremely high.

CLAIMS

1. A process for producing coarse particles of aluminium hydroxide, no more than 15% by weight of the particles being less than $45\text{ }\mu\text{m}$ in size, which comprises adding aluminium hydroxide seed material, in two stages, to an alkaline aluminate solution super-saturated, with respect to the ratio between the aluminium hydroxide and aluminate in the solution under equilibrium conditions, with aluminium hydroxide; in which first stage there are from 7 to 25 grams of super-saturated Al_2O_3 per square meter of the surface area of the seed material, the first stage being conducted at a temperature of from 66 to 77°C ; in which there is an interval of at least two hours between the first and second stages of addition; and in which second stage the total amount of seed material added is at least 130 grams $\text{Al}(\text{OH})_3$ per litre of aluminate liquor, the second stage being conducted at a temperature lower than the first.
2. A process according to claim 1, in which, in the first stage, there are from 7 to 16 grams of super-saturated Al_2O_3 per square meter of the surface area of the seed material.
3. A process according to claim 1 or claim 2, in which the interval between the first and second stages of the addition is about 6 hours.
4. A process according to any preceding claim, in which the solution contains at least 100 g/l Na_2O .
5. A process according to claim 4, in which the solution contains at least 120 g/l Na_2O .
6. A process according to any preceding claim, in which, between the first and second stages, the temperature is reduced step-wise.
7. A process according to claim 1, substantially as herein described with reference to Figure 1 of the accompanying drawings.
8. A process according to claim 1, substantially as described in any of Examples 1 to 4.
9. A process according to claim 1, substantially as described in Example 5 or Example 6.



PATENTS ACT 1977

SPECIFICATION NO 2034681B

The following amendments were allowed under Section 27 on 22 April 1983

Page 2, line 9 *after* stages *insert*, and the product is then separated

Page 4, line 7 *after* illustrate the *insert* two-stage addition process involved in the

Page 6, line 8 *after* hydroxide; *insert* and separating the product;

Page 6, lines 24 and 25 *after* claim 1, *insert* in which the two-stage addition is

THE PATENT OFFICE

23 May 1983

Bas 251380/2

PATENTS ACT 1977

SPECIFICATION NO 2034681B

The following corrections were allowed under Section 117 on 2 September 1982:

Front page, Heading (73) Proprietor *for* Swiss Aluminium Limited *read* Swiss Aluminium Ltd.

THE PATENT OFFICE

24 June 1983

Bas 251994/4