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[54] TREATMENT OF ALUMINATE DIGESTER LIQUOR

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[51] **Int. Cl.** **B01d 7/00,** B01d 9/00, F26b 3/12, B01d 3/02, C01f 7/34, B01d 11/04
[58] **Field of Search** .... 159/2, 2 MS, 4 MS, 159/46, 17 VS, 45, 47, DIG. 8, DIG. 25; 202/173; 23/143, 297–299, 305–306

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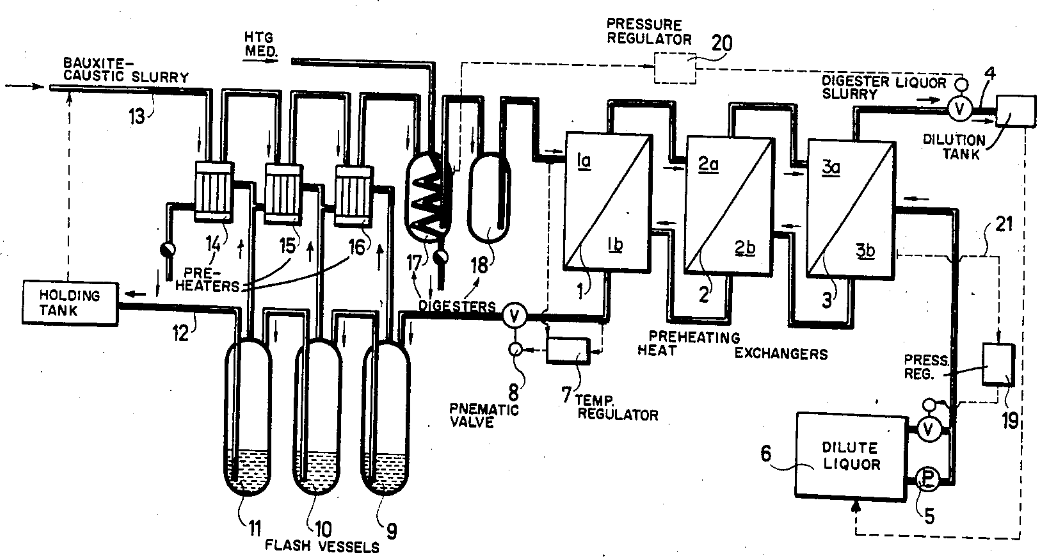
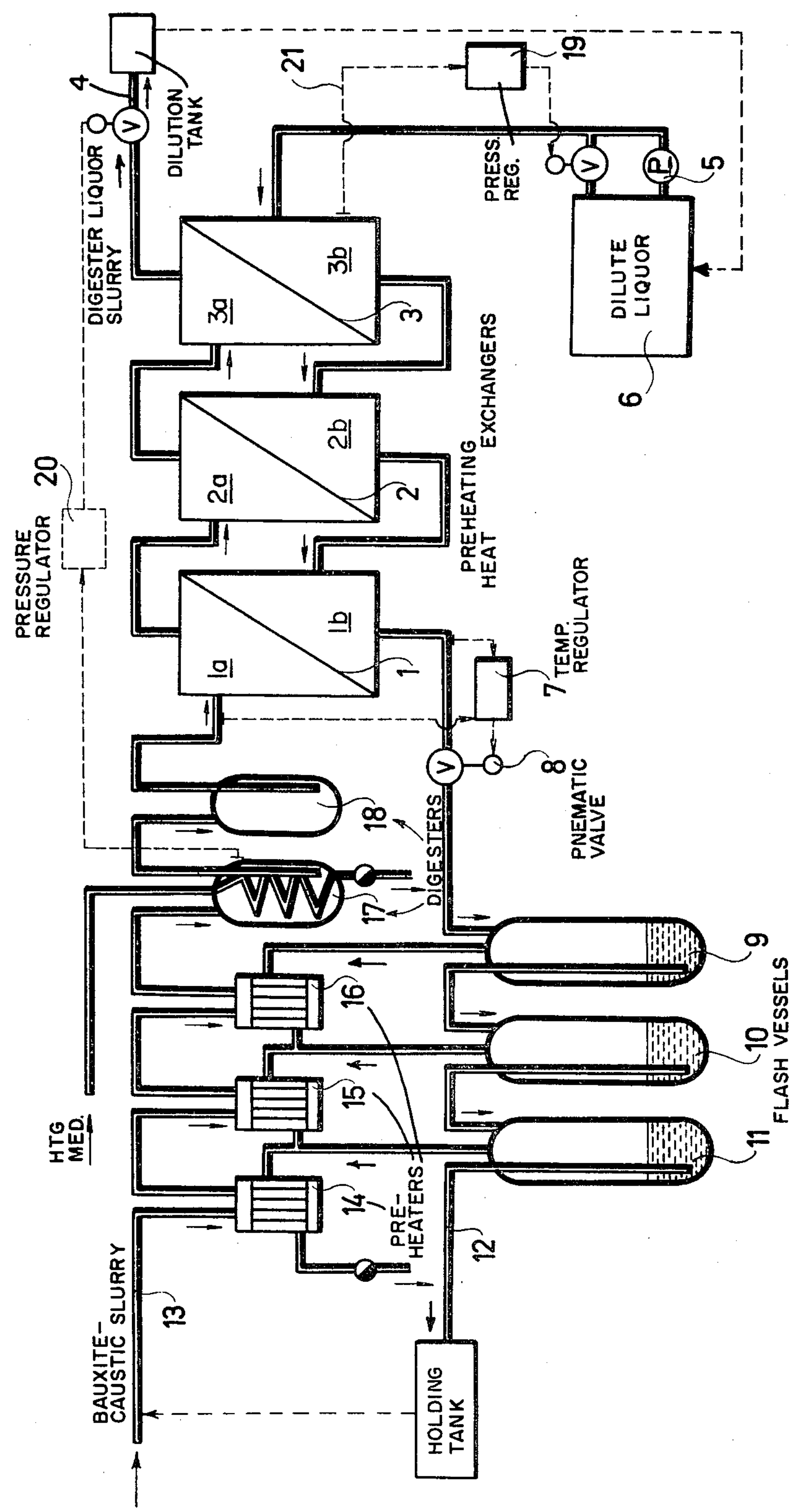
[57] **ABSTRACT**

Aluminum-containing minerals, such as bauxite, are digested in sodium aluminate liquor, wherein the digestion liquor leaves the digester at a temperature above 150°C and is conducted, without flashing, in a heat exchanger in a countercurrent flow with respect to the feed liquor for the digester so that the temperature difference between the two liquors is less than 10°C.

4 Claims, 1 Drawing Figure




DILUTION TANK
DIGESTER LIQUOR SLURRY
4
21
19
PRESS. REG.
5
DILUTE LIQUOR
6
3a
3b
3
2a
2b
2
1a
1b
1
PREHEATING HEAT EXCHANGERS
PRESSURE REGULATOR
20
TEMP. REGULATOR
7
8
PNEMATIC VALVE
18
DIGESTERS
17
9
10
11
FLASH VESSELS
16
15
14
PRE-HEATERS
HTG MED.
12
13
BAUXITE-CAUSTIC SLURRY
HOLDING TANK

TREATMENT OF ALUMINATE DIGESTER LIQUOR

The digestion of alumina containing minerals, e.g., of bauxite, is carried out, as known, in a continuously operating digester line with sodium aluminate liquor at temperatures above 150°C and under pressure according to the Bayer process. An increase of the concentration of caustic Na_2O (e.g., above 220 g/l caustic Na_2O) — to be designated hereinafter in the specification and the claims as $kxNa_2O$ — in the digesting liquor is advantageous for the digestion, since higher caustic concentrations allow the application of lower temperatures and reduced pressure, further specific pressure may also be lowered compared to the process in which the digesting liquor has a lower concentration of kx Na_2O.

Nevertheless the recent trend is to perform bauxite digestion with dilute liquors (below 220 g/l $kxNa_2O$), since thereby the amount of dilute liquor to be evaporated will be diminished resulting in a saving in steam and elimination of the maintenance costs which compensate for the drawbacks of the digestion process.

If, however, digestion is carried out with a dilute liquor a smaller amount of wash water will be sufficient to eluate the caustic which has been introduced into the cycle and this fact causes caustic losses. Compared to the saving in steam this loss causes, however, only a relatively insignificant rise in costs, provided multistep settlers are used and at the end of the line the filtration of the red mud is carried out e.g., by means of filter presses. Increasing the concentration of the digesting liquor is achieved by means of evaporating the dilute liquor which has been obtained in the course of precipitation.

In alumina production water has to be evaporated not only when concentrating the dilute liquor obtained after precipitation of aluminum hydroxide, but evaporation results also due to the expansion of the digester liquor leaving the digester, which is at a temperature above 150°C. Since the evaporation of the digester liquor takes place only after digestion, its occurrence does not result in any particular advantage in the bauxite decomposition process. This is because during the flashing the temperature of the resulting concentrated slurry becomes so low that it has no significance in the digestion. Digestion with dilute liquor involves as a rule the evaporation of less water from the spent liquor than the quantity of water which evaporates when the digester liquor is subjected to expansion. This fact is illustrated on an example in the following table.

	Digesting liquor	liquor after mixing prior to digestion	liquor after expansion of the digester liquor	liquor after precipitation of the aluminate liquor
$kxNa_2O$	180 g/l	172	236	145
m^3 of water per metric ton of alumina	12	12.57	9.17	14.90

In case of a digester liquor with 180 g/l of $kxNa_2O$ concentration the total quantity of water leaving the cycle will therefore be 6.30 m^3 per metric ton of alumina of which 2.90 m^3 of water per metric ton of alumina can be removed by evaporation in an evaporator and 3.40 m^3 of water per metric ton of alumina by means of the expansion of the spent liquor.

Evaporation of the dilute liquor is absolutely necessary, for a digesting liquor with a concentration lower than 170 g/l $kxNa_2O$ is uneconomical due to a deterioration in digestion efficiency. Another method of eliminating the evaporation of the liquor may be carried out by diluting the digester liquor only to a degree which will ensure that after decomposition and precipitation of the aluminum hydroxyde, a concentration of 180 g/l of $kxNa_2O$ will obtain. This solution is however uneconomical partly because of the less satisfactory settling of the red mud and partly because of a lowering of the decomposition efficiency.

By applying the method and apparatus in accordance with the present invention evaporation of the dilute liquor can be eliminated without causing a reduction in the efficiency of the process.

The method for the processing of digester liquor slurry obtained in the continuous digestion of alumina containing minerals, especially of bauxite, with sodium aluminate liquor according to the present invention is characterized by leading the liquor leaving the digester at a temperature above 150°C without expansion in indirect countercurrent heat exchange with respect to the dilute liquor used for digestion through heat exchangers or through series connected heat exchangers preferably so that the temperature difference between the dilute liquor exiting from the heat exchanger and of the feed digester liquor slurry entering the heat exchanger should be less than 10°C and evaporating the heated dilute liquor in one or several steps by expansion (flashing).

The sodium aluminate liquor used for the digestion of bauxite is a liquor which is obtained by the dilution of the digester liquor and separation of the red mud by decomposition.

The digester liquor is diluted to a value suitably of about 120 to 150 g/l of $kxNa_2O$.

The dilute liquor to be evaporated and used for digestion is preferably led at pressure values of 5 to 60 atm. through the heat exchanger, thereafter the flashing of the heated dilute liquor leaving the heat exchangers is effected in several steps.

The super-heated steam formed by the flashing of the dilute liquor is used for pre-heating the starting mixture.

The apparatus for the implementation of the method according to the present invention is characterized by the used of at least one heat exchanger between the digester and the flashing (expansion) equipment said heat exchanger being fitted on one end with a conveyor pump to feed the dilute liquor to be evaporated and at the opposite end of the heat exchanger with a pipe for feeding the digester liquor, and with automatic temperature and pressure control devices.

As heat exchanger preferably a shell tube heat exchanger is used which withstands operation pressures up to 100 atm., or heat exchangers with laminar plates or of helical construction withstanding operation pressures pressures between 15 and 50 atm.

For most effective heat exchange it is advantageous to have on the one hand a desilicated digester liquor and on the other hand solids of small particle sizes in the digester liquor. The diameter of the particles is between of about 1 to about 45 microns.

According to one embodiment of the present invention in cases in which part of the liquor recirculated into the digestion process for the removal of the inherent salts must be adjusted to a higher Na_2O concentration than the concentration of the digesting liquor, it is possible to proceed in such a way, that a part of the flashed liquor is fed back into the container fitted before the heat exchanger where said liquor is reheated, i.e., evaporated, and part of the dilute liquor is led not through the heat exchanger, but mixed directly with the concentrated liquor obtained after desalting and used as digesting liquor.

The dilute liquor to be evaporated is transported by means of piston or centrifugal pumps capable of producing over-pressures of 5 to 60 atm. into the heat exchanger, while at the opposite side of the heat exchanger the pressure of the digester liquor may be used for transporting it.

An embodiment of the equipment for the application of the method in accordance with the present invention is shown on the attached FIGURE.

The digester liquor slurry leaving the digesters **17** and **18** at a temperature above 150°C and under pressure is led through one of the chambers **1***a*, **2***a* and **3***a* of the series connected heat exchangers **1**, **2** and **3**, while in the other chambers **1***b*, **2***b* and **3***b* of the series connected heat exchangers dilute liquor flows in countercurrent. The dilute liquor originates from tank **6** which is designed to store the decomposed dilute liquor and is transported by means of pump **5** into the heat exchanger series. In the series connected heat exchangers **1**, **2** and **3** part of the heat content of the digester liquor slurry is transmitted to the dilute liquor preferably in such a way that the temperature difference between the dilute liquor leaving from the series connected heat exchangers and the introduced digester liquor slurry should be less than 10°C. In the heat transfer process the desired temperature difference can be adjusted by means of a temperature regulator **7**, and a pneumatic valve **8**. Automatically controlled pressure regulators **19** and **20** serve to ensure the heat transfer. The dilute liquor which leaves the heat exchangers at a temperature higher than its boiling point and under pressure is led through flash vessels **9**, **10** and **11** in which it is stepwise expanded and finally through pipe **12** into a holding tank, for the concentrated liquor which is kept under atmospheric pressure for use in the treatment of bauxite. The caustic is mixed with the bauxite and the resulting slurry **13** is introduced through preheaters **14–16** into the digesters.

The digester liquor slurry which leaves the part **3***a* of the heat exchanger **3** and has been cooled to below its boiling point is led through pipe **4** into a dilution tank (not shown) which is also under atmospheric pressure. The red mud is separated from the slurry, the aluminate is precipitated and separated by filtration and the caustic liquid is introduced into the tank **6**. The overheated vapors which leave the flash vessels **9**, **10** and **11** are led as heating steam into preheaters **16**, **15** and **14**, respectively, of the initial liquor. The starting bauxite slurry arriving through pipe **13** is heated in these preheaters.

The following examples illustrate the process of the present invention. Example 2 is intended as a comparison with the known process.

Example 1

3.1 metric ton of moist bauxite per metric ton of alumina is mixed with 12 m^3 digesting liquor per metric ton of alumina, said digesting liquor having a concentration of 180 g/l of $kxNa_2O$. In this way the quantity of the liquor increases after mixing to 12.57 m^3 per metric ton of alumina, while its concentration drops to 172 g/l of $kxNa_2O$. This starting mixture is treated in a digester at a temperature of 240°C and under pressure of 40 to 60 atm. According to the invention the digester liquor obtained in this way is led into a surface heat exchanger in which the liquor is cooled without flashing in such a way that in the heat exchanger the dilute liquor obtained after decomposition is led in countercurrent to the digester liquor. From the surface heat exchanger the cooled digester liquor is led into the dilution tank, while the dilute liquor flowing in countercurrent is led in 10 steps through a flash equipment in which it expands to atmospheric pressure and the flashed steam of the dilute liquor is used for heating the starting mixture. Flashing of the dilute liquor is performed in such a way that 3.4 m^3 of water per metric ton of alumina is removed.

In the dilution tank the digester liquor is diluted to 135 g/l of $kxNa_2O$ concentration by means of the red mud liquor. The quantity of wash water used for dilution is 3.4 m^3 per metric ton of alumina. The smaller quantity of wash water which can be used for the washing of the red mud may raise in this case the loss of caustic which can be washed out from the red mud, therefore at the end of the settling-washing line the mud is filtered to compensate for the caustic losses. The concentration of the spent liquor obtained after decomposition increases as a result of the removal of the hydrate crystal water to 140 g/l of $kxNa_2O$, whereby in the dilute liquor flash equipment of the digester plant by means of flashing of 3.4 m^3 of dilute liquor per metric ton of alumina a digester liquor with a $kxNa_2O$ concentration of 180 g/l is obtained.

Hence the method according to the present invention eliminates the application of a separate liquor evaporator unit.

Example 2

3.1 metric ton of bauxite per metric ton of alumina is digested with 12 m^3 digesting liquor of a $kxNa_2O$ concentration of 180 g/l. After mixing of the bauxite with the digesting liquor the quantity of the liquor is increased by the moisture content of the bauxite to 12.57 m^3 per metric ton of alumina, while at the same time the concentration of the liquor drops to 172 g/l of $kxNa_2O$. The starting mixture is heated in the digester to 240°C under a pressure of 40 to 60 atm. Under these conditions the alumina content of the bauxite dissolves in the liquor. The digester liquor under pressure is led through a flash line having 10 stages where it is expanded to atmospheric pressure and the flashed steam is used for heating the liquor prepared for digestion. The digester liquor which has been cooled in this way to 107°C is led then into the dilution tank. The digester liquor is concentrated in this way to 236 g/l of $kxNa_2O$. The degree of water removal amounts to 3.4 m^3 per metric ton of alumina, the volume is reduced to 9.17 m^3 per metric ton of alumina. In the course of dilution the digester liquor is diluted with red mud water to 140 g/l of $kxNa_2O$, but is concentrated during decomposition to 145 g/l of $kxNa_2O$. The water requirement of dilution amounts to 6.3 m^3 per ton of alumina. From the dilute liquor obtained after decomposition a quantity of water of 2.90 m^3 per metric ton of alumina is evaporated in the liquor evaporator whereby a digestion liquor of a concentration of 180 g/l of $kxNa_2O$ is obtained. The water removal of $6.3 - 2.9 = 3.4$ m^3 per metric ton of alumina required for the water balance of the cycle is ensured by the flashing of the digester liquor.

What we claim is:

1. In a process for the treatment of alumina-containing minerals, wherein the aluminum content of the mineral is extracted in a reaction zone with a caustic solvent under elevated temperature to form a hot liquid slurry, the improvement which comprises transferring heat without expansion in an indirect heat exchanger from the hot liquid slurry after it leaves the reaction zone in countercurrent to a dilute caustic liquor, and concentrating the thus heated dilute caustic liquor by flashing, wherein said dilute liquor is obtained by separating the solids content and precipitating at least a major portion of the dissolved aluminum content of said liquid slurry after it leaves the heat exchanger.

2. The improvement of the process of claim 1, wherein the temperature difference between the hot liquid slurry entering the heat exchanger and the dilute caustic liquor leaving the heat exchanger, is not greater than about 10°C.

3. The improvement of the process of claim 1, wherein the dilute caustic liquor which enters the heat exchanger contains from about 120 to about 150 g/l *kx* Na_2O and the pressure of the dilute caustic liquor in the heat exchanger is from about 5 atm. to about 60 atm.

4. The improvement of the process of claim 1, wherein the dilute caustic liquor which was concentrated by flashing is slurried with an alumina-containing mineral and the slurry is preheated prior to the digestion-extraction thereof, the preheating being carried out by utilizing the steam liberated during flashing.

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