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(54) Title: REDUCING AUTOPRECIPIATION IN BAYER LIQUOR

(57) Abstract: A method to inhibit autprecipitation of aluminum containing compounds in a Bayer process liquor includes adding an effective amount of a polysaccharide to the Bayer process liquor. Polysaccharides which are added in accordance with the present method selected from gum arahic, tamarind gum, gum ghatti and mixtures thereof. Effective addition sites for the autprecipitation inhibitor are prior to filtering clarified process liquor and subsequent to condensation of caustic soda from spent process liquor.

## Reducing Autoprecipitation in Bayer Liquor

### CROSS REFERENCE TO RELATED APPLICATION(S)

[0001] N.A.

### U.S. GOVERNMENT RIGHTS

[0002] N.A.

### BACKGROUND

[0003] Field

[0004] There is disclosed a method to inhibit autoprecipitation of aluminum compounds from supersaturated solutions utilized in a Bayer process to recover alumina from bauxite. More particularly, an effective amount of a polymers such as gum Arabic, tamrind gum, gum ghatti, both natural and synthetic versions and mixtures thereof is added to Bayer process liquor either at or upstream of a thickener tank or washer tank.

[0005] Description of the Related Art

[0006] A majority of aluminum is produced by reducing alumina recovered from bauxite through the Bayer process. Bauxite is pulverized, heated, pressurized and treated with caustic liquor in a digester to produce a saturated sodium aluminate solution containing an insoluble "red mud". The red mud slurry is treated with flocculants in thickeners in a step or steps where the red mud solids and flocculants are separated from the saturated liquor by gravity settling. The thickener underflow goes through several steps of counter-current washing and the thickener overflow is further purified in a filtration process using a Kelly filter or a sand filter to remove suspended fine solids and other impurities. The purified liquor is then cooled down and seeded with aluminum trihydrate crystals in a precipitation process to produce aluminum trihydrate followed by trihydrate calcination to produce the final product, alumina. The cooled and alumina-depleted liquor, or spent liquor, is then reheated in heat exchangers and concentrated in evaporators before being recycled back to digesters.

[0007] The thickener overflow is supersaturated with dissolved aluminum compounds. When the aluminum compounds spontaneously precipitate from the overflow, a phenomena referred to as autoprecipitation, the aluminum values within those precipitated compounds are commingled with the red mud and lost.

[0008] Synthetic polymers are used in the Bayer process as flocculants to aid in the solid-liquor separation. Particularly well known in this arena are hydroxamated polyacrylamide polymers which have been used both as flocculants and disclosed as being effective for gibbsite scale deposition inhibition in United States Patent No. 5,733,460 to Rothenberg et al. Sodium silicate polymers have been disclosed for use as adjuvants with hydroxamated polymers in flocculation processes to increase flocculation of desilication products in the red mud.

[0009] Natural polymers or polysaccharides are also disclosed either alone or in combination with synthetic polymers in the Bayer process to purify the thickener overflow, as in U.S. Patent No. 5,478,477 to Ramesh et al. which discloses alginic acid for this purpose; aid in overflow liquor filtration, as disclosed in U.S. Patent No. 5,716,530 to Strominger et al. which discloses biopolymers such as Dextran, pullulan, zooglan, lactan, alginates and starch.; and trihydrate flocculation, as disclosed in Canadian Patent No. CA 825,234, which discloses the use of Dextran for this purpose. While Dextran polysaccharide has been used in the reduction of autoprecipitation of aluminum compounds in the Bayer process, it has its limitations and is extremely costly to use. There therefore remains a need for an autoprecipitation reduction aid and method for use in the Bayer process which is both effective in reducing or eliminating autoprecipitation of aluminum compounds and cost effective.

#### SUMMARY OF THE INVENTION

[00010] The present invention therefore provides herein is a method and polysaccharide aid to inhibit autoprecipitation of aluminum containing compounds in a Bayer process liquor. The method includes adding an effective amount of the polysaccharide to the Bayer process liquor. Polysaccharides particularly useful in the practice of the present invention include, natural and synthetic gum Arabic, tamarind gum, gum ghatti and functional equivalents and mixtures thereof.

[00011] The details of one or more embodiments of the invention are set forth in the description below. Other features, objects and advantages of the invention will be apparent from the examples and from the claims.

### DETAILED DESCRIPTION

[00012] In a typical Bayer method bauxite ore is crushed to a powder to increase surface area. The powder is combined with a hot caustic soda in a digester. The hot caustic soda is typically an aqueous solution containing a high concentration of sodium hydroxide (NaOH). The NaOH dissolves aluminum and silicon containing constituents of the bauxite, while other constituents, primarily iron containing, are not dissolved. A slurry of undissolved constituents in a supersaturated sodium aluminate solution is transferred to a thickener tank. Red mud separates by settling from the process liquor. Flocculants and other chemicals are typically added to the thickener tank to increase the rate of settling. Autoprecipitation, a spontaneous precipitation of aluminum containing compounds, in particular aluminum trihydrate (Gibbsite) from the solution, is an undesired, but common, occurrence in the thickener tank. The precipitated aluminum containing compounds are commingled with the red mud wherein the aluminum values can be lost.

[00013] Clarified process liquor then flows over a washer tank and fine particles, typically iron-based particles, suspended in the process liquor are removed by filtration. The filtered clarified process liquor is then cooled and seeded with aluminum trihydrate crystals to precipitate aluminum trihydrate. After precipitation, the liquor becomes spent liquor. This spent liquor is then evaporated or condensed. Caustic soda is recovered from the condensate, heated and combined with additional caustic, as needed, to return as hot caustic soda.

[00014] Autoprecipitation of the alumina containing compounds into the red mud is inhibited by the present invention where polysaccharides are added upstream of the filter, thickener or washers, such as by addition to the process liquor or the clarified process liquor. Other addition sites in the Bayer process wherein the polysaccharide can be added in accordance with the method of the present invention include the digester and the slurry. Still another addition site is the hot caustic soda upstream of the evaporator.

[00015] Polysaccharides useful in the method of the present invention include naturally occurring carbohydrate polymers in which monosaccharide units are linked through glycosidic linkages. Common monosaccharides include, but are not limited to xylose, arabinose, glucose, mannose, fructose and rhamnose. The hydroxyl group (OH) may be substituted by any standard reaction of organic chemistry and thus, may be reduced (deoxy), oxidized (uronic acid), esterfied (acetylated, sulfated) or replaced by amino or acetamido functions. Combinations of substitutions are also possible.

[00016] Polysaccharides useful in the method of the present invention can be linear (one chain) or branched (a main chain joined by side chains). The side chains may, further, be branched. The monosaccharide units in a polysaccharide can be linked in different manners, e.g.  $\alpha$ -1 $\rightarrow$ 3,  $\beta$ -1 $\rightarrow$ 3,  $\alpha$ -1 $\rightarrow$ 4,  $\beta$ -1 $\rightarrow$ 4,  $\alpha$ -1 $\rightarrow$ 6,  $\beta$ -1 $\rightarrow$ 6, etc., with the number being the position of a carbon atom in the monosaccharide cyclic structure and  $\alpha$  and  $\beta$  representing two different orientations of the OH group on the C-1 position. When a polysaccharide is dissolved in a Bayer process liquor, the orientation may be determined by one or a combination of analytical techniques known in the art such as nuclear magnetic resonance (NMR), ultra-violet and infrared.

[00017] In preferred embodiments, the polysaccharides have a mass molecular weight in the range of from 5,000 to 2,000,000 and a preferred mass molecular weight of from 10,000 to 300,000. When added to a Bayer process liquor in accordance with the method of the present invention, polysaccharide concentrations, measured in weight percent, in excess of 2 parts per million (ppm) are effective to inhibit autprecipitation and polyaluminate polymerization. A nominal polysaccharide concentration is from 2 ppm to 200 ppm and a preferred concentration is from 2 ppm to 50 ppm. Most preferred is from 4 ppm to 20 ppm.

[00018] In accordance with the present invention, preferred polysaccharides are highly branched, with more than 50% of the monosaccharide units making up the polysaccharide chain bonded to at least three other polysaccharides. Particularly effective are natural gums and there synthetic equivalents including gum arabic, tamarind gum, gum ghatti, functional equivalents and mixtures of the preceding. Substitutions, as described above, may also modify these gums. As gum arabic, tamarind gum, gum ghatti are naturally occurring polysaccharides, it can be appreciated that these terms should be interpreted to include naturally occurring equivalents as well as synthetic versions thereof.

[00019] The presence of these polysaccharides in the Bayer process liquor can be determined by using analytical techniques known in the art such as nuclear magnetic resonance (NMR), ultra-violet and infrared to detect the monosaccharide units making up the polysaccharide chain.

[00020] The efficacy of the polysaccharide additions is illustrated in the Example that follows:

#### EXAMPLE

[00021] A series of laboratory tests are carried out with varying levels of polysaccharides added to a prepared Bayer liquor at 105 °C saturated with respect to aluminum trihydrate. The following polysaccharides are evaluated:

[00022] Dextran (Control), has an  $\alpha$ -1 $\rightarrow$ 6 polysaccharide chain formed from glucopyranose monosaccharide units and is not highly branched with 1 of every 3 monosaccharide units bonded to three other monosaccharide units. .

[00023] Gum arabic has a  $\beta$ -1 $\rightarrow$ 3 polysaccharide chain formed from pyranose monosaccharide and is highly branched with 3 of every 4 monosaccharide units bonded to three other monosaccharide units and some of the branches further containing additional branches. The gum arabic monomer is illustrated in FIG. 2.

[00024] Gum Agar (Control) has a linear polysaccharide chain formed from alternating linkages of  $\alpha$ -1 $\rightarrow$ 3 and  $\beta$ -1 $\rightarrow$ 4 galactopyranose monosaccharides.

[00025] Gum Ghatti is a highly branched polysaccharide formed from  $\beta$ -galactopyranose, arabinofuranose, arabinopyranose, mannopyranose and gulopyranose.

[00026] Gum Karaya (Control) has a polysaccharide formed from  $\alpha$ -pyranose monosaccharide units and rhamnopyranose units and is branched.

[00027] Gum Tragacanth has an  $\alpha$ -1 $\rightarrow$ 4 polysaccharide chain formed from galacturonic acid monosaccharide units and is highly branched with 3 of every 4 monosaccharide units bonded to three other monosaccharide units.

[00028] Gum Tamarind has a  $\beta$ -1 $\rightarrow$ 4 polysaccharide chain formed from glucopyranose monosaccharide units and is highly branched with 3 of every 4 monosaccharide units bonded to three other monosaccharide units with one of the monosaccharide units terminated by  $\beta$ -D-pyranose.

[00029] Alginate (Control) has a polysaccharide chain formed from  $\alpha$ -1 $\rightarrow$ 4 gulopyranuronic acid and  $\beta$ -1 $\rightarrow$ 4 mannopyranuronic acid and is a linear polymer.

[00030] Welan Gum (Control) has 1 $\rightarrow$ 4 tetrasaccharide repeating units from 3- $\beta$ -D-glucopyranose units and 1- $\alpha$ -L-rhamnopyranose units with one of the monosaccharide units bonded to either an  $\alpha$ -L-rhamnopyranose monosaccharide unit or to an  $\alpha$ -L-mannopyranose

monosaccharide unit. Hence, Welan gum has 25% of the monosaccharide units making up the polysaccharide chain bonded to another monosaccharide.

[00031] As shown in the following Table, gum arabic showed the best inhibition of alumina trihydrate autoprecipitation followed by tamarind gum and gum ghatti. The other polysaccharides had little or no inhibition effect. Structure features of the tested polysaccharides are summarized in Table 2.

Addition Amount	Amount of Alumina Trihydrate (Gibbsite) Precipitation (grams / 100 milliliters)					
	4.5 ppm	7.5 ppm				10.5 ppm
Run	1	1	2	3	4	1
None	Large	Large	1.246	0.169	1.390	1.951
Dextran	Small	Little	0.000	X	0.003	0.019
Gum Arabic	Small	Little	X	X	0.002	0.038
Gum Agar	X	X	1.053	X	1.126	1.480
Gum Ghatti	X	X	0.895	X	0.764	1.282
Gum Karaya	X	X	0.490	X	1.065	0.994
Gum Tragacanth	X	X	0.476	X	0.855	0.883
Tamarind Gum	X	X	X	0.011	0.287	1.301
Alginate	X	X	X	0.003	0.804	1.540
Welan Gum	X	X	X	0.076	1.372	1.659

X=Not Measured

One or more embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, modifications such as deoxy group, amino group, carboxyl groups on certain sugar residues, or presence of small amount of certain foreign sugar residues, and changes in branching. Accordingly, other embodiments are within the scope of the following claims.



## WHAT IS CLAIMED IS:

1. A method to reduce autoprecipitation of aluminum containing compounds in a Bayer process liquor comprising the step of adding a polysaccharide selected from the group consisting of gum arabic, tamarind gum, gum ghatti and mixtures thereof, in an amount effective to inhibit autoprecipitation to said Bayer process liquor.
2. The method of claim 1 wherein said Bayer process liquor flows through a thickening tank effective to separate red mud from a process liquor whereby clarified process liquor exits said thickening tank by flowing over a weir and then flows through a filter and said polysaccharide is added upstream of said filter.
3. The method of claim 1 wherein said Bayer process liquor flows through a thickening tank effective to separate red mud from a process liquor whereby clarified process liquor exits said thickening tank by flowing over a weir and then flows through a filter, aluminum trihydrate crystals are precipitated from said filtered clarified process liquor and then spent process liquor is evaporated and hot caustic soda recovered and said polysaccharide is added to said recovered hot caustic soda.
4. The method of claim 1 wherein said polysaccharide is present in said process liquor in an amount of from about 2 ppm, by weight, to about 200 ppm, by weight.
5. The method of claim 4, wherein said polysaccharide is present in said process liquor in an amount of from about 2 ppm, by weight, to about 50 ppm, by weight.
6. The method of claim 5, wherein said polysaccharide is present in said process liquor in an amount of from about 4 ppm, by weight, to about 20 ppm, by weight.
7. The method of any one of claims 4 to 6 wherein said polysaccharide is gum arabic.
8. The method of any one of claims 4 to 6 wherein said polysaccharide is tamarind gum.

9. The method of any one of claims 4 to 6 wherein said polysaccharide is gum ghatti.