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(54) Title: METHODS FOR THE TREATMENT OF RED MUD SLURRIES

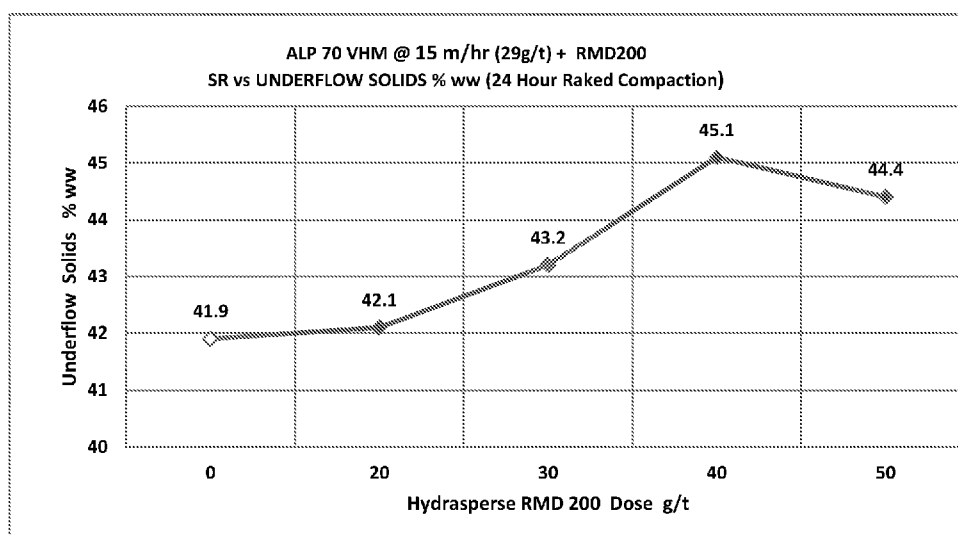


Figure 1

(57) Abstract: The present invention broadly relates to methods for treating red mud slurries, and more particularly to methods for increasing underflow solids in red mud slurries and to methods for accelerating the consolidation of flocculated solids in red mud slurries.



Methods for the treatment of red mud slurries

Field of the Invention

The present invention broadly relates to methods for treating red mud slurries, and more particularly to methods for increasing underflow solids in red mud slurries and to methods for accelerating the consolidation of flocculated solids in red mud slurries.

Background of the Invention

The production of alumina from ores such as bauxite is typically performed using the Bayer process. As part of the Bayer process alumina-containing ores are digested with sodium hydroxide at elevated temperature and pressure. The insoluble product generated following digestion is known as "red mud". Amongst other compounds, red mud comprises iron oxide (which is responsible for the red colour), silica, unleached aluminium and titanium oxide. Disposal of red mud is problematic due to its high alkalinity. The total alkalinity of a super thickener feed from an alumina refinery typically ranges anywhere between about 5 gpl and 35 gpl.

Red mud is typically treated by first removing coarse material, such as sand, followed by settling in raking thickeners with the addition of flocculants. The underflow solids are then pumped to settling ponds where dewatering and air-drying take place to provide a residue having about 65% w/w solids. Residue containing this amount of solids may be disposed of by the so-called "dry-stacking" method.

Optimisation of the underflow solids obtained following settling is crucial to minimising the footprint of the settling ponds. A decrease in underflow solids density of only a few percent can substantially increase the settling pond footprint. However, increasing the density of the underflow solids may lead to a concomitant increase in the yield stress of the slurry, thereby reducing the ability of the underflow to be pumped.

Against this background the present inventors have developed a red mud treatment method in which underflow solids may be optimised without compromising pumpability and dry stacking characteristics.

Summary of the Invention

In a first aspect the present invention provides a method for treating a red mud slurry, the method comprising:

- (i) adding a dextran and a lignosulfonate to the slurry; and
- (ii) adding a flocculant to the slurry.

The method may further comprise separating flocculated solids from liquid obtained following steps (i) and (ii).

In a second aspect the present invention provides a method for increasing underflow solids density in a red mud slurry comprising:

- (i) adding a dextran and a lignosulfonate to the slurry; and
- (ii) adding a flocculant to the slurry.

Following steps (i) and (ii) the solids may be capable of being pumped.

In a third aspect the present invention provides a method for accelerating the consolidation of flocculated solids in a red mud slurry comprising:

- (i) adding a dextran and a lignosulfonate to the slurry; and
- (ii) adding a flocculant to the slurry.

The method may further comprise separating flocculated solids from liquid obtained following steps (i) and (ii).

In a fourth aspect the present invention provides a method for modulating the rheology of a red mud slurry comprising:

- (i) adding a dextran and a lignosulfonate to the slurry; and
- (ii) adding a flocculant to the slurry.

The method may further comprise separating flocculated solids from liquid obtained following steps (i) and (ii).

The dextran and the lignosulfonate may be present in a single composition when added to the slurry. In an alternative embodiment the dextran and the lignosulfonate may be added separately to the slurry.

The dextran and the lignosulfonate may be added to the slurry prior to addition of the flocculant. In an alternative embodiment the dextran and the lignosulfonate may be added to the slurry after addition of the flocculant. In a further embodiment the dextran and the lignosulfonate may be added to the slurry simultaneously with the flocculant.

The dextran and the lignosulfonate may be added neat to the slurry, or alternatively may be diluted with water, such as for example lakewater, pond water, sea water or any other suitable source of water.

The dextran may have a number average molecular weight (Mn) between about 1 million and about 100 million, or between about 5 million and about 50 million.

In some embodiments the dextran is cross-linked. In some embodiments the dextran is non-newtonian.

The dextran may have a viscosity of about 60,000 cPs at 15% w/w in water at a temperature of about 20 °C.

The flocculant may be a synthetic polymer, for example a water-soluble polymer of one or more ethylenically unsaturated monomers.

In one embodiment the flocculant is an anionic acrylate/acrylamide copolymer.

The dextran may be added to the slurry in an amount between about 0.1 grams per ton and about 30 grams per ton, or in an amount between about 0.1 grams per ton and about 20 grams per ton, or in an amount between about 0.1 grams per ton and about 15 grams per ton, or in an amount between about 1 gram per ton and about 10 grams per ton.

The lignosulfonate may be added to the slurry in an amount between about 0.1 grams per ton and about 10 grams per ton, or in an amount between about 0.1 grams per ton and about 7.5 grams per ton. The methods may be performed in a thickener or a settler.

In a fifth aspect the present invention provides a composition comprising a dextran and a lignosulfonate.

The dextran may be as defined above.

In a sixth aspect the present invention provides use of a composition of the fifth aspect in the treatment of a red mud slurry.

In a seventh aspect the present invention provides use of a composition of the fifth aspect as a conditioning aid in the treatment of a red mud slurry.

Brief Description of the Figures

Figure 1 is a plot of underflow solids (% w/w) versus RMD200 dose.

Definitions

The following are some definitions that may be helpful in understanding the description of the present invention. These are intended as general definitions and should in no way limit the scope of the present invention to those terms alone, but are put forth for a better understanding of the following description.

Throughout this specification, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or

steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps. Thus, in the context of this specification, the term "comprising" means "including principally, but not necessarily solely".

In the context of this specification the term "about" is understood to refer to a range of numbers that a person of skill in the art would consider equivalent to the recited value in the context of achieving the same function or result.

In the context of this specification the terms "a" and "an" are used herein to refer to one or to more than one (i.e. to at least one) of the grammatical object of the article. By way of example, "an element" means one element or more than one element.

In the context of this specification the term "dextran" is understood to refer to an α -D-1,6 glucose-linked glucan with side chains 1-3 linked to the backbone units of the polysaccharide.

In the context of this specification the term "lignosulfonate" is understood to refer to water-soluble polymers that are by-products from the production of wood pulp using sulfite pulping.

In the context of this specification the term "flocculant" is understood to mean a compound or composition which when added to a liquid containing finely divided suspended particles, destabilises and aggregates the solids.

In the context of this specification the term "red mud" refers to the insoluble solid material which is a residual product from Bayer process liquor that does not freely dissolve during the digestion stage, or which precipitates as part of the digestion process.

Detailed Description of the Invention

The present invention is predicated on the surprising finding by the inventors that treatment of a red mud slurry with dextran and a lignosulfonate together with a flocculant increases the rate of solids compaction and ultimately delivers higher underflow solids compared to use of the flocculant alone, without compromising pumpability and dry stacking characteristics. For example, it has been found that pre-dosing a composition comprising dextran and lignosulfonate into a super thickener feedline prior to addition of an anionic flocculant increased underflow density by 3.2% w/w compared to use of the anionic flocculant alone.

Accordingly, in one embodiment the present invention relates to a method for treating a red mud slurry comprising adding a dextran and a lignosulfonate to the slurry, and adding a flocculant to the slurry.

In another aspect the present invention relates to a method for increasing underflow solids density in a red mud slurry comprising adding a dextran and a lignosulfonate to the slurry, and adding a flocculant to the slurry. In this aspect, "increasing underflow solids density" may be measured relative to the underflow solids density obtained when using the flocculant only.

In yet another aspect the present invention relates to a method for accelerating the consolidation of flocculated solids in a red mud slurry comprising adding a dextran and a lignosulfonate to the slurry, and adding a flocculant to the slurry.

In a further aspect the present invention provides a method for modulating the rheology of a red mud slurry comprising adding a dextran and a lignosulfonate to the slurry and adding a flocculant to the slurry. Without wishing to be bound by theory it is thought that the dextran/lignosulfonate combination alters the rheology of the underflow such that the underflow has properties that would otherwise be associated with an underflow slurry of lower solids density. In other words, the dextran/lignosulfonate combination acts as a slurry conditioning aid.

In the above aspects the methods may further comprise separating flocculated solids from the liquid obtained following steps (i) and (ii). Removal of flocculated red mud from the supernatant liquid may be performed by methods well known to those skilled in the art, for example by sedimentation, centrifugation, filtration, or by use of a washer, thickener or settler.

In still a further aspect the present invention relates to a composition comprising a dextran and a lignosulfonate. The dextran and the lignosulfonate may be as described herein.

In another aspect the present invention provides use of a composition comprising a dextran and a lignosulfonate in the treatment of a red mud slurry.

Typically, in the methods of the invention, the dextran and the lignosulfonate are present in a single composition when added to the red mud slurry. However, the dextran and the lignosulfonate may be added separately to the slurry if desired. For example, there may be application scenarios where there is an inherently high slurry viscosity in a thickener feed which may compromise feedwell flocculation and impact on a range of key thickener performance indicators including dose rates, underflow density, overflow clarity etc. In such scenarios it may be beneficial to add the lignosulfonate earlier in the process so as to reduce the feed slurry viscosity.

Typically, the dextran and the lignosulfonate are added to the red mud slurry prior to addition of the flocculant. However, the dextran and the lignosulfonate may be added to the red mud slurry after addition of the flocculant, or simultaneously with addition of the flocculant. The time difference between addition of the dextran and the lignosulfonate and the flocculant may vary depending on process throughput, however in some embodiments the difference will be between about 10 seconds and 10 minutes.

The dextran and the lignosulfonate may be added neat to the red mud slurry, or alternatively may be diluted with any aqueous liquid, such as for example, lake water, pond water, sea water or any other suitable source of water. In some embodiments the dextran and the lignosulfonate are added as part of a single aqueous composition prior to addition of the flocculant. In other embodiments the dextran and the lignosulfonate are added as part of a single aqueous composition after addition of the flocculant.

Dextrans suitable for use in the methods and compositions of the invention may have a number average molecular weight (M_n) between about 1 million and about 100 million, or between about 5 million and about 50 million. The dextrans may be anionic, non-ionic or cationic. In some embodiments the dextran has a viscosity between about 55,000 and 65,000 cPs at 15% solution in water at a temperature of about 20 °C. In alternative embodiments the dextran is non-newtonian. In other embodiments the dextran is cross-linked.

Dextrans suitable for use in the methods and compositions of the invention may be obtained from High Performance Product Engineering, Columbus, GA, USA.

Lignosulfonates suitable for use in the methods and compositions of the invention include those commercially available from Borregaard AS under the trade name PIONERA L-800.

In the methods of the invention the dextran may be added to the slurry in an amount between about 0.1 grams per ton and about 30 grams per ton, or in an amount between about 0.1 grams per ton and about 20 grams per ton, or in an amount between about 0.1 grams per ton and about 15 grams per ton, or in an amount between about 1 gram per ton and about 10 grams per ton.

In the methods of the invention the lignosulfonate may be added to the slurry in an amount between about 0.1 grams per ton and about 10 grams per ton, or in an amount between about 0.1 grams per ton and about 7.5 grams per ton, or in an amount between about 0.2 grams per ton and about 5 grams per ton.

The exact amounts of dextran and lignosulfonate employed will likely depend on a variety of factors, including the particular dextran and lignosulfonate used, the flocculant used and the physical and chemical properties of the red mud slurry (i.e., alkalinity amount of suspended solids, mineral composition etc). Those skilled in the art will however be able to determine appropriate amounts of dextran and lignosulfonate to use under any given circumstances using only routine trial and experimentation. In some embodiments the ratio of dextran and lignosulfonate may be varied depending on the particular circumstances as well as the molecular weight and degree of cross-linking of the dextran.

Flocculants that may be used in the methods of the invention include any cationic, anionic, non-ionic or zwitterionic flocculants. In some embodiments the flocculant is a synthetic polymer or copolymer, for example a water-soluble polymer of one or more ethylenically unsaturated monomers. Typically these polymers are anionic with the anionic content dictated by the alkalinity of the red mud. Examples of water-soluble polymers of one or more ethylenically unsaturated monomers include, but are not limited to, polyacrylamides, copolymers of acrylic acid and acrylamide, copolymers of acrylate and acrylamide, copolymers of acrylic acid and acrylamide modified to include a hydroxamic acid moiety and copolymers of acrylic acid and acrylamide modified to include ammonium acrylate. Examples of other flocculants that may be employed in the methods of the invention include, but are not limited to, polyDADMAC, polyhydroxamates, polyamines, polyimides, carboxymethylcellulose, chitosan, guar and polyglutamic acid. Typically, the polymer has a molecular weight of greater than 10 million. In some embodiments the flocculant may also be a dextran. In other embodiments the flocculant may be a flocculant other than a dextran.

The amount of flocculant used will depend primarily on the properties of the red mud slurry being treated and can be empirically determined readily by one of skill in the art. Typically, the amount of flocculant required is dependent on both the nature of the slurry, the type of flocculant used and the target settling rate band required.

Preconditioning the slurry with dextran and lignosulfonate may also aid the overall reduction in flocculant requirements as the settling rate and sometimes clarity will improve, over the "blank", prior to the addition of the flocculant.

The methods of the invention may be performed in a thickener. The use and operation of thickeners in red mud treatment is well known amongst those skilled in the art. The dextran/lignosulfonate combination and the flocculant may be added in various regimens so as to enhance red mud disposal properties. For example, a composition comprising

dextran and lignosulfonate may be introduced via a thickener feed line prior to addition of a flocculant. Alternatively, the dextran/lignosulfonate combination and the flocculant could be added simultaneously into a thickener feedwell. As a further alternative the dextran/lignosulfonate combination may be injected into a primary flocculant dilution line. Yet another alternative may involve addition of the flocculant via a thickener feed line followed by injection of the dextran/lignosulfonate combination into the suction and/or discharge side of the thickener underflow pumps.

In some embodiments a composition comprising dextran and lignosulfonate can be used as either a preconditioning, post-conditioning or added simultaneously with flocculants/coagulants or other process additive(s) to a process slurry where the term "slurry" includes:

- Process slurry feeding into a thickener/washer;
- Underflow slurry pumped from a thickener/washer to another thickener/washer in circuit;
- Underflow slurry pumped from a thickener that is subsequently blended with a coarser tailings fraction (e.g. codisposal) and then reflocculated;
- Slurry being pumped to "any" type of filtration, dewatering and or clarification process.

Examples

The invention will now be described in more detail, by way of illustration only, with respect to the following examples. The examples are intended to serve to illustrate this invention and should not be construed as limiting the generality of the disclosure of the description throughout this specification.

Example 1 – Preparation of a composition comprising dextran and lignosulfonate

Form a solution by adding 97.5 kg of HPPE dextran (approximately 15% w/w active in water) Spec 5 -50M molecular weight (available from High Performance Product Engineering, Columbus, GA, USA) to 2.5 kg of a 30% w/v solution of PIONERA L-800 powder (available from Borregaard AS, Norway). Mix the solution using mechanical agitation for a minimum of 30 minutes to ensure solution homogeneity. A longer mixing time may be required, however typically the mixing time required will not exceed 60 minutes.

Example 2 – Laboratory test

The composition prepared in Example 1 (which may be referred to as "RMD200") was used in a bench red mud treatment method together with an anionic flocculant

(ALP70VHM obtained from SNF (Australia) Pty Ltd, Lara, Victoria). Red mud was obtained from the Alcoa refinery located in Kwinana, Western Australia.

RMD200 (diluted to 1.0% w/v using lakewater followed by dilution to 0.025% w/v using lakewater again) was added to the red mud slurry in doses ranging from 20 to 50 grams per ton (g/t), followed by the addition of 29 g/t of ALP70VHM flocculant (this amount may be varied depending on the target settling rate). An increase in underflow solids density from 41.9% w/w to 45.1% w/w was observed using 24 hour raked compaction tests and targeting a feedwell settling rate of around 15 m/hr. This represented an increase of around 3.2% w/w above the underflow density of 41.9% w/w, achieved with the flocculant only, or a relative increase in the order of about 8%. Relevant data are presented below in Table 1 and in Figure 1.

Figure 1 shows a strong point of inflection from around 30 g/t of RMD200 and a "dose window" of 30 – 45 g/t. Thereafter there is a decline in the underflow, however at 50 g/t RMD200 dose rate there is still a substantial increase in underflow density.

Slurry Conditioning Aid	Anionic Flocculant	24 Hour Raked Underflow Density % w/w	Increase in Underflow Solids % w/w	*SLUMP TESTS (Sheared U/F Solids)				
				Cylinder Diameter = 48mm Cylinder Height = 96mm	Centre	Radial	Edge	% Slump
RMD200 Dose g/t	ALP70 VHM Dose g/t (15 m/hr)							Change in % Slump
0	29 g/t	41.9 %	Baseline	14 mm	90 mm	7 mm	7.8 %	Baseline
20 g/t	29 g/t	42.1 %	+ 0.3% ww	16	67	8	11.9%	+ 4.1%
30 g/t	29 g/t	43.2 %	+ 1.4% ww	14	70	7	10.0%	+ 2.2%
40 g/t	29 g/t	45.1%	+ 3.3% ww	18	66	9	13.6%	+ 5.8%
50 g/t	29 g/t	44.4%	+ 2.6% ww	13	76	6	9.2%	+ 1.4%

Note * % Slump = $\frac{C-E}{R} \times 100$

R

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgement or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavor to which this specification relates.

It will be appreciated by those skilled in the art that numerous variations and/or modifications may be made to the invention without departing from the spirit or scope of the invention as broadly described. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive.

CLAIMS:

1. A method for treating a red mud slurry, the method comprising:
 - (i) adding a dextran and a lignosulfonate to the slurry; and
 - (ii) adding a flocculant to the slurry.
2. The method of claim 1, further comprising separating flocculated solids from liquid obtained following steps (i) and (ii).
3. A method for increasing underflow solids density in a red mud slurry comprising:
 - (i) adding a dextran and a lignosulfonate to the slurry; and
 - (ii) adding a flocculant to the slurry.
4. The method of claim 3, wherein following steps (i) and (ii) the underflow solids are capable of being pumped.
5. A method for accelerating the consolidation of flocculated solids in a red mud slurry comprising:
 - (i) adding a dextran and a lignosulfonate to the slurry; and
 - (ii) adding a flocculant to the slurry.
6. The method of claim 5, further comprising separating flocculated solids from liquid obtained following steps (i) and (ii).
7. A method for modulating the rheology of a red mud slurry comprising:
 - (i) adding a dextran and a lignosulfonate to the slurry; and
 - (ii) adding a flocculant to the slurry.
8. The method of claim 7, further comprising separating flocculated solids from liquid obtained following steps (i) and (ii).
9. The method of any one of claims 1 to 8, wherein the dextran and the lignosulfonate are present in a single composition when added to the slurry.
10. The method of any one of claims 1 to 8, wherein the dextran and the lignosulfonate are added separately to the slurry.
11. The method of any one of claims 1 to 10, wherein the dextran and the lignosulfonate are added to the slurry prior to addition of the flocculant.
12. The method of any one of claims 1 to 10, wherein the dextran and the lignosulfonate are added to the slurry after addition of the flocculant.

13. The method of any one of claims 1 to 10, wherein the dextran and the lignosulfonate are added to the slurry simultaneously with the flocculant.
14. The method of any one of claims 1 to 13, wherein the dextran has a number average molecular weight (Mn) between about 1 million and about 100 million.
15. The method of any one of claims 1 to 14, wherein the dextran has a viscosity of about 60,000 cPs at 15% w/w in water at a temperature of about 20 °C.
16. The method of any one of claims 1 to 15, wherein the flocculant is a synthetic polymer.
17. The method of claim 16, wherein the synthetic polymer is a water-soluble polymer of one or more ethylenically unsaturated monomers.
18. The method of claim 16, wherein the synthetic polymer is an anionic acrylate/acrylamide copolymer.
19. The method of any one of claims 1 to 18, wherein the dextran is added to the slurry in an amount between about 0.1 grams per ton and about 30 grams per ton.
20. The method of any one of claims 1 to 19, wherein the lignosulfonate is added to the slurry in an amount between about 0.1 grams per ton and about 10 grams per ton.
21. The method of any one of claims 1 to 20, wherein the method is performed in a thickener or in a settler.
22. A composition comprising dextran and lignosulfonate.
23. Use of a composition according to claim 22 in the treatment of a red mud slurry.
24. Use of a composition according to claim 22 as a conditioning aid in the treatment of a red mud slurry.

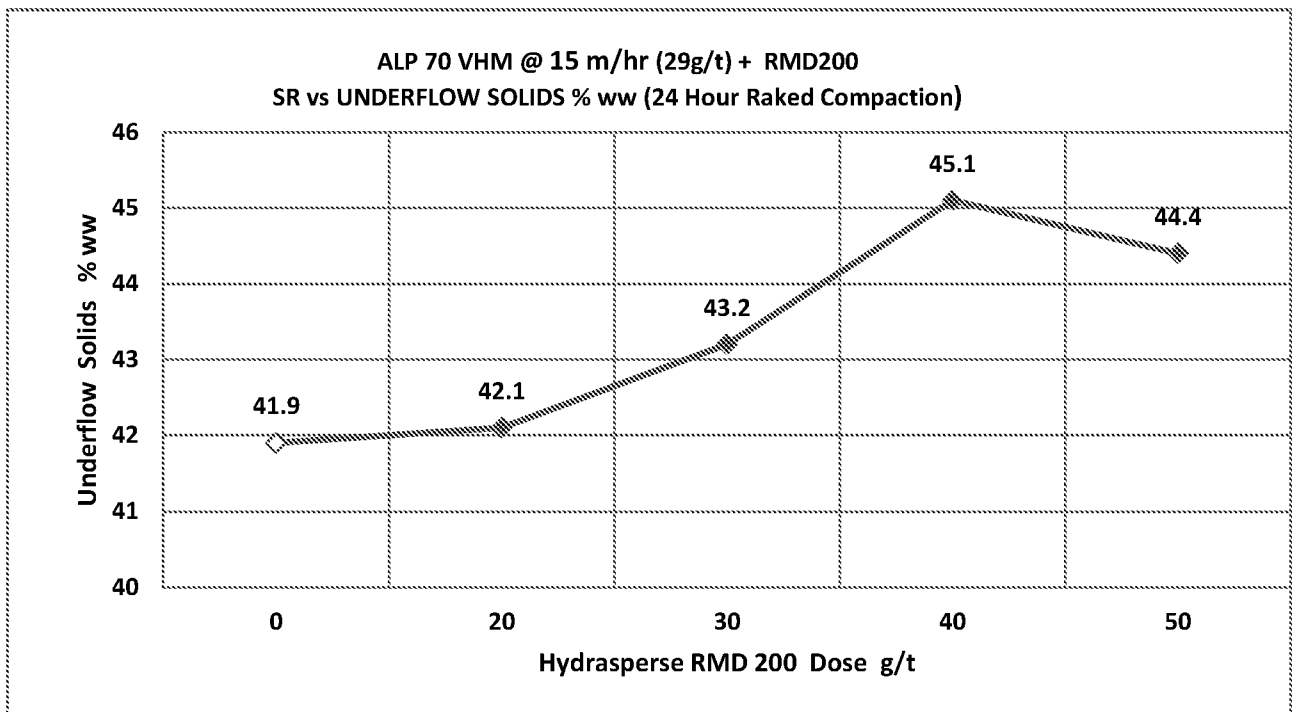


Figure 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2017/050421

A. CLASSIFICATION OF SUBJECT MATTER

C01F 7/06 (2006.01) B01D 21/01 (2006.01) B01D 37/03 (2006.01) C02F 11/14 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATENW: IPC/CPC (C01F 7/06, C01F 7/0653, C01F 7/066, Y02P 10/21/LOW, C02F 2103/10, C02F11/14) AND (C08L 5/02) AND (C08L 97/005) AND (C02F 1/52/LOW, B01D 21/01, B01D 37/03); PATENW: IPC/CPC (C02F 2103/10, C02F 11/14) using keywords SLURRY, DEXTRAN, LIGNOSULFONATE, FLOCCULANT) and like terms; PATENW: IPC/CPC (C01F 7/06, C01F 7/0653, C01F 7/066, Y02P 10/21/LOW, C02F 2103/10, C02F 11/14, C08L 5/02, C08L 97/005, C02F 1/52/LOW, B01D 21/01, B01D 37/03, C02F 2103/10, C02F 11/14) using keywords (SLURRY, DEXTRAN, LIGNOSULFONATE, FLOCCULANT) and like terms; ESPACENET, GOOGLE PATENTS: using keywords (RED, MUD, SLURRY, TREATMENT, DEXTRAN, LIGNOSULFONATE) and like terms; ESPACENET, AUSPAT, INTERNAL DATABASES provided by IP Australia: Applicant and Inventor(s) name searched

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search 26 June 2017		Date of mailing of the international search report 26 June 2017	
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au		Authorised officer Vijaya Mathe AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262256162	

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2017/050421
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2007/134957 A1 (CIBA SPECIALTY CHEMICALS HOLDING INC [CH]) 29 November 2007 page 2, line 24 – page 3, line 4; page 4, line 9 – page 5, line 16; page 8, line 25 – page 9, line 7; page 10, line 16 - page 11, line 17; page 13, lines 22 – 30; page 14, lines 4 – 24; page 15, lines 12 – 22; page 20, lines 4 – 13	1 - 21
X	US 2014/0080944 A1 (ANDERMANN, JR. et al.) 20 March 2014 paragraphs [0008], [0035], [0053]	22 - 24
Y	paragraphs [0008], [0035], [0053]	1 - 21
X	US 3065170 A (JERSEY PRODUCTION RESEARCH COMPANY) 20 November 1962 claim 1	22 - 24
A	WO 2014/105484 A1 (NALCO COMPANY [US]) 03 July 2014 abstract; claims 1 - 13	1 - 24

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INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/AU2017/050421	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
WO 2007/134957 A1	29 November 2007	WO 2007134957 A1	29 Nov 2007
		AP 2716 A	31 Jul 2013
		AR 061022 A1	30 Jul 2008
		AU 2007253484 A1	29 Nov 2007
		AU 2007253484 B2	26 May 2011
		BR PI0711946 A2	13 Dec 2011
		CA 2651440 A1	29 Nov 2007
		CN 101448583 A	03 Jun 2009
		CN 101448583 B	05 Sep 2012
		EA 200802252 A1	30 Jun 2009
		EA 015587 B1	31 Oct 2011
		EP 2021135 A1	11 Feb 2009
		JP 2009537315 A	29 Oct 2009
		JP 5021025 B2	05 Sep 2012
		MX 2008014564 A	27 Nov 2008
		PE 05362008 A1	29 Apr 2008
		US 2010006510 A1	14 Jan 2010
		US 7875188 B2	25 Jan 2011
		ZA 200809051 B	27 May 2009
US 2014/0080944 A1	20 March 2014	US 2014080944 A1	20 Mar 2014
		US 9290642 B2	22 Mar 2016
		AU 2012229023 A1	05 Sep 2013
		AU 2012229023 B2	28 Jul 2016
		BR 112013023822 A2	13 Dec 2016
		CA 2830294 A1	20 Sep 2012
		CN 103842300 A	04 Jun 2014
		EA 201391344 A1	30 Jan 2014
		EP 2686275 A1	22 Jan 2014
		MX 2013010200 A	17 Jan 2014
		MX 344872 B	11 Jan 2017
		PE 03762014 A1	26 Mar 2014
		WO 2012125918 A1	20 Sep 2012
US 3065170 A	20 November 1962	US 3065170 A	20 Nov 1962
WO 2014/105484 A1	03 July 2014	WO 2014105484 A1	03 Jul 2014
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.
Form PCT/ISA/210 (Family Annex)(July 2009)

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/AU2017/050421	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
		AU 2011289700 A1	21 Feb 2013
		AU 2011289700 B2	12 May 2016
		AU 2013338371 A1	26 Mar 2015
		AU 2013338371 B2	09 Mar 2017
		AU 2013368247 A1	21 May 2015
		AU 2013368247 B2	09 Mar 2017
		AU 2014242325 A1	05 Nov 2015
		AU 2014242325 B2	15 Dec 2016
		AU 2016203536 A1	23 Jun 2016
		BR 112013002971 A2	07 Jun 2016
		CA 2885192 A1	08 May 2014
		CA 2892628 A1	03 Jul 2014
		CA 2904522 A1	02 Oct 2014
		CN 103068735 A	24 Apr 2013
		CN 103068735 B	18 Mar 2015
		CN 104768627 A	08 Jul 2015
		CN 104768627 B	22 Mar 2017
		CN 104870373 A	26 Aug 2015
		CN 105073642 A	18 Nov 2015
		EP 2911764 A1	02 Sep 2015
		EP 2938575 A1	04 Nov 2015
		JP 2016503374 A	04 Feb 2016
		JP 2016508068 A	17 Mar 2016
		JP 2016517385 A	16 Jun 2016
		RU 2013105410 A	20 Sep 2014
		US 2012034142 A1	09 Feb 2012
		US 8298508 B2	30 Oct 2012
		US 2013195739 A1	01 Aug 2013
		US 9102995 B2	11 Aug 2015
		US 2013058847 A1	07 Mar 2013
		US 9174852 B2	03 Nov 2015
		US 2013112627 A1	09 May 2013
		US 9199855 B2	01 Dec 2015
		WO 2012021375 A2	16 Feb 2012
		WO 2014070487 A1	08 May 2014
		WO 2014158381 A1	02 Oct 2014
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			

INTERNATIONAL SEARCH REPORT Information on patent family members		International application No. PCT/AU2017/050421	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
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