

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
(day/month/year)

20 NOV 2017

Applicant's or agent's file reference
N00452WO-PCT

FOR FURTHER ACTION

See paragraph 2 below

International application No.

PCT/US 17/36730

International filing date (day/month/year)

09 June 2017 (09.06.2017)

Priority date (day/month/year)

10 June 2016 (10.06.2016)

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

IPC(8) - A23P 1/06, A23L 1/28 (2017.01)

CPC - A23V 2002/00, A23L 33/24, A23L 7/115

Applicant CARGILL, INCORPORATED

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US
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Date of completion of this opinion

30 October 2017

Authorized officer

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PCT OSP: 571-272-7774

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Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:
 - ☒ the international application in the language in which it was filed.
 - ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a)).
3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. ☐ forming part of the international application as filed:
 - ☐ in the form of an Annex C/ST.25 text file.
 - ☐ on paper or in the form of an image file.
 - b. ☐ furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. ☐ furnished subsequent to the international filing date for the purposes of international search only:
 - ☐ in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - ☐ on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

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Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:
- ☐ paid additional fees.
- ☐ paid additional fees under protest and, where applicable, the protest fee.
- ☐ paid additional fees under protest but the applicable protest fee was not paid.
- ☒ not paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-18 and 37-43, directed to a suspension comprising about 10-60 wt% of beta glucan (BG), that when diluted achieves a filterability ratio less than about 1.5 or when diluted achieves less than 10% viscosity loss during filtration.

Group II: Claims 19-36, directed to a suspension comprising about 10-60 wt% of beta glucan (BG) wherein greater than 50% of ultimate viscosity can be recovered after running specified dilution procedure for one pass and greater than 70% of ultimate viscosity after two passes.

The inventions listed as Groups I-II do not relate to a single inventive concept under PCT Rule 13.1 because under PCT Rule 13.2 they lack the same or corresponding technical features for the following reasons:

Special Technical Features

Group I includes a suspension comprising about 10-60 wt% of beta glucan (BG), that when diluted achieves a filterability ratio less than about 1.5 or when diluted achieves less than 10% viscosity loss during filtration, not required by Group II

Group II includes a suspension comprising about 10-60 wt% of beta glucan (BG) wherein greater than 50% of ultimate viscosity can be recovered after running specified dilution procedure for one pass and greater than 70% of ultimate viscosity after two passes, not required by Group I

Shared Technical Features

Groups I-II share the common features of a suspension comprising about 10-60 wt% of beta glucan. However, this shared technical feature does not represent a contribution over prior art as being obvious over WO 2016/087521 A1 to Wintershall Holding GmbH (hereafter 'Wintershall'). Wintershall teaches a suspension comprising beta glucan (BG), that achieves a filterability ratio less than about 1.5 (pg 10, ln 7-14; Thus, in another embodiment, the presently claimed invention is directed to an aqueous solution of at least one beta-glucan which is obtainable by the inventively claimed method. The good quality of the aqueous solution comprising at least one beta-glucan is evident from the good filtration properties, which are expressed by the low filtration ratio (FR value). The FR value of the product is preferably in the range of ≥ 1.0 to ≤ 2.0 , more preferably in the range of ≥ 1.0 to ≤ 1.8 , even more preferably in the range of ≥ 1.0 to ≤ 1.3 , as in each case determined by using a membrane having a pore size of 1.2 μm ; pg 14, Table; showing inventive examples 1-4 all having filterability ratios (FR) below 1.5), but does not specifically teach the suspension comprises beta-glucan at about 10-60 wt%. Nonetheless, 60 wt% beta-glucan compositions are well known in the art and commercially available (see US 2006/0040036 A1 to Vasanthan et al. (hereafter, Vasanthan); para [0027]; BBG specifically refers to beta-glucan derived from barley; para [0028]; Barley Viscofiber, a concentrated form of BBG (about 60-65%, w/w, beta-glucan) was obtained from Cevena BioProducts Inc., Edmonton, AB), and it would have been obvious to one of ordinary skill in the art to choose for the suspension to be about 10-60 wt% beta-glucan, during routine experimentation to identify the most desirable suspension.

Therefore, Groups I-II lack unity under PCT Rule 13 because they do not share a same or corresponding technical feature.

4. Consequently, this opinion has been established in respect of the following parts of the international application:

☐ all parts.

☒ the parts relating to claims Nos. 1-18 and 37-43

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Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-18, 37-43	YES
	Claims	none	NO
Inventive step (IS)	Claims	9	YES
	Claims	1-8, 10-18, 37-43	NO
Industrial applicability (IA)	Claims	1-18, 37-43	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-7 lack an inventive step under PCT Article 33(3) as being obvious over WO 2016/087521 A1 to Wintershall Holding GmbH (hereafter, Wintershall 521).

Regarding claim 1, Wintershall 521 teaches a suspension comprising beta glucan (BG), that achieves a filterability ratio less than about 1.5 (pg 10, ln 7-14; Thus, in another embodiment, the presently claimed invention is directed to an aqueous solution of at least one beta-glucan which is obtainable by the inventively claimed method. The good quality of the aqueous solution comprising at least one beta-glucan is evident from the good filtration properties, which are expressed by the low filtration ratio (FR value). The FR value of the product is preferably in the range of ≥ 1.0 to ≤ 2.0 , more preferably in the range of ≥ 1.0 to ≤ 1.8 , even more preferably in the range of ≥ 1.0 to ≤ 1.3 , as in each case determined by using a membrane having a pore size of 1.2 μm ; pg 14, Table; showing inventive examples 1-4 all having filterability ratios (FR) below 1.5), but does not specifically teach the suspension comprises beta-glucan at about 10-60 wt%, and that the filterability ratio of less than about 1.5 is achieved when diluted.

Nonetheless, 60 wt% beta-glucan compositions are well known in the art and commercially available (see US 2006/0040036 A1 to Vasanthan et al. (hereafter, Vasanthan); para [0027]; BBG specifically refers to beta-glucan derived from barley; para [0028]; Barley Viscifer, a concentrated form of BBG (about 60-65%, w/w, beta-glucan) was obtained from Cevena BioProducts Inc., Edmonton, AB), and it would have been obvious to one of ordinary skill in the art to choose for the suspension to be about 10-60 wt% beta-glucan, during routine experimentation to identify the most desirable suspension. Additionally, Wintershall 521 teaches of a fermentation broth containing concentrations of beta glucan between 4.9 g/L to 6.3 g/L that achieves the desired filterability ratio of less than 1.5 (pg 14, Table; showing inventive example 4 at 4.9 g/L and example 2 at 6.3 g/L of beta glucan schizophyllan with filterability ratios at 1.16 and 1.21 respectively), and also that the beta glucan can be further concentrated (pg 10, ln 22-23; The aqueous solution containing at least one beta-glucan may be further worked up and concentrated in order to obtain the at least one beta-glucan in highly concentrated form). Accordingly, it would have been obvious to one of ordinary skill in the art to concentrate the suspensions up to about 10-60 wt%, which when subsequently diluted down to the concentrations taught by Wintershall 521 would then achieve a filterability ratio less than about 1.5.

Regarding claim 2, Wintershall 521 teaches the suspension of claim 1, wherein the BG is 1,3 beta glucan (pg 4, ln 30-32; In the context of the presently claimed invention, the at least one beta-glucan to be produced as described herein is preferably selected from the group consisting of schizophyllan and scleroglucan, particularly preferably the at least one beta-glucan is schizophyllan; pg 5, ln 1-7; Schizophyllan and scleroglucan can both be referred to as beta-1,3-glucans).

Regarding claim 3, Wintershall 521 teaches the suspension of claim 2, wherein the BG is 1,3-1,6 beta glucan (pg 4, ln 30-32; In the context of the presently claimed invention, the at least one beta-glucan to be produced as described herein is preferably selected from the group consisting of schizophyllan and scleroglucan, particularly preferably the at least one beta-glucan is schizophyllan; pg 5, ln 1-7; Schizophyllan and scleroglucan can both be referred to as beta-1,3-glucans. The polysaccharide chains usually form a three-dimensional structure of triple helices; polymer chains consist of glucose units whose hydroxy groups in 1- and 3-position are beta-linked to form the polymer main chain, and wherein each third glucose unit contains in position 6 a further glucose moiety linked by its hydroxyl function in position 1 (beta-1,3-bonded glucopyranose as the main chain and beta-1,6-bonded glucopyranose as side chains)).

Regarding claim 4, Wintershall 521 teaches the suspension of claim 2, but does not specifically teach wherein the BG is 1,3-1,4 beta glucan. Nonetheless, it is well known in the art that 1,3-1,4 beta-glucan can form suspensions (see Vasanthan; para [0004]; Recently, mixed linked (1-3)(1-4) beta-glucan obtained from cereals (concentrated in walls of endosperm cell) has been reported to possess unique physicochemical properties desired in a hydrocolloid (suspension)), and it would have been obvious to one of ordinary skill in the art to choose for the BG to be 1,3-1,4 beta glucan, during routine experimentation to identify the most desirable suspension.

Regarding claim 5, Wintershall 521 teaches the suspension of claim 1, wherein the BG is scleroglucan (pg 4, ln 30-32; In the context of the presently claimed invention, the at least one beta-glucan to be produced as described herein is preferably selected from the group consisting of schizophyllan and scleroglucan).

Regarding claim 6, Wintershall 521 teaches the suspension of claim 1, wherein the BG is schizophyllan (pg 4, ln 30-32; particularly preferably the at least one beta-glucan is schizophyllan).

— Continued in Supplemental Box —

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In case the space in any of the preceding boxes is not sufficient.

Continuation of:

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Regarding claim 7, Wintershall 521 teaches the suspension of claim 1, wherein the filterability ratio is less than about 1.2 (pg 14, Table; showing inventive examples 1 and 4 having filterability ratios (FR) of 1.17 and 1.16 respectively).

Claims 37-43 lack an inventive step under PCT Article 33(3) as being obvious over WO 2007/003688 A1 to Avenly Oy (hereafter, Avenly).

Regarding claim 37, Avenly teaches a suspension comprising about 10-60 wt% of beta glucan (BG) (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%), but does not specifically teach that when diluted the suspension achieves less than 10% viscosity loss during filtration. Nonetheless, it is well known in the art that the viscosity of any polymer solution depends on the concentration (see the article titled "Viscosity of Dilute and Moderately Concentrated Polymer Solutions" by Weissberg et al. (hereafter, Weissberg); pg 299, col 2, para 4; c = polymer concentration in grams per 100 ml of solution, η_r = relative viscosity = η/η_0 , where η is the viscosity of the solution and η_0 that of the solvent; pg 300, col 1, para 1; $(\eta_{sp})/c$ = reduced specific viscosity = $(\eta_r - 1)/C$, where $[\eta]$ is the intrinsic viscosity defined as $\lim_{c \rightarrow 0} (\eta_{sp})/c$; pg 302, col 1, para 1; some viscosity-concentration functions are quite useful for certain purposes. Two such are the Martin equation: $(\eta_{sp})/c = [\eta] \exp(k_1 [\eta] c)$ and the Baker equation: $\eta_r = (1 + [\eta] c/n)^n$, and that filtration is ipso facto able to affect the concentration and therefore the viscosity of the filtered solution, such that it would have been obvious to one of ordinary skill in the art to dilute the suspension to a chosen concentration and choose a method of filtration such that less than 10% viscosity loss occurs during the filtration, during routine experimentation to identify the most desirable suspension.

Regarding claim 38, Avenly teaches the suspension of claim 37, but does not specifically teach wherein the BG is 1,3 beta glucan. Nonetheless, it is well known in the art that 1,3 beta glucan with either 1,4 or 1,6 branches is generally recognized as safe by the FDA for food consumption (see the document titled "DETERMINATION OF THE GENERALLY RECOGNIZED AS SAFE (GRAS) STATUS OF MUSHROOM BETA-GLUCANS AS A FOOD INGREDIENT" by Super Beta Glucan Inc. (hereafter, SBG); pg 23, para 2; The source mushroom from which beta-glucans is derived is an edible species which has been consumed for centuries. Additionally, beta-glucans is commonly found in the bran of cereal grains, the cell wall of yeast, certain fungi, seaweed, mushrooms and bacteria that have been consumed by humans ... All this information suggests that there is a common knowledge of safe consumption of beta-glucans from different food sources or products; pg 10, para 2; Beta-glucans from oat and barley are primarily linear with large regions of beta(1,4) linkages separating shorter stretches of beta(1,3) structures, whereas beta-glucans from yeast have a beta(1,3) backbone with beta(1,6)-linked beta(1,3) branches. Beta-Glucans from mushroom are similar to yeast except that they are comprised of short beta(1,6) branches coming off of a beta(1,3) backbone), and it would have been obvious to one of ordinary skill in the art to recognize that the BG in the suspension taught by Avenly can be 1,3 beta glucan.

Regarding claim 39, Avenly teaches the suspension of claim 38, and following the arguments in claim 38, it would have been obvious to one of ordinary skill in the art to specify wherein the BG is 1,3-1,6 beta glucan (see SBG; pg 10, para 2; Beta-glucans from oat and barley are primarily linear with large regions of beta(1,4) linkages separating shorter stretches of beta(1,3) structures, whereas beta-glucans from yeast have a beta(1,3) backbone with beta(1,6)-linked beta(1,3) branches. Beta-Glucans from mushroom are similar to yeast except that they are comprised of short beta(1,6) branches coming off of a beta(1,3) backbone).

Regarding claim 40, Avenly teaches the suspension of claim 38, and following the arguments in claim 38, it would have been obvious to one of ordinary skill in the art to specify wherein the BG is 1,3-1,4 beta glucan (see SBG; pg 10, para 2; Beta-glucans from oat and barley are primarily linear with large regions of beta(1,4) linkages separating shorter stretches of beta(1,3) structures, whereas beta-glucans from yeast have a beta(1,3) backbone with beta(1,6)-linked beta(1,3) branches. Beta-Glucans from mushroom are similar to yeast except that they are comprised of short beta(1,6) branches coming off of a beta(1,3) backbone).

Regarding claim 41, Avenly teaches the suspension of claim 37, wherein the suspension is pumpable (pg 5, ln 26-30; The food suspension can be in a drinkable, spoonable or spreadable form; (a drinkable suspension is pumpable)).

Regarding claim 42, Avenly teaches the suspension of claim 37, wherein the suspension is flowable (pg 5, ln 26-30; The food suspension can be in a drinkable, spoonable or spreadable form; (a drinkable suspension is flowable)).

Regarding claim 43, Avenly teaches the suspension of claim 37, wherein the suspension is pumpable and flowable (pg 5, ln 26-30; The food suspension can be in a drinkable, spoonable or spreadable form; (a drinkable suspension is pumpable and flowable)).

Claims 8, 16-18 lack an inventive step under PCT Article 33(3) as being obvious over Wintershall 521 in view of Avenly.

Regarding claim 8, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the viscosity of the suspension ranges from 0.1 to 2 million cP at 70 degrees C measured at 100 s⁻¹ of shear, instead teaching of the diluted solution at about 29 to 36 cP at measured at 25 degrees C and 7 s⁻¹ of shear (pg 14, Table; showing inventive examples 1-4 having viscosities between 29.4 mPa s and 36.5 mPa s, which is equivalent to cP in units; pg 13, ln 36-37; The viscosity of the aqueous solution containing schizophyllan is determined at a concentration of 0.35 g/l at a temperature of 25 degrees C and a shear rate of 7 s⁻¹). Nonetheless, Avenly teaches a beta-glucan suspension wherein the viscosity is between 100 - 2000000 cP at a temperature of 25 degrees C at 12 s⁻¹ shear (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%, preferably 7-25 w-% and most preferably 9-16 w-%; pg 5, ln 26-30; The viscosity of the food suspension in accordance with the invention can be 100 - 2000000 cP at a temperature of 25 degrees C (Brookfield, rotation speed 12 rpm, spindle No. 3 or 4), and it would have been obvious to one of ordinary skill in the art to recognize that the suspension taught by Wintershall 521 when concentrated to about 10-60 wt% can achieve viscosity of 0.1 to 2 million cP at 70 degrees C measured at 100 s⁻¹ of shear, during routine experimentation to identify the most desirable suspension.

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In case the space in any of the preceding boxes is not sufficient.

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Regarding claim 16, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the suspension is pumpable. Nonetheless, Avenly teaches a beta-glucan suspension wherein the suspension is drinkable, spoonable or spreadable, and therefore pumpable (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%, preferably 7-25 w-% and most preferably 9-16 w-%; pg 5, ln 26-30; The viscosity of the food suspension in accordance with the invention can be 100 - 2000000 cP at a temperature of 25 degrees C (Brookfield, rotation speed 12 rpm, spindle No. 3 or 4). The food suspension can be in a drinkable, spoonable or spreadable form), and it would have been obvious to one of ordinary skill in the art to recognize that the suspension taught by Wintershall 521 when concentrated to about 10-60 wt% can be pumpable, during routine experimentation to identify the most desirable suspension.

Regarding claim 17, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the suspension is flowable. Nonetheless, Avenly teaches a beta-glucan suspension wherein the suspension is drinkable, spoonable or spreadable, and therefore flowable (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%, preferably 7-25 w-% and most preferably 9-16 w-%; pg 5, ln 26-30; The viscosity of the food suspension in accordance with the invention can be 100 - 2000000 cP at a temperature of 25 degrees C (Brookfield, rotation speed 12 rpm, spindle No. 3 or 4). The food suspension can be in a drinkable, spoonable or spreadable form), and it would have been obvious to one of ordinary skill in the art to recognize that the suspension taught by Wintershall 521 when concentrated to about 10-60 wt% can be flowable, during routine experimentation to identify the most desirable suspension.

Regarding claim 18, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the suspension is pumpable and flowable. Nonetheless, Avenly teaches a beta-glucan suspension wherein the suspension is drinkable, spoonable or spreadable, and therefore pumpable and flowable (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%, preferably 7-25 w-% and most preferably 9-16 w-%; pg 5, ln 26-30; The viscosity of the food suspension in accordance with the invention can be 100 - 2000000 cP at a temperature of 25 degrees C (Brookfield, rotation speed 12 rpm, spindle No. 3 or 4). The food suspension can be in a drinkable, spoonable or spreadable form), and it would have been obvious to one of ordinary skill in the art to recognize that the suspension taught by Wintershall 521 when concentrated to about 10-60 wt% can be pumpable and flowable, during routine experimentation to identify the most desirable suspension.

Claims 10-12 lack an inventive step under PCT Article 33(3) as being obvious over Wintershall 521 in view of US 2007/0128331 A1 to Kvist et al. (hereafter, Kvist).

Regarding claim 10, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the BG is suspended in a hydrophobic fluid. Nonetheless, Kvist teaches wherein beta-glucan can act as an emulsifier in oil and water emulsions (para [0028]; The present invention relates in particular to a process for preparing a stable emulsion/dispersion of an oil and an aqueous phase wherein a beta-glucans rich powder or granulate containing at least 12% by weight of beta-glucans having a molecular weight of more than 1,000,000 Daltons is added in a step-wise sequence to the oil phase or to a part of the oil phase and is mixed and dispersed, followed by addition of the aqueous phase at temperatures below 40 degrees C. with concomitant mixing and stirring to form an oil-in-water emulsion or a water-in-oil emulsion), and it would have been obvious to one of ordinary skill in the art to recognize that beta-glucan is suspendable in oil or a hydrophobic fluid, during routine experimentation to identify the most desirable suspension.

Regarding claim 11, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the BG is suspended in a hydrophilic fluid. Nonetheless, Kvist teaches wherein beta-glucan can act as an emulsifier in oil and water emulsions (para [0028]; The present invention relates in particular to a process for preparing a stable emulsion/dispersion of an oil and an aqueous phase wherein a beta-glucans rich powder or granulate containing at least 12% by weight of beta-glucans having a molecular weight of more than 1,000,000 Daltons is added in a step-wise sequence to the oil phase or to a part of the oil phase and is mixed and dispersed, followed by addition of the aqueous phase at temperatures below 40 degrees C. with concomitant mixing and stirring to form an oil-in-water emulsion or a water-in-oil emulsion), and it would have been obvious to one of ordinary skill in the art to recognize that beta-glucan is suspendable in water or a hydrophilic fluid, during routine experimentation to identify the most desirable suspension.

Regarding claim 12, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the BG is suspended in an amphiphilic fluid. Nonetheless, Kvist teaches wherein beta-glucan can act as an emulsifier in oil and water emulsions (para [0028]; The present invention relates in particular to a process for preparing a stable emulsion/dispersion of an oil and an aqueous phase wherein a beta-glucans rich powder or granulate containing at least 12% by weight of beta-glucans having a molecular weight of more than 1,000,000 Daltons is added in a step-wise sequence to the oil phase or to a part of the oil phase and is mixed and dispersed, followed by addition of the aqueous phase at temperatures below 40 degrees C. with concomitant mixing and stirring to form an oil-in-water emulsion or a water-in-oil emulsion), and it would have been obvious to one of ordinary skill in the art to recognize that beta-glucan is suspendable in an amphiphilic fluid since beta-glucan itself is amphiphilic, during routine experimentation to identify the most desirable suspension.

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In case the space in any of the preceding boxes is not sufficient.

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Claim 13 lacks an inventive step under PCT Article 33(3) as being obvious over Wintershall 521 in view of US 2004/0258829 A1 to Zheng et al. (hereafter, Zheng).

Regarding claim 13, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein dilution is carried out at a shear rate of 40,000 s⁻¹ to 300,000 s⁻¹. Nonetheless, Zheng teaches wherein a concentrated beta glucan product can be shear mixed into water using high shear mixing (para [0177]; As a highly concentrated source of soluble dietary fiber, only 0.45% barley beta fiber is needed to deliver 0.75 g beta-glucan per 8 oz serving; para [0181]; Slowly meter the barley beta fiber into the vortex of vigorously agitated hot water to thoroughly disperse. This can be achieved using high shear mixing), and it is well known in the art that shear mixing can achieve up to 300,000 s⁻¹ (see US 4,946,702 A to Stipp et al. (hereafter, Stipp); col 6, ln 45-48; Typically, high shear treatment methods useful in the present invention impart shear rates to the concentrated orange juice of from about 300,000 to about 10,000,000 sec.⁻¹). Accordingly, it would have been obvious to one of ordinary skill in the art to choose to carry out the dilution at a shear rate of 40,000 s⁻¹ to 300,000 s⁻¹, during routine experimentation to identify the most desirable suspension.

Claims 14-15 lack an inventive step under PCT Article 33(3) as being obvious over Wintershall 521 in view of WO 2013/171137 A1 to Wintershall Holding GmbH (hereafter, Wintershall 137).

Regarding claim 14, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein dilution is carried out in salt water. Nonetheless, Wintershall 137 teaches wherein dried beta-glucan can be dissolved in salt water (pg 7, ln 11-15; In accordance with the method described and provided herein, after precipitation and, if applicable, after drying and/or swelling or steeping, the beta-glucan is re-dissolved in water. In this context, the water may be high-purity/ultrapure water ... Also, the water may contain further ions or particles), and it would have been obvious to one of ordinary skill in the art to recognize that similar to the redissolution, the beta-glucan suspension can be diluted with salt water, during routine experimentation to identify the most desirable suspension.

Regarding claim 15, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein dilution is carried out in fresh water. Nonetheless, Wintershall 137 teaches wherein dried beta-glucan can be dissolved in fresh water (pg 7, ln 11-15; In accordance with the method described and provided herein, after precipitation and, if applicable, after drying and/or swelling or steeping, the beta-glucan is re-dissolved in water. In this context, the water may be high-purity/ultrapure water), and it would have been obvious to one of ordinary skill in the art to recognize that similar to the redissolution, the beta-glucan suspension can be diluted with fresh water, during routine experimentation to identify the most desirable suspension.

Claim 9 meets the criteria set out under PCT Article 33 (2)-(3) because the prior art does not teach or fairly suggest the claimed invention.

Regarding claim 9, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the BG is suspended in alcohol, and instead teaches away by indicating that BG precipitates in alcohol (pg 10, ln 24-30; the aqueous solution comprising at least one beta-glucan can be contacted with at least one precipitating agent to obtain at least one precipitated beta-glucan ... Preferably, the at least one precipitating agent is selected from the group consisting of low boiling liquids ... Examples of low boiling liquids are ... alcohols). Similarly, Vasanathan teaches wherein BG precipitates in alcohol (para [0029]; The purification of BBG from Viscofiber was based on a traditional aqueous technology as shown in FIG. 1. The method involved alkali extraction followed by enzymatic treatments. In brief, the steps involved were the solubilization of BBG in deionized Milli-Q water, treatment with thermostable alpha-amylase (added at a rate of 1%, w/w, of available starch in the sample), followed by the protein precipitation and subsequent alcohol-assisted precipitation of BBG).

The prior art does not teach individually nor fairly suggest in combination a beta-glucan suspension that is suspended in alcohol, and teaches away from that application.

Claims 1-18, 37-43 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44bis)

Applicant's or agent's file reference N00452WO-PCT	FOR FURTHER ACTION	See item 4 below
International application No. PCT/US2017/036730	International filing date (<i>day/month/year</i>) 09 June 2017 (09.06.2017)	Priority date (<i>day/month/year</i>) 10 June 2016 (10.06.2016)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant CARGILL, INCORPORATED		

1.	This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 bis.1(a).																								
2.	This REPORT consists of a total of 8 sheets, including this cover sheet.																								
In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.																									
3.	This report contains indications relating to the following items: <table style="width: 100%;"> <tr> <td style="width: 5%; text-align: center;">☒</td> <td style="width: 25%;">Box No. I</td> <td>Basis of the report</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. II</td> <td>Priority</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. III</td> <td>Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td> </tr> <tr> <td style="text-align: center;">☒</td> <td>Box No. IV</td> <td>Lack of unity of invention</td> </tr> <tr> <td style="text-align: center;">☒</td> <td>Box No. V</td> <td>Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. VI</td> <td>Certain documents cited</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. VII</td> <td>Certain defects in the international application</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. VIII</td> <td>Certain observations on the international application</td> </tr> </table>	☒	Box No. I	Basis of the report	☐	Box No. II	Priority	☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability	☒	Box No. IV	Lack of unity of invention	☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement	☐	Box No. VI	Certain documents cited	☐	Box No. VII	Certain defects in the international application	☐	Box No. VIII	Certain observations on the international application
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☐	Box No. VII	Certain defects in the international application																							
☐	Box No. VIII	Certain observations on the international application																							
4.	The International Bureau will communicate this report to designated Offices in accordance with Rules 44bis.3(c) and 93bis.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44bis .2).																								

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Date of issuance of this report 11 December 2018 (11.12.2018)</td> </tr> <tr> <td style="padding: 5px;">Authorized officer Agnès Wittmann-Regis e-mail: pct.team6@wipo.int</td> </tr> </table>	Date of issuance of this report 11 December 2018 (11.12.2018)	Authorized officer Agnès Wittmann-Regis e-mail: pct.team6@wipo.int
Date of issuance of this report 11 December 2018 (11.12.2018)			
Authorized officer Agnès Wittmann-Regis e-mail: pct.team6@wipo.int			

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: JIHAN A. R. JENKINS
MS 24
15407 MCGINTY ROAD WEST
WAYZATA, MN 55391

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
(day/month/year)

20 NOV 2017

Applicant's or agent's file reference
N00452WO-PCT

FOR FURTHER ACTION

See paragraph 2 below

International application No.

PCT/US 17/36730

International filing date (day/month/year)

09 June 2017 (09.06.2017)

Priority date (day/month/year)

10 June 2016 (10.06.2016)

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

IPC(8) - A23P 1/06, A23L 1/28 (2017.01)

CPC - A23V 2002/00, A23L 33/24, A23L 7/115

Applicant CARGILL, INCORPORATED

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-8300

Date of completion of this opinion

30 October 2017

Authorized officer

Lee W. Young

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US 17/36730

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:
 - ☒ the international application in the language in which it was filed.
 - ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a)).
3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. ☐ forming part of the international application as filed:
 - ☐ in the form of an Annex C/ST.25 text file.
 - ☐ on paper or in the form of an image file.
 - b. ☐ furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. ☐ furnished subsequent to the international filing date for the purposes of international search only:
 - ☐ in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - ☐ on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US 17/36730

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:
- ☐ paid additional fees.
- ☐ paid additional fees under protest and, where applicable, the protest fee.
- ☐ paid additional fees under protest but the applicable protest fee was not paid.
- ☒ not paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-18 and 37-43, directed to a suspension comprising about 10-60 wt% of beta glucan (BG), that when diluted achieves a filterability ratio less than about 1.5 or when diluted achieves less than 10% viscosity loss during filtration.

Group II: Claims 19-36, directed to a suspension comprising about 10-60 wt% of beta glucan (BG) wherein greater than 50% of ultimate viscosity can be recovered after running specified dilution procedure for one pass and greater than 70% of ultimate viscosity after two passes.

The inventions listed as Groups I-II do not relate to a single inventive concept under PCT Rule 13.1 because under PCT Rule 13.2 they lack the same or corresponding technical features for the following reasons:

Special Technical Features

Group I includes a suspension comprising about 10-60 wt% of beta glucan (BG), that when diluted achieves a filterability ratio less than about 1.5 or when diluted achieves less than 10% viscosity loss during filtration, not required by Group II

Group II includes a suspension comprising about 10-60 wt% of beta glucan (BG) wherein greater than 50% of ultimate viscosity can be recovered after running specified dilution procedure for one pass and greater than 70% of ultimate viscosity after two passes, not required by Group I

Shared Technical Features

Groups I-II share the common features of a suspension comprising about 10-60 wt% of beta glucan. However, this shared technical feature does not represent a contribution over prior art as being obvious over WO 2016/087521 A1 to Wintershall Holding GmbH (hereafter 'Wintershall'). Wintershall teaches a suspension comprising beta glucan (BG), that achieves a filterability ratio less than about 1.5 (pg 10, ln 7-14; Thus, in another embodiment, the presently claimed invention is directed to an aqueous solution of at least one beta-glucan which is obtainable by the inventively claimed method. The good quality of the aqueous solution comprising at least one beta-glucan is evident from the good filtration properties, which are expressed by the low filtration ratio (FR value). The FR value of the product is preferably in the range of ≥ 1.0 to ≤ 2.0 , more preferably in the range of ≥ 1.0 to ≤ 1.8 , even more preferably in the range of ≥ 1.0 to ≤ 1.3 , as in each case determined by using a membrane having a pore size of 1.2 μm ; pg 14, Table; showing inventive examples 1-4 all having filterability ratios (FR) below 1.5), but does not specifically teach the suspension comprises beta-glucan at about 10-60 wt%. Nonetheless, 60 wt% beta-glucan compositions are well known in the art and commercially available (see US 2006/0040036 A1 to Vasanthan et al. (hereafter, Vasanthan); para [0027]; BBG specifically refers to beta-glucan derived from barley; para [0028]; Barley Viscofiber, a concentrated form of BBG (about 60-65%, w/w, beta-glucan) was obtained from Cevena BioProducts Inc., Edmonton, AB), and it would have been obvious to one of ordinary skill in the art to choose for the suspension to be about 10-60 wt% beta-glucan, during routine experimentation to identify the most desirable suspension.

Therefore, Groups I-II lack unity under PCT Rule 13 because they do not share a same or corresponding technical feature.

4. Consequently, this opinion has been established in respect of the following parts of the international application:

☐ all parts.

☒ the parts relating to claims Nos. 1-18 and 37-43

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

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Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-18, 37-43	YES
	Claims	none	NO
Inventive step (IS)	Claims	9	YES
	Claims	1-8, 10-18, 37-43	NO
Industrial applicability (IA)	Claims	1-18, 37-43	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-7 lack an inventive step under PCT Article 33(3) as being obvious over WO 2016/087521 A1 to Wintershall Holding GmbH (hereafter, Wintershall 521).

Regarding claim 1, Wintershall 521 teaches a suspension comprising beta glucan (BG), that achieves a filterability ratio less than about 1.5 (pg 10, ln 7-14; Thus, in another embodiment, the presently claimed invention is directed to an aqueous solution of at least one beta-glucan which is obtainable by the inventively claimed method. The good quality of the aqueous solution comprising at least one beta-glucan is evident from the good filtration properties, which are expressed by the low filtration ratio (FR value). The FR value of the product is preferably in the range of ≥ 1.0 to ≤ 2.0 , more preferably in the range of ≥ 1.0 to ≤ 1.8 , even more preferably in the range of ≥ 1.0 to ≤ 1.3 , as in each case determined by using a membrane having a pore size of 1.2 μm ; pg 14, Table; showing inventive examples 1-4 all having filterability ratios (FR) below 1.5), but does not specifically teach the suspension comprises beta-glucan at about 10-60 wt%, and that the filterability ratio of less than about 1.5 is achieved when diluted.

Nonetheless, 60 wt% beta-glucan compositions are well known in the art and commercially available (see US 2006/0040036 A1 to Vasanthan et al. (hereafter, Vasanthan); para [0027]; BBG specifically refers to beta-glucan derived from barley; para [0028]; Barley Viscifer, a concentrated form of BBG (about 60-65%, w/w, beta-glucan) was obtained from Cevena BioProducts Inc., Edmonton, AB), and it would have been obvious to one of ordinary skill in the art to choose for the suspension to be about 10-60 wt% beta-glucan, during routine experimentation to identify the most desirable suspension. Additionally, Wintershall 521 teaches of a fermentation broth containing concentrations of beta glucan between 4.9 g/L to 6.3 g/L that achieves the desired filterability ratio of less than 1.5 (pg 14, Table; showing inventive example 4 at 4.9 g/L and example 2 at 6.3 g/L of beta glucan schizophyllan with filterability ratios at 1.16 and 1.21 respectively), and also that the beta glucan can be further concentrated (pg 10, ln 22-23; The aqueous solution containing at least one beta-glucan may be further worked up and concentrated in order to obtain the at least one beta-glucan in highly concentrated form). Accordingly, it would have been obvious to one of ordinary skill in the art to concentrate the suspensions up to about 10-60 wt%, which when subsequently diluted down to the concentrations taught by Wintershall 521 would then achieve a filterability ratio less than about 1.5.

Regarding claim 2, Wintershall 521 teaches the suspension of claim 1, wherein the BG is 1,3 beta glucan (pg 4, ln 30-32; In the context of the presently claimed invention, the at least one beta-glucan to be produced as described herein is preferably selected from the group consisting of schizophyllan and scleroglucan, particularly preferably the at least one beta-glucan is schizophyllan; pg 5, ln 1-7; Schizophyllan and scleroglucan can both be referred to as beta-1,3-glucans).

Regarding claim 3, Wintershall 521 teaches the suspension of claim 2, wherein the BG is 1,3-1,6 beta glucan (pg 4, ln 30-32; In the context of the presently claimed invention, the at least one beta-glucan to be produced as described herein is preferably selected from the group consisting of schizophyllan and scleroglucan, particularly preferably the at least one beta-glucan is schizophyllan; pg 5, ln 1-7; Schizophyllan and scleroglucan can both be referred to as beta-1,3-glucans. The polysaccharide chains usually form a three-dimensional structure of triple helices; polymer chains consist of glucose units whose hydroxy groups in 1- and 3-position are beta-linked to form the polymer main chain, and wherein each third glucose unit contains in position 6 a further glucose moiety linked by its hydroxyl function in position 1 (beta-1,3-bonded glucopyranose as the main chain and beta-1,6-bonded glucopyranose as side chains)).

Regarding claim 4, Wintershall 521 teaches the suspension of claim 2, but does not specifically teach wherein the BG is 1,3-1,4 beta glucan. Nonetheless, it is well known in the art that 1,3-1,4 beta-glucan can form suspensions (see Vasanthan; para [0004]; Recently, mixed linked (1-3)(1-4) beta-glucan obtained from cereals (concentrated in walls of endosperm cell) has been reported to possess unique physicochemical properties desired in a hydrocolloid (suspension)), and it would have been obvious to one of ordinary skill in the art to choose for the BG to be 1,3-1,4 beta glucan, during routine experimentation to identify the most desirable suspension.

Regarding claim 5, Wintershall 521 teaches the suspension of claim 1, wherein the BG is scleroglucan (pg 4, ln 30-32; In the context of the presently claimed invention, the at least one beta-glucan to be produced as described herein is preferably selected from the group consisting of schizophyllan and scleroglucan).

Regarding claim 6, Wintershall 521 teaches the suspension of claim 1, wherein the BG is schizophyllan (pg 4, ln 30-32; particularly preferably the at least one beta-glucan is schizophyllan).

— Continued in Supplemental Box —

**WRITTEN OPINION OF THE
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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

--- V.2 Citations and explanations ---

Regarding claim 7, Wintershall 521 teaches the suspension of claim 1, wherein the filterability ratio is less than about 1.2 (pg 14, Table; showing inventive examples 1 and 4 having filterability ratios (FR) of 1.17 and 1.16 respectively).

Claims 37-43 lack an inventive step under PCT Article 33(3) as being obvious over WO 2007/003688 A1 to Avenly Oy (hereafter, Avenly).

Regarding claim 37, Avenly teaches a suspension comprising about 10-60 wt% of beta glucan (BG) (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%), but does not specifically teach that when diluted the suspension achieves less than 10% viscosity loss during filtration. Nonetheless, it is well known in the art that the viscosity of any polymer solution depends on the concentration (see the article titled "Viscosity of Dilute and Moderately Concentrated Polymer Solutions" by Weissberg et al. (hereafter, Weissberg); pg 299, col 2, para 4; c = polymer concentration in grams per 100 ml of solution, η_r = relative viscosity = η/η_0 , where η is the viscosity of the solution and η_0 that of the solvent; pg 300, col 1, para 1; $(\eta_{sp})/c$ = reduced specific viscosity = $(\eta_r - 1)/C$, where $[\eta]$ is the intrinsic viscosity defined as $\lim_{c \rightarrow 0} (\eta_{sp})/c$; pg 302, col 1, para 1; some viscosity-concentration functions are quite useful for certain purposes. Two such are the Martin equation: $(\eta_{sp})/c = [\eta] \exp(k_1 [\eta] c)$ and the Baker equation: $\eta_r = (1 + [\eta] c/n)^n$, and that filtration is ipso facto able to affect the concentration and therefore the viscosity of the filtered solution, such that it would have been obvious to one of ordinary skill in the art to dilute the suspension to a chosen concentration and choose a method of filtration such that less than 10% viscosity loss occurs during the filtration, during routine experimentation to identify the most desirable suspension.

Regarding claim 38, Avenly teaches the suspension of claim 37, but does not specifically teach wherein the BG is 1,3 beta glucan. Nonetheless, it is well known in the art that 1,3 beta glucan with either 1,4 or 1,6 branches is generally recognized as safe by the FDA for food consumption (see the document titled "DETERMINATION OF THE GENERALLY RECOGNIZED AS SAFE (GRAS) STATUS OF MUSHROOM BETA-GLUCANS AS A FOOD INGREDIENT" by Super Beta Glucan Inc. (hereafter, SBG); pg 23, para 2; The source mushroom from which beta-glucans is derived is an edible species which has been consumed for centuries. Additionally, beta-glucans is commonly found in the bran of cereal grains, the cell wall of yeast, certain fungi, seaweed, mushrooms and bacteria that have been consumed by humans ... All this information suggests that there is a common knowledge of safe consumption of beta-glucans from different food sources or products; pg 10, para 2; Beta-glucans from oat and barley are primarily linear with large regions of beta(1,4) linkages separating shorter stretches of beta(1,3) structures, whereas beta-glucans from yeast have a beta(1,3) backbone with beta(1,6)-linked beta(1,3) branches. Beta-Glucans from mushroom are similar to yeast except that they are comprised of short beta(1,6) branches coming off of a beta(1,3) backbone), and it would have been obvious to one of ordinary skill in the art to recognize that the BG in the suspension taught by Avenly can be 1,3 beta glucan.

Regarding claim 39, Avenly teaches the suspension of claim 38, and following the arguments in claim 38, it would have been obvious to one of ordinary skill in the art to specify wherein the BG is 1,3-1,6 beta glucan (see SBG; pg 10, para 2; Beta-glucans from oat and barley are primarily linear with large regions of beta(1,4) linkages separating shorter stretches of beta(1,3) structures, whereas beta-glucans from yeast have a beta(1,3) backbone with beta(1,6)-linked beta(1,3) branches. Beta-Glucans from mushroom are similar to yeast except that they are comprised of short beta(1,6) branches coming off of a beta(1,3) backbone).

Regarding claim 40, Avenly teaches the suspension of claim 38, and following the arguments in claim 38, it would have been obvious to one of ordinary skill in the art to specify wherein the BG is 1,3-1,4 beta glucan (see SBG; pg 10, para 2; Beta-glucans from oat and barley are primarily linear with large regions of beta(1,4) linkages separating shorter stretches of beta(1,3) structures, whereas beta-glucans from yeast have a beta(1,3) backbone with beta(1,6)-linked beta(1,3) branches. Beta-Glucans from mushroom are similar to yeast except that they are comprised of short beta(1,6) branches coming off of a beta(1,3) backbone).

Regarding claim 41, Avenly teaches the suspension of claim 37, wherein the suspension is pumpable (pg 5, ln 26-30; The food suspension can be in a drinkable, spoonable or spreadable form; (a drinkable suspension is pumpable)).

Regarding claim 42, Avenly teaches the suspension of claim 37, wherein the suspension is flowable (pg 5, ln 26-30; The food suspension can be in a drinkable, spoonable or spreadable form; (a drinkable suspension is flowable)).

Regarding claim 43, Avenly teaches the suspension of claim 37, wherein the suspension is pumpable and flowable (pg 5, ln 26-30; The food suspension can be in a drinkable, spoonable or spreadable form; (a drinkable suspension is pumpable and flowable)).

Claims 8, 16-18 lack an inventive step under PCT Article 33(3) as being obvious over Wintershall 521 in view of Avenly.

Regarding claim 8, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the viscosity of the suspension ranges from 0.1 to 2 million cP at 70 degrees C measured at 100 s⁻¹ of shear, instead teaching of the diluted solution at about 29 to 36 cP at measured at 25 degrees C and 7 s⁻¹ of shear (pg 14, Table; showing inventive examples 1-4 having viscosities between 29.4 mPa s and 36.5 mPa s, which is equivalent to cP in units; pg 13, ln 36-37; The viscosity of the aqueous solution containing schizophyllan is determined at a concentration of 0.35 g/l at a temperature of 25 degrees C and a shear rate of 7 s⁻¹). Nonetheless, Avenly teaches a beta-glucan suspension wherein the viscosity is between 100 - 2000000 cP at a temperature of 25 degrees C at 12 s⁻¹ shear (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%, preferably 7-25 w-% and most preferably 9-16 w-%; pg 5, ln 26-30; The viscosity of the food suspension in accordance with the invention can be 100 - 2000000 cP at a temperature of 25 degrees C (Brookfield, rotation speed 12 rpm, spindle No. 3 or 4), and it would have been obvious to one of ordinary skill in the art to recognize that the suspension taught by Wintershall 521 when concentrated to about 10-60 wt% can achieve viscosity of 0.1 to 2 million cP at 70 degrees C measured at 100 s⁻¹ of shear, during routine experimentation to identify the most desirable suspension.

--- Continued in next Supplemental Box ---

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US 17/36730

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

— V.2 Citations and explanations —

Regarding claim 16, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the suspension is pumpable. Nonetheless, Avenly teaches a beta-glucan suspension wherein the suspension is drinkable, spoonable or spreadable, and therefore pumpable (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%, preferably 7-25 w-% and most preferably 9-16 w-%; pg 5, ln 26-30; The viscosity of the food suspension in accordance with the invention can be 100 - 2000000 cP at a temperature of 25 degrees C (Brookfield, rotation speed 12 rpm, spindle No. 3 or 4). The food suspension can be in a drinkable, spoonable or spreadable form), and it would have been obvious to one of ordinary skill in the art to recognize that the suspension taught by Wintershall 521 when concentrated to about 10-60 wt% can be pumpable, during routine experimentation to identify the most desirable suspension.

Regarding claim 17, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the suspension is flowable. Nonetheless, Avenly teaches a beta-glucan suspension wherein the suspension is drinkable, spoonable or spreadable, and therefore flowable (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%, preferably 7-25 w-% and most preferably 9-16 w-%; pg 5, ln 26-30; The viscosity of the food suspension in accordance with the invention can be 100 - 2000000 cP at a temperature of 25 degrees C (Brookfield, rotation speed 12 rpm, spindle No. 3 or 4). The food suspension can be in a drinkable, spoonable or spreadable form), and it would have been obvious to one of ordinary skill in the art to recognize that the suspension taught by Wintershall 521 when concentrated to about 10-60 wt% can be flowable, during routine experimentation to identify the most desirable suspension.

Regarding claim 18, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the suspension is pumpable and flowable. Nonetheless, Avenly teaches a beta-glucan suspension wherein the suspension is drinkable, spoonable or spreadable, and therefore pumpable and flowable (pg 4, ln 13-16; When preparing in a manner such as this, one achieves a stabile cereal-based food suspension having a beta-glucan concentration of at least 0.25 g/100 g of food suspension; pg 5, ln 3-5; The beta-glucan concentration of the cereal material can be 1-60 w-%, preferably 7-25 w-% and most preferably 9-16 w-%; pg 5, ln 26-30; The viscosity of the food suspension in accordance with the invention can be 100 - 2000000 cP at a temperature of 25 degrees C (Brookfield, rotation speed 12 rpm, spindle No. 3 or 4). The food suspension can be in a drinkable, spoonable or spreadable form), and it would have been obvious to one of ordinary skill in the art to recognize that the suspension taught by Wintershall 521 when concentrated to about 10-60 wt% can be pumpable and flowable, during routine experimentation to identify the most desirable suspension.

Claims 10-12 lack an inventive step under PCT Article 33(3) as being obvious over Wintershall 521 in view of US 2007/0128331 A1 to Kvist et al. (hereafter, Kvist).

Regarding claim 10, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the BG is suspended in a hydrophobic fluid. Nonetheless, Kvist teaches wherein beta-glucan can act as an emulsifier in oil and water emulsions (para [0028]; The present invention relates in particular to a process for preparing a stable emulsion/dispersion of an oil and an aqueous phase wherein a beta-glucans rich powder or granulate containing at least 12% by weight of beta-glucans having a molecular weight of more than 1,000,000 Daltons is added in a step-wise sequence to the oil phase or to a part of the oil phase and is mixed and dispersed, followed by addition of the aqueous phase at temperatures below 40 degrees C. with concomitant mixing and stirring to form an oil-in-water emulsion or a water-in-oil emulsion), and it would have been obvious to one of ordinary skill in the art to recognize that beta-glucan is suspendable in oil or a hydrophobic fluid, during routine experimentation to identify the most desirable suspension.

Regarding claim 11, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the BG is suspended in a hydrophilic fluid. Nonetheless, Kvist teaches wherein beta-glucan can act as an emulsifier in oil and water emulsions (para [0028]; The present invention relates in particular to a process for preparing a stable emulsion/dispersion of an oil and an aqueous phase wherein a beta-glucans rich powder or granulate containing at least 12% by weight of beta-glucans having a molecular weight of more than 1,000,000 Daltons is added in a step-wise sequence to the oil phase or to a part of the oil phase and is mixed and dispersed, followed by addition of the aqueous phase at temperatures below 40 degrees C. with concomitant mixing and stirring to form an oil-in-water emulsion or a water-in-oil emulsion), and it would have been obvious to one of ordinary skill in the art to recognize that beta-glucan is suspendable in water or a hydrophilic fluid, during routine experimentation to identify the most desirable suspension.

Regarding claim 12, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the BG is suspended in an amphiphilic fluid. Nonetheless, Kvist teaches wherein beta-glucan can act as an emulsifier in oil and water emulsions (para [0028]; The present invention relates in particular to a process for preparing a stable emulsion/dispersion of an oil and an aqueous phase wherein a beta-glucans rich powder or granulate containing at least 12% by weight of beta-glucans having a molecular weight of more than 1,000,000 Daltons is added in a step-wise sequence to the oil phase or to a part of the oil phase and is mixed and dispersed, followed by addition of the aqueous phase at temperatures below 40 degrees C. with concomitant mixing and stirring to form an oil-in-water emulsion or a water-in-oil emulsion), and it would have been obvious to one of ordinary skill in the art to recognize that beta-glucan is suspendable in an amphiphilic fluid since beta-glucan itself is amphiphilic, during routine experimentation to identify the most desirable suspension.

— Continued in next Supplemental Box —

**WRITTEN OPINION OF THE
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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

— Supplemental Box — V.2 Citations and explanations —

Claim 13 lacks an inventive step under PCT Article 33(3) as being obvious over Wintershall 521 in view of US 2004/0258829 A1 to Zheng et al. (hereafter, Zheng).

Regarding claim 13, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein dilution is carried out at a shear rate of 40,000 s⁻¹ to 300,000 s⁻¹. Nonetheless, Zheng teaches wherein a concentrated beta glucan product can be shear mixed into water using high shear mixing (para [0177]; As a highly concentrated source of soluble dietary fiber, only 0.45% barley betafiber is needed to deliver 0.75 g beta-glucan per 8 oz serving; para [0181]; Slowly meter the barley betafiber into the vortex of vigorously agitated hot water to thoroughly disperse. This can be achieved using high shear mixing), and it is well known in the art that shear mixing can achieve up to 300,000 s⁻¹ (see US 4,946,702 A to Stipp et al. (hereafter, Stipp); col 6, ln 45-48; Typically, high shear treatment methods useful in the present invention impart shear rates to the concentrated orange juice of from about 300,000 to about 10,000,000 sec.⁻¹). Accordingly, it would have been obvious to one of ordinary skill in the art to choose to carry out the dilution at a shear rate of 40,000 s⁻¹ to 300,000 s⁻¹, during routine experimentation to identify the most desirable suspension.

Claims 14-15 lack an inventive step under PCT Article 33(3) as being obvious over Wintershall 521 in view of WO 2013/171137 A1 to Wintershall Holding GmbH (hereafter, Wintershall 137).

Regarding claim 14, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein dilution is carried out in salt water. Nonetheless, Wintershall 137 teaches wherein dried beta-glucan can be dissolved in salt water (pg 7, ln 11-15; In accordance with the method described and provided herein, after precipitation and, if applicable, after drying and/or swelling or steeping, the beta-glucan is re-dissolved in water. In this context, the water may be high-purity/ultrapure water ... Also, the water may contain further ions or particles), and it would have been obvious to one of ordinary skill in the art to recognize that similar to the redissolution, the beta-glucan suspension can be diluted with salt water, during routine experimentation to identify the most desirable suspension.

Regarding claim 15, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein dilution is carried out in fresh water. Nonetheless, Wintershall 137 teaches wherein dried beta-glucan can be dissolved in fresh water (pg 7, ln 11-15; In accordance with the method described and provided herein, after precipitation and, if applicable, after drying and/or swelling or steeping, the beta-glucan is re-dissolved in water. In this context, the water may be high-purity/ultrapure water), and it would have been obvious to one of ordinary skill in the art to recognize that similar to the redissolution, the beta-glucan suspension can be diluted with fresh water, during routine experimentation to identify the most desirable suspension.

Claim 9 meets the criteria set out under PCT Article 33 (2)-(3) because the prior art does not teach or fairly suggest the claimed invention.

Regarding claim 9, Wintershall 521 teaches the suspension of claim 1, but does not specifically teach wherein the BG is suspended in alcohol, and instead teaches away by indicating that BG precipitates in alcohol (pg 10, ln 24-30; the aqueous solution comprising at least one beta-glucan can be contacted with at least one precipitating agent to obtain at least one precipitated beta-glucan ... Preferably, the at least one precipitating agent is selected from the group consisting of low boiling liquids ... Examples of low boiling liquids are ... alcohols). Similarly, Vasanthan teaches wherein BG precipitates in alcohol (para [0029]; The purification of BBG from Viscofiber was based on a traditional aqueous technology as shown in FIG. 1. The method involved alkali extraction followed by enzymatic treatments. In brief, the steps involved were the solubilization of BBG in deionized Milli-Q water, treatment with thermostable alpha-amylase (added at a rate of 1%, w/w, of available starch in the sample), followed by the protein precipitation and subsequent alcohol-assisted precipitation of BBG).

The prior art does not teach individually nor fairly suggest in combination a beta-glucan suspension that is suspended in alcohol, and teaches away from that application.

Claims 1-18, 37-43 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

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(54) Title: PUMPABLE AND/OR FLOWABLE BIOPOLYMER SUSPENSION

(57) Abstract: Described herein is a pumpable and/or flowable suspension comprising about 10-60 wt% of beta glucan (BG) that when diluted achieves a filterability ratio less than about 1.5. Further described herein is a pumpable and/or flowable suspension comprising about 10-60 wt% of BG wherein greater than 50% of ultimate viscosity can be recovered after running specified dilution procedure for one pass and greater than 70% of ultimate viscosity after two passes.



WO 2017/214492 A2

PUMPABLE AND/OR FLOWABLE BIOPOLYMER SUSPENSION

TECHNICAL FIELD

[0001] The present invention relates to the preparation of a pumpable and/or flowable beta glucan suspension that achieves desired filterability and viscosity build for enhanced oil recovery applications.

BACKGROUND

[0002] Beta glucans are widely used as thickeners in enhanced oil recovery (EOR) applications. Particularly in off-shore applications, there is a desire to utilize such beta glucans, however given the limited amount of real estate it is desirable to receive the beta glucan in solid or suspended form, quickly solubilize or dilute using the water on hand and minimal equipment, wherein the solubilization/dilution procedure provides desirable properties, for example filterability and viscosity, necessary for enhanced oil recovery operations. The major drawback of scleroglucan polymer (a beta glucan) is its poor solubilization. Methods have been investigated and studied in this regard, however each of these methods have presented limitations.

BRIEF SUMMARY

[0003] Described herein is a pumpable and/or flowable suspension comprising about 10-60 wt% of beta glucan (BG) that when diluted, under specified dilution procedure, has a filterability ratio less than about 1.5. Further described herein is a pumpable and/or flowable suspension comprising about 10-60 wt% of BG wherein greater than 50% of ultimate viscosity can be recovered after running a specified dilution procedure for one pass and greater than 70% after two passes.

DEFINITIONS

[0004] "Flowable" is defined as a suspension that retains at least 80% of the beta glucan solids when transferred according to the Transfer Procedure. As described herein, the suspension is pumpable and/or flowable.

[0005] "Molecular Weight" is defined as the weight average molecular weight.

[0006] "Particle Size Distribution" is defined as the mass-median-diameter of the BG powder.

[0007] "Pumpable" is defined as a suspension having a viscosity ranging from 0.1 to 2 million cP at 70°C measured at 100 s⁻¹ of shear. As described herein, the suspension is pumpable and/or flowable.

[0008] “Solid” is defined as a solid (i.e., not a liquid or gas) at standard atmospheric conditions. For the avoidance of doubt, the term “solid” includes powders, pressed or wet cakes, and solids surrounded by an alcohol solution or hydrophobic liquid.

[0009] “Suspension” is defined as a stable or unstable, heterogeneous mixture of solid or semi-solid beta glucan particles and a carrier fluid.

[00010] “Ultimate Viscosity” is defined as the viscosity measured at a given shear rate after 6 passes through the specified dilution procedure.

DETAILED DESCRIPTION

[00011] Disclosed herein is a pumpable and/or flowable suspension of beta glucan, that when diluted, under a specified dilution procedure, builds viscosity faster than existing commercially available beta glucan materials, provides higher filterability with minimal processing than existing commercially available beta glucan materials, and maintains viscosity throughout filterability testing.

Beta Glucan Solid Material

[00012] The beta glucans (“BG”) described in the present invention include polysaccharides classified as 1,3 beta-D-glucans, i.e., any polysaccharide which has a beta-(1,3)-linked backbone of D-glucose residues, and modifications thereof.

[00013] Fungal strains which secrete such glucans are known to those skilled in the art. Examples comprise *Schizophyllum commune*, *Sclerotium rolfii*, *Sclerotium glaucum*, *Monilinia fructigena*, *Lentinula edodes* or *Botrytis cinerea*. The fungal strains used are preferably *Schizophyllum commune* or *Sclerotium rolfii*.

[00014] Examples of such 1,3 beta-D-glucans include curdlan (a homopolymer of beta-(1,3)-linked D-glucose residues produced from, e.g., *Agrobacterium spp.*), grifolan (a branched beta-(1,3)-D-glucan produced from, e.g., the fungus *Grifola frondosa*), lentinan (a branched beta-(1,3)-D-glucan having two glucose branches attached at each fifth glucose residue of the beta-(1,3)-backbone produced from, e.g., the fungus *Lentinus edodes*), schizophyllan (a branched beta-(1,3)-D-glucan having one glucose branch for every third glucose residue in the beta-(1,3)-backbone produced from, e.g., the fungus *Schizophyllum commune*), scleroglucan (a branched beta-(1,3)-D-glucan with one out of three glucose molecules of the beta-(1,3)-backbone being linked to a side D-glucose unit by a (1,6)-beta bond produced from, e.g., fungi of the *Sclerotium spp.*), SSG (a highly branched beta-(1,3)-glucan produced from, e.g., the fungus *Sclerotinia sclerotiorum*), soluble glucans from yeast (a beta-(1,3)-D-glucan with beta-(1,6)-linked side groups produced from, e.g., *Saccharomyces cerevisiae*), laminarin (a beta-(1,3)-glucan with

beta-(1,3)-glucan and beta-(1,6)-glucan side groups produced from, e.g., the brown algae *Laminaria digitata*), and cereal glucans such as barley beta glucans (linear beta-(1,3)(1,4)-D-glucan produced from, e.g., *Hordeum vulgare*, *Avena sativa*, or *Triticum vulgare*).

[00015] Preferably, 1,3–1,6 beta-D-glucans, i.e., beta glucans comprising a main chain from beta-1,3-glycosidically bonded glucose units and side groups which are formed from glucose units and are beta-1,6-glycosidically bonded thereto, and modifications are used herein. Examples of such beta glucans are scleroglucan and schizophyllan.

Pumpable And/Or Flowable Beta Glucan Suspension

[00016] In accordance with the present invention, solid beta glucan, as described above, may be included in a suspension to obtain a pumpable and/or flowable suspension of beta glucan.

[00017] The carrier fluid for the suspension can generally be any fluid that will suspend or partially a dispersion of solid beta glucan material. The beta glucan must not be readily soluble in the carrier fluid or the concentrated suspension may become too viscous (i.e., exceeds 2 million cP at 25°C). It is also desirable to limit the hydration characteristics of the carrier fluid to limit hydration of the beta glucan being suspended. It shall also be understood that the particle size of the beta glucan will impact viscosity and other properties of the suspension. Accordingly, in creating the suspension, there is a balance between having larger beta glucan particle size (which may aid in the flowability of the suspension) and perhaps selecting a smaller beta glucan particle size (which may aid in solubilization).

[00018] It shall be understood that the beta glucan suspension may be amphiphilic, hydrophobic, or hydrophilic. Five preferred types of suspensions are contemplated herein: (1) solid beta glucan material in an immiscible hydrophobic carrier, (2) mixture of solid beta glucan material and alcohol in a hydrophobic carrier, (3) mixture of alcohol, water, and solid beta glucan material in alcohol, (4) solid beta glucan material in a hydrophobic system with reintroduced water, or (5) solid beta glucan material dispersed in an alcohol.

[00019] Accordingly, in aspects of the present invention, the carrier fluid can include various alcohols (for example, butanol, heptane, hexane, octanol, pentanol, and isopropyl alcohol), glycols and glycol ethers such as ethylene glycol monobutyl ether (EGMBE), hexylene glycol, 2-methyl hexanol, propylene glycol n-butyl ether, ethylene glycol methyl ether, ethylene glycol ethyl ether, dipropylene glycol methyl ether, dipropylene glycol n-butyl ether, diethylene glycol ethyl ether, propylene glycol, diethylene glycol methyl ether, and the like.

[00020] Furthermore, the carrier fluid can include hydrophobic, non-water soluble organic liquids, particularly those having a Log K_0 value ranging from 0.1-10 and more preferably 0.3-8.5, wherein K_0 is the partition coefficient of a hydrophobic material in water. Examples of such hydrophobic liquids may be hydrocarbons such as alkenes (paraffins, isoparaffins) having the molecular formula C_nH_{2n+2} , alkenes (olefins, alpha olefins, polyalphaolefins) having the molecular formula C_nH_{2n} , various petroleum fractions such as mineral oils, diesel oil, white oils, and the like. Other water insoluble organic liquids which may be useful in this invention are terpenes, vegetable oils, carboxylic esters, malonic esters, sulfonic esters, limonene, alcohols containing 6 to 10 carbon atoms, and the like.

[00021] The carrier fluid can be in a single-phase system or a multi-phase system.

[00022] In the various aspects of the present invention, the suspension comprises about 10-60 wt% beta glucan, more preferably 20-50 wt%, more preferably 30-40 wt%, more preferably 35-45 wt%, and even more preferably 35-40 wt%. The suspension optionally can comprise one or more suspension, dispersing, or thinning agents and optionally may comprise a biocide.

Dilution of Suspension

[00023] The pumpable and/or flowable beta glucan suspension described herein has desirable properties for EOR applications. When diluted under specified dilution procedure (which is further described below) the beta glucan suspension achieves a filterability ratio less than about 1.5, and more preferably a filterability ratio less than about 1.2.

[00024] As to be understood, the specified dilution procedure generally involves dispersing the beta glucan suspension into an aqueous solution and subjecting said resulting solution to relatively high shear. Notably, the equipment and procedures utilized to dilute the beta glucan suspension are suitable for off shore EOR applications and accommodate the limited real estate typically available in off shore EOR applications.

[00025] Dilution of the beta glucan suspension can be carried out in either salt water or fresh water. Further, dilution may occur in pH conditions ranging from about 6 to about 8, and in temperature conditions ranging from about 10°C to 120°C, in preferred aspects from 80°C to 120°C, and in other preferred aspects from 20°C to about 40°C. Dilution is achieved via an in-line shear device at a shear rate of 100,000 s⁻¹ to 300,000 s⁻¹. The shear can be applied via many approaches known to one familiar in the art, including moving parts like a rotor-stator pair or a colloidal mixer or static devices like an orifice plate or a narrow tube with high velocity flow. To ensure adequate mixing between the beta glucan suspension and the water source, the

dilution can require between 1 and 6 passes through the shear device. Multiple passes, e.g., greater than one pass could be required if viscosity continues to rise, with final dilution occurring after a consistent or slightly dropping viscosity on two consecutive passes.

[00026] The beta glucan suspension described herein has a purity sufficient enough that greater than 42%, and in most aspects greater than 50% of ultimate viscosity can be recovered after running the specified dilution procedure for one pass and greater than 70% after two passes. In preferred aspects, greater than 60%, greater than 70%, and even greater than 80% of ultimate viscosity is achieved after running the specified dilution procedure for one pass. In additional preferred aspects, greater than 80%, and even greater than 90% of ultimate viscosity is achieved after running the specified dilution procedure for two passes.

[00027] Furthermore, the beta glucan suspension described herein achieves less than 15% viscosity loss during filtration, in preferred aspects has less than 10% viscosity loss, and in more preferred aspects less than 5% viscosity loss during filtration.

Surfactant Systems

[00028] Surfactants have previously been used in EOR applications to enhance overall oil recovery. Accordingly, the pumpable and/or flowable beta glucan suspension described herein may further include a surfactant. In preferred aspects, the surfactant is an anionic surfactant. Anionic surfactants are desirable because of their strong surfactant properties, they are relatively stable, they exhibit relatively low adsorption on reservoir rock, and can be manufactured economically. Typical anionic surfactants are sulfates for low temperature EOR applications and sulfonates, and more specifically sulfonated hydrocarbons, for high temperature EOR applications. Crude oil sulfonates is a product when a crude oil is sulfonated after it's been topped, petroleum sulfonates is a product when an intermediate-molecular-weight refinery stream is sulfonated, and synthetic sulfonates is a product when a relatively pure organic compound is sulfonated. These are all examples of surfactants that may be used herein. Cationic and nonionic surfactants, while not as desirable as anionic surfactants, may also be used primarily as a cosurfactants to improve the behavior of surfactant systems. The surfactant in the pumpable and/or flowable beta glucan suspension described herein may be generated prior to its inclusion into the pumpable and/or flowable beta glucan suspension or alternatively may be generated in situ. It shall also be understood that surfactant floods having a pH ranging from 9-10 are likely more compatible with the pumpable and/or flowable beta glucan suspension described herein.

MATERIALS & PROCEDURES

[00029] It shall be understood that the procedures described herein should be carried out at temperatures ranging from 20-30°C (except as otherwise noted).

Specified Dilution Procedure (to achieve dilution)

1. Prepare 30 g/l salt water solution, using deionized water and S9883 Sigma-Aldrich sea salts.
2. Use Pall stainless steel filter funnel (4280) to filter salt water through a 0.8 um EMD Millipore filter (AAWP04700) at 100-300 mL/min.
3. After filtering, check pH of salt water using a properly calibrated pH meter. Adjust to 7.0 using HCl or NaOH if outside of 6.0 to 8.0 pH range. Place salt water solution on a Fisher Scientific Isotemp mixing plate (S88857290) at 800 rpm. Add beta glucan suspension, wherein the beta glucan suspension has at target concentration of 1 g/L of BG, and allow it to stir for 5 minutes. (Note that if concentration at 1 g/L achieves less than 10 cP at 30 rpm after 6 passes, dilution should be rerun such that 10-100 cP is achieved after 6 passes)
4. At 26,000 rpm, feed solution through IKA® Magic Lab® Ultra-Turrax® Inline (UTL) module equipped with the 4M generator set.
5. Measure viscosity after removing air bubbles from solution, for example by letting sample sit or accelerating the separation with a centrifuge or similar device.
6. Continue running for up to 6 passes, or until consecutive passes demonstrate a stable viscosity or a slightly decreasing viscosity.
7. The elapsed time between the beginning of Step 4 and the end of Step 7 of the Specified Dilution Procedure should take between 30 minutes and 2 hours.

Filtration Procedure

1. Start with a diluted beta glucan suspension according to the Standard Dilution Procedure above. (note: the filtration procedure should be carried out on the resultant solution before microbes begin to form as microbial growth may negatively impact filtration)
2. Assemble Pall stainless steel filter housing (4280) with a 47 mm Millipore AP25 filter (AP2504700). Close exit of filter housing until ready to start flowing.
3. Pass solution through housing at 100-300 ml/min of flow
4. Assemble Pall stainless steel filter housing (4280) with a 47 mm, 1.2 µm filter, EMD

Millipore cellulosic-ester filter (part # RAWP04700), with >200 mL of solution.

5. Place a container on a mass balance for recording mass of material passing through filter.
6. Apply pressure to the filter.
7. Open exit of filter housing and target flux of 1-3 g/s, adjusting pressure as necessary.
8. Once flow is established, maintain constant pressure during filtration testing.
9. Record time to flow 60g, 80g, 160g, and 180g of solution through the filter using the balance.
10. Calculate filterability ratio using the filterability ratio equation : $\frac{Time(180g)-Time(160g)}{Time(80g)-Time(60g)}$
11. The elapsed time between the beginning of Step 4 of the Standard Dilution Procedure and the end of Step 9 of the Filtration Procedure should take between 30 minutes and 4 hours.

Viscosity Measurement

The following viscometer was used on the experiment to test viscosity.

1. Viscosity measurements were done on degassed samples using a Brookfield Ametek® LVT (spindle 1, 12, 30, and 60 rpm) viscometer, referenced as LVT.

Transfer Procedure

1. Agitate suspension with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to a RPM ranging from 500 - 2000 RPM with an IKA® R 1381 3-bladed impeller.
2. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation.
3. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.
4. Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the carrier fluid through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed.

5. Over 30 seconds uniformly rinse the cake with solvent while manually agitating the cake with a spatula while avoiding disturbing the filter. Stop once filtrate flow ceases and a wet cake is clearly formed.
6. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, transfer cake to an atmospheric oven at 150C for 14 to 20 hours. Remove the filter cake from the oven and weigh the dry cake and filter paper.
7. For the dried transferred solution calculate the mass concentration of solids to compare against initial solution.
8. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

EXAMPLES

Example 1: Production of Beta Glucan Material (Scleroglucan) Described Herein

[00030] Using a 5000 liter jacketed vessel with moderate agitation, 7 g/L of commercial Actigum CS6 from Cargill is added to 2400 liters of 11.8°C water and mixed for 1 hour. After an hour of mixing, the vessel is heated to 85°C and left under agitation for 12 hours without temperature control. After 12 hours the temperature is 41.3°C and the vessel is reheated to 80°C and passed through a Guerin homogenizer (ALM6; Series B 8250 30 000; Year 1998) at 200 bar of pressure and 300 l/hr.

[00031] The homogenized mixture is cooled to 50°C. 4 g/L of $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ was added. pH is reduced to 1.81 using 20% HCl. This mixture is agitated for 30 minutes to enable precipitation of oxalic acid.

[00032] After maturation, the solution is adjusted back to 5.62 pH using 10% Na_2CO_3 and heated to 85°C and left under agitation without temperature control for 14 hours the reheated to 80°C.

[00033] After reaching 80°C 20 g/L of Dicalite 4158 filter aid is added to the vessel and mixed for 10 minutes.

[00034] After mixing, the solution is fed to a clean Choquenot 12 m² press filter with Sefar Fyltris 25080 AM filter clothes at 1400 L/hr recycling the product back to the feed tank for 10 minutes. At the end of recycle, the flow is adjusted to 1300 L/hr and passed through the filter. Once the tank is empty an additional 50 liters of water is pushed into the filter. The fluid from this water flush and a 12 bar compression of the cake is both added to the collected permeate. The filter is cleaned after use.

[00035] The filtered permeate, water flush, and compression fluid is agitated and heated back to 80°C.

[00036] The heated mixture has 6 kg of Dicalite 4158 added and mixed for 10 minutes. At 1400 L/hr this solution is recycled through a clean Choquenot 12 m² press filter with Sefar Fyltris 25080 AM filter clothes at 1400 L/hr for 15 minutes. After the recycle, the tank is passed through the filter at 1400 L/hr.

[00037] Without cleaning the filter, 5.33 g/L of Clarcel® DICS and 6.667 g/L of Clarcel® CBL is added to the mixture and agitated for one hour while maintaining temperature at 80°C. This mixture is then recycled through the Dicalite coated Choquenot 12 m² press filter with Sefar Fyltris 25080 AM filter clothes at 1400 L/hr for 15 minutes. After the recycle, the tank is passed through the filter at 1350 L/hr. An additional 50 liters of flush water is pushed through the filter and collected as permeate as well. Compression fluid from the filter is not captured.

[00038] This twice filtered material is heated to 85°C and left agitated without temperature control for 14 hours. At this point the material is reheated to 80°C for a third filtration step.

The heated mixture has 6 kg of Dicalite 4158 added and mixed for 10 minutes. At 1400 L/hr this solution is recycled through a clean Choquenot 12 m² press filter with Sefar Fyltris 25080 AM filter clothes at 1400 L/hr for 15 minutes. After the recycle, the tank is passed through the filter at 1450 L/hr.

[00039] Without cleaning the filter, 5.33 g/L of Clarcel® DICS and 6.667 g/L of Clarcel® CBL is added to the mixture and agitated for one hour while maintaining temperature at 80°C. This mixture is then recycled through the Dicalite coated Choquenot 12 m² press filter with Sefar Fyltris 25080 AM filter clothes at 1600 L/hr for 15 minutes. After the recycle, the tank is passed through the filter at 1700 L/hr. An additional 50 liters of flush water is pushed through the filter and collected as permeate as well. Compression fluid from the filter is not captured.

[00040] The triple filtered permeate is cooled to 60°C and mixed with 83% IPA at a 1:2 ratio, 2 g IPA solution for each g of scleroglucan solution. This precipitates scleroglucan fibers which can be mechanical separated from the bulk solution. In this example, a tromel separator is used to partition the precipitated fibers from the bulk liquid solution.

[00041] After recovery of the fibers they are washed with another 0.5 g 83% IPA solution for each 1 g of initial triple filtered permeate scleroglucan solution.

[00042] Wash fibers are dried in an ECI dryer (Volume 100 litres; Type 911-10; Year 1987) with 95°C hot water for 1 hour and 13 minutes to produce a product with 89.3% dry matter. This material is ground up and sieved to provide powder smaller in size than 250

micron. This final ground scleroglucan material is the beta glucan material described herein and is used in some of the examples.

Example 2: 20% BG Suspension in Mineral Oil

[00043] A mineral oil suspension was made blending the beta glucan from example 1 and mineral oil (Sigma Aldrich M1180-4L). Mass measurements of both components were made and samples were manually stirred into a beaker to have 20% BG solids and 80% mineral oil.

[00044] Using the dilution procedure, put 1 gram per liter (g/L) BG or 5 g/L of suspension in solution. The suspension was stirred before measuring to ensure uniform distribution. After mixing, add solution to IKA® Magic Lab® in UTL configuration with a 4M rotor stator pair running unit at 26,000 rpm. Measure viscosity using LVT viscometer. Repeat processing through Magic Lab, measuring viscosity with LVT viscometer each pass for a total of 6 passes. Table 1 provides the results of the viscosity build, where viscosity build is average of measured viscosity divided by the viscosity after 6 passes through the unit.

[00045] The filterability ratio of the 6 pass material was 1.32.

Table 1

Pass	Average Viscosity Build	Viscosity Build Measured on Brookfield @12 rpm	Viscosity Build Measured on Brookfield @30 rpm	Viscosity Build Measured on Brookfield @60 rpm
1	88%	93%	87%	86%
2	113%	122%	112%	105%
3	106%	111%	106%	103%
4	104%	107%	102%	101%
5	102%	104%	102%	100%
6	100%	100%	100%	100%
After Filtration	102%	107%	100%	97%

Example 3: 40% BG Suspension in Mineral Oil

[00046] A mineral oil suspension was made blending the beta glucan from example 1 and mineral oil (Sigma Aldrich M1180-4L). Mass measurements of both components were made and samples were manually stirred into a beaker to have 40% BG solids and 60% mineral oil.

[00047] Using the solubilization procedure, put 1 gram per liter (g/L) BG or 2.5 g/L of suspension in solution. The suspension was stirred before measuring to ensure uniform distribution. After mixing, add solution to IKA® Magic Lab® in UTL configuration with a 4M rotor stator pair running unit at 26,000 rpm. Measure viscosity using LVT viscometer. Repeat processing through Magic Lab, measuring viscosity with LVT viscometer each pass for a total of 6 passes. Table 2 provides the results of the viscosity build, where viscosity build is average of measured viscosity divided by the viscosity after 6 passes through the unit.

[00048] The filterability ratio of the 6 pass material was 1.12.

Table 2

Pass	Average Viscosity Build	Viscosity Build Measured on Brookfield @12 rpm	Viscosity Build Measured on Brookfield @30 rpm	Viscosity Build Measured on Brookfield @60 rpm
1	76%	75%	75%	77%
2	109%	114%	108%	104%
3	108%	112%	107%	104%
4	104%	105%	104%	102%
5	102%	102%	102%	103%
6	100%	100%	100%	100%
After Filtration	96%	96%	96%	97%

Example 4: 35% BG Suspension in 90% n-Butanol / 10% Water

[00050] Prepare a suspension using material from Example 3, n-Butanol, and water. Place 2.7 grams of a mixture of 90% butanol and 10% water by mass are put into an ASTM-E960 low form 20 mL beaker. Add 1.44 grams of BG to beaker and stir to create a 35% suspension.

[00051] Using the dilution procedure, measure out 2g/kg NaCl to put the entire suspension in solution at a concentration of 1 g/L of the BG. After dumping material, use a pipette to rinse any residual suspension from the stir rod and beaker to ensure the entire mass of BG is used. After mixing, add solution to IKA® Magic Lab® in UTL configuration with a 4M rotor stator pair running unit at 16,000 rpm. After each pass centrifuge solution and measure

viscosity on Brookfield LVT. Repeat processing through Magic Lab and sampling for viscosity for the first 3 passes and the 6th, 9th, and 12th pass. Table 3 provides the results of the viscosity build. Ultimate viscosity is achieved after 6 passes.

Based on rotor geometry and 10,000 rpm the system shear is around 105,000 s⁻¹.

Table 3 - Ultimate Viscosity determination

Solution	6 RPM	12 RPM	30 RPM	60 RPM
1st pass	125%	110%	98%	97%
2nd pass	131%	110%	100%	101%
3rd pass	119%	110%	103%	101%
6th pass (Ultimate)	100%	100%	100%	100%
9th pass	106%	100%	95%	100%
12th pass	88%	90%	97%	99%
After Filtration	106%	97%	98%	99%

Filterability of material after 12 passes using the filterability procedure was 1.15.

Example 5: Flowability of 35% Actigum® CS11 in n-Heptane

[00052] In a 600 mL low form ASTM E960 beaker, add 61.3g of Actigum® CS11 to 113.8g of n-Heptane, a 35% solution (Note: Actigum® CS11 was used because of limited beta glucan material available made according to Example 1 and because CS11's flowability performance is substantially similar to the beta glucan material made according to Example 1 and described and claimed herein. This is the case for all Examples herein utilizing Actigum ® CS11). Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 658 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer

approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[00053] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (n-heptane) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 80C for drying. After two hours, remove the filter cake from the oven. Weigh the dry cake and filter paper.

[00054] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[00055] The measured masses are:

[00056] Transferred solution : 149.1 grams

[00057] Filter paper : 0.9 grams

[00058] Dried transferred solution + paper : 51.1 grams

[00059] Recovered mass fraction : 34%

[00060] The measured solids fraction of the transferred solution is 34% and in the initial solution is 35%. This is a measured recovery of 97%.

Example 6: Flowability of 35% Actigum® CS11 in n-Hexane

[00061] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.8g of n-Hexane, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 658 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[00062] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass

some of the solvent (n-hexane) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 80C for drying. After two hours, remove the filter cake from the oven. Weigh the dry cake and filter paper.

[00063] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: $(\text{mass of dry cake} + \text{paper} - \text{mass of dry paper}) / (\text{mass of solution})$.

[00064] The measured masses are:

[00065] Transferred solution : 146.9 grams

[00066] Filter paper : 0.9 grams

[00067] Dried transferred solution + paper : 51.6 grams

[00068] Recovered mass fraction : 35%

The measured solids fraction of the transferred solution is 35% and in the initial solution is 35%. This is a measured recovery of 100%.

Example 7: Flowability of 35% Actigum® CS11 in n-Octanol

[00069] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.9g of n-Octanol, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 610 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[00070] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H2O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (n-octanol) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[00071] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[00072] The measured masses are:

[00073] Transferred solution : 135 grams

[00074] Filter paper : 0.9 grams

[00075] Dried transferred solution + paper : 44.3 grams

[00076] Recovered mass fraction : 32%

The measured solids fraction of the transferred solution is 32% and in the initial solution is 35%. This is a measured recovery of 91%.

Example 8: Flowability of 35% Actigum® CS11 in n-Pentanol

[00077] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.9g of n-pentanol, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 610 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[00078] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (n-pentanol) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[00079] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[00080] The measured masses are:

[00081] Transferred solution : 137.1 grams

[00082] Filter paper : 0.9 grams

[00083] Dried transferred solution + paper : 45.5 grams

[00084] Recovered mass fraction : 33%

The measured solids fraction of the transferred solution is 33% and in the initial solution is 35%. This is a measured recovery of 94%.

Example 9: Flowability of 35% Actigum® CS11 in isopropyl alcohol

[00085] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.8g of isopropyl alcohol, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 531 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[00086] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (isopropyl alcohol) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[00087] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[00088] The measured masses are:

[00089] Transferred solution : 137.6 grams

[00090] Filter paper : 0.9 grams

[00091] Dried transferred solution + paper : 45.1 grams

[00092] Recovered mass fraction : 32%

The measured solids fraction of the transferred solution is 32% and in the initial solution is 35%. This is a measured recovery of 91%.

Example 10: Flowability of 35% Actigum® CS11 in n-Butanol

[00093] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.9g of n-butanol, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 655 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[00094] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (n-butanol) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[00095] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[00096] The measured masses are:

[00097] Transferred solution : 135.2 grams

[00098] Filter paper : 0.9 grams

[00099] Dried transferred solution + paper : 45.6 grams

[000100] Recovered mass fraction : 33%

The measured solids fraction of the transferred solution is 33% and in the initial solution is 35%. This is a measured recovery of 94%.

Example 11: Flowability of 35% Actigum® CS11 in mineral oil

[000101] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.8g of Sigma-Aldrich® M1180 mineral oil, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 951 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[000102] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some n-heptane solvent through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed. Over 30 seconds uniformly rinse the cake with 100 mL of n-heptane solvent to pass mineral oil through the filter paper. Stop once filtrate flow ceases and a wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, transfer cake to an atmospheric oven at 150C for 14 to 20 hours. Remove the filter cake from the oven and weigh the dry cake and filter paper.

[000103] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[000104] The measured masses are:

[000105] Transferred solution : 129.6 grams

[000106] Filter paper : 0.9 grams

[000107] Dried transferred solution + paper : 41.6 grams

[000108] Recovered mass fraction : 31%

The measured solids fraction of the transferred solution is 31% and in the initial solution is 35%. This is a measured recovery of 88%.

Example 12: Flowability of 35% Actigum® CS11 in Tween® 20

[000109] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.9g of Tween® 20, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 733 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[000110] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some n-heptane solvent through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed. Over 30 seconds uniformly rinse the cake with 5 mL of heptane and 100 mL of n-pentanol solvent while manually agitating the cake with a spatula while avoiding disturbing the filter to pass twent through the filter paper. Stop once filtrate flow ceases and a wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, transfer cake to an atmospheric oven at 150C for 14 to 20 hours. Remove the filter cake from the oven and weigh the dry cake and filter paper.

[000111] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: $(\text{mass of dry cake} + \text{paper} - \text{mass of dry paper}) / (\text{mass of solution})$.

[000112] The measured masses are:

[000113] Transferred solution : 106 grams

[000114] Filter paper : 0.9 grams

[000115] Dried transferred solution + paper : 32.8 grams

[000116] Recovered mass fraction : 30%

The measured solids fraction of the transferred solution is 30% and in the initial solution is 35%. This is a measured recovery of 85%.

Example 13: Flowability of 35% Actigum® CS11 in Dipropylene glycol methyl ether

[000117] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.8g of Sigma-Aldrich® 283282 dipropylene glycol monomethyl ether (DPGME), a 35% solution.

Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 693 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[000118] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some n-heptane solvent through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed. Over 30 seconds uniformly rinse the cake with 100 mL of n-heptane solvent to clear high boiling point DPGME through the filter paper. Stop once filtrate flow ceases and a wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, transfer cake to an atmospheric oven at 150C for between 14 to 20 hours. Remove the filter cake from the oven and weigh the dry cake and filter paper.

[000119] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: $(\text{mass of dry cake} + \text{paper} - \text{mass of dry paper}) / (\text{mass of solution})$.

[000120] The measured masses are:

[000121] Transferred solution : 137.1 grams

[000122] Filter paper : 0.9 grams

[000123] Dried transferred solution + paper : 44.3 grams

[000124] Recovered mass fraction : 32%

The measured solids fraction of the transferred solution is 32% and in the initial solution is 35%. This is a measured recovery of 91%.

Example 14: Flowability of 65% Actigum® CS11 in n-Heptane

[000125] In a 600 mL low form ASTM E960 beaker, add 113.8g of CS11 to 61.3g of n-heptane, a 65% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 951 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of

a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and attempt to transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet.

[000126] Due to the high level of solids in the solution, the pump was unable to transfer the solution to the other beaker, plugging after only a small amount of solution was pumped.

Example 15: Flowability of 55% Actigum® CS11 in n-Heptane

[000127] In a 600 mL low form ASTM E960 beaker, add 96.3g of CS11 to 78.8g of n-heptane, a 55% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 950 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[000128] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (n-heptane) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[000129] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[000130] The measured masses are:

[000131] Transferred solution : 103.7 grams

[000132] Filter paper : 0.9 grams

[000133] Dried transferred solution + paper : 50.2 grams

[000134] Recovered mass fraction : 48%

The measured solids fraction of the transferred solution is 48% and in the initial solution is 55%.
This is a measured recovery of 87%.

Example 16: Flowability of 45% Actigum® CS11 in n-Butanol

[000135] In a 600 mL low form ASTM E960 beaker, add 78.8g of CS11 to 96.4g of n-butanol, a 45% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 804 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[000136] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (n-butanol) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[000137] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[000138] The measured masses are:

[000139] Transferred solution : 138.1 grams

[000140] Filter paper : 0.9 grams

[000141] Dried transferred solution + paper : 55.8 grams

[000142] Recovered mass fraction : 40%

The measured solids fraction of the transferred solution is 40% and in the initial solution is 45%.
This is a measured recovery of 88.9%.

Example 17: Flowability of 40% Actigum® CS11 in n-Butanol

[000143] In a 600 mL low form ASTM E960 beaker, add 70g of CS11 to 105g of n-butanol, a 40% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 654 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[000144] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (n-butanol) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[000145] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: $(\text{mass of dry cake} + \text{paper} - \text{mass of dry paper}) / (\text{mass of solution})$.

[000146] The measured masses are:

[000147] Transferred solution : 148 grams

[000148] Filter paper : 0.9 grams

[000149] Dried transferred solution + paper : 55.4 grams

[000150] Recovered mass fraction : 37%

The measured solids fraction of the transferred solution is 37% and in the initial solution is 40%. This is a measured recovery of 92.5%.

Example 18: Flowability of 35% Actigum® CS11 in 90% n-Butanol and 10% H₂O

[000151] In a 600 mL low form ASTM E960 beaker, add 61.3g of CS11 to 113.8g of 90% n-butanol and 10% water solvent, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 633 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom.

Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[000152] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (90% n-butanol / 10% water) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[000153] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: (mass of dry cake + paper – mass of dry paper)/(mass of solution).

[000154] The measured masses are:

[000155] Transferred solution : 125.1 grams

[000156] Filter paper : 0.9 grams

[000157] Dried transferred solution + paper : 40.5 grams

[000158] Recovered mass fraction : 32%

The measured solids fraction of the transferred solution is 32% and in the initial solution is 35%. This is a measured recovery of 91%.

Example 19: Flowability of 30% Beta Glucan as Described in Example 1 in 90% n-Butanol and 10% H₂O

[000159] In a 600 mL low form ASTM E960 beaker, add 70g of scleroglucan as described in Example 1 to 105g of 90% n-butanol and 10% water solvent, a 35% solution. Agitate the solution with an IKA® Eurostar Power Control-Visc (PWR CV S1) set to 1979 RPM with an IKA® R 1381 3-bladed impeller. Mount the bottom of the impeller blade in the middle of the beaker 8.5mm above the bottom. Connect the middle of a 50" Masterflex® Tygon LFL 0.25" diameter tubing to a Masterflex® Variable-Speed Drive model EW-07559-00 pump. Place one end of the tube in the suspension above the base of the beaker and just below the bottom of the

agitator and the other in a second empty 600 mL beaker such that the two beakers are level and on the same elevation. Turn the pump on to a setting of 7 and transfer approximately 135 grams of solution, stopping as soon as liquid drops below the bottom of the agitator but still covers the tubing inlet. Measure the mass of solution.

[000160] Weigh and put a Whatman® #4 125mm filter paper into a Coors® 60246 Buchner funnel under 4" H₂O vacuum such that filtrate is pulled into the collection flask. Pass some of the solvent (90% n-butanol and 10% H₂O) through the filter to wet the paper. Pour the transferred solution into the Buchner funnel and continue to pull vacuum until no more filtrate flow is observed, wet cake is clearly formed. Recover the wet cake and filter paper and put into a 20 mmHg vacuum oven at 150C for drying. After two hours, remove the filter cake from the oven and weigh the dry cake and filter paper.

[000161] For the dried transferred solution calculate the mass concentration of solids to compare against initial solution. Calculations are done by comparing mass of solids to the mass of solution: $(\text{mass of dry cake} + \text{paper} - \text{mass of dry paper}) / (\text{mass of solution})$.

[000162] The measured masses are:

[000163] Transferred solution : 130.9 grams

[000164] Filter paper : 0.9 grams

[000165] Dried transferred solution + paper : 37.3 grams

[000166] Recovered mass fraction : 28%

The measured solids fraction of the transferred solution is 28% and in the initial solution is 30%. This is a measured recovery of 93%.

CLAIMS

1. A suspension comprising about 10-60 wt% of beta glucan (BG), that when diluted achieves a filterability ratio less than about 1.5.
2. The suspension of claim 1, wherein the BG is 1,3 beta glucan.
3. The suspension of claim 2, wherein the BG is 1,3–1,6 beta glucan.
4. The suspension of claim 2, wherein the BG is 1,3–1,4 beta glucan.
5. The solid of claim 1, wherein the BG is scleroglucan.
6. The solid of claim 1, wherein the BG is schizophyllan.
7. The suspension of claim 1, wherein the filterability ratio is less than about 1.2.
8. The suspension of claim 1, wherein the viscosity of the suspension ranges from 0.1 to 2 million cP at 70°C measured at 100 s⁻¹ of shear.
9. The suspension of claim 1, wherein the BG is suspended in alcohol.
10. The suspension of claim 1, wherein the BG is suspended in a hydrophobic fluid.
11. The suspension of claim 1, wherein the BG is suspended in a hydrophilic fluid.
12. The suspension of claim 1, wherein the BG is suspended in an amphiphilic fluid.
13. The suspension of claim 1, wherein dilution is carried out at a shear rate of 40,000 s⁻¹ to 300,000 s⁻¹.
14. The suspension of claim 1, wherein dilution is carried out in salt water.
15. The suspension of claim 1, wherein dilution is carried out in fresh water.
16. The suspension of claim 1, wherein the suspension is pumpable.

17. The suspension of claim 1, wherein the suspension is flowable.
18. The suspension of claim 1, wherein the suspension is pumpable and flowable.
19. A suspension comprising about 10-60 wt% of beta glucan (BG) wherein greater than 50% of ultimate viscosity can be recovered after running specified dilution procedure for one pass and greater than 70% of ultimate viscosity after two passes.
20. The suspension of claim 19, wherein greater than 60% of ultimate viscosity can be recovered after one pass.
21. The suspension of claim 19, wherein greater than 70% of ultimate viscosity can be recovered after running specified dilution procedure for one pass.
22. The suspension of claim 19, wherein greater than 80% of ultimate viscosity can be recovered after running specified dilution procedure for one pass.
23. The suspension of claim 19, wherein greater than 80% of ultimate viscosity can be recovered after running specified dilution procedure for two passes.
24. The suspension of claim 19, wherein greater than 90% of ultimate viscosity can be recovered after running specified dilution procedure for two passes.
25. The suspension of claim 19, wherein the filterability ratio of the diluted suspension is less than about 1.2.
26. The suspension of claim 19 wherein the BG is 1,3 beta glucan.
27. The suspension of claim 26 wherein the BG is 1,3–1,6 beta glucan.
28. The suspension of claim 26 wherein the BG is 1,3–1,4 beta glucan.
29. The suspension of claim 19, wherein the BG is scleroglucan.
30. The suspension of claim 19, wherein the BG is schizophyllan.

31. The suspension of claim 19, wherein dilution is carried out at a shear rate of 40,000 s⁻¹ to 300,000 s⁻¹.
32. The suspension of claim 19, wherein dilution is carried out in salt water.
33. The suspension of claim 19, wherein dilution is carried out in fresh water.
34. The suspension of claim 19, wherein the suspension is pumpable.
35. The suspension of claim 19, wherein the suspension is flowable.
36. The suspension of claim 19, wherein the suspension is pumpable and flowable.
37. A suspension comprising about 10-60 wt% of beta glucan (BG) that when diluted achieves less than 10% viscosity loss during filtration.
38. The suspension of claim 37 wherein the BG is 1,3 beta glucan.
39. The suspension of claim 38 wherein the BG is 1,3–1,6 beta glucan.
40. The suspension of claim 38 wherein the BG is 1,3–1,4 beta glucan.
41. The suspension of claim 37, wherein the suspension is pumpable.
42. The suspension of claim 37, wherein the suspension is flowable.
43. The suspension of claim 37, wherein the suspension is pumpable and flowable.