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DESCRIPTION

FIELD OF THE INVENTION

[0001] Described herein are plaster compositions comprising specific foaming agent compositions, plasterboards obtained using said plaster compositions, and methods for the manufacture of said plasterboards.

BACKGROUND OF THE INVENTION

[0002] Plasterboard or drywall is a panel made of gypsum, which is typically used in the construction of walls and ceilings. Fig. 1 illustrates a part of a typical process for the manufacture of plasterboard. A bottom liner, facer, or facing sheet (2) is rolled from a lower supply roll (not shown) onto one or more forming tables (1) moving in the direction of the dotted arrow. Plaster slurry (3) is prepared in a mixer (not shown) and is subsequently deposited on the forming table (1) via one or more outlets or boots (4) of the mixer. In order to reduce the plasterboard weight, the slurry typically comprises foam, resulting in the presence of voids (bubbles) in the core. In order to obtain good quality plasterboards, the foam should have a good stability and have a sufficiently large volume. An upper facing sheet (5) is rolled from an upper supply roll (not shown) in the direction of the dashed arrow and applied to the slurry (3) as it moves to an extruder plate (7), thus shaping the slurry into a panel which is sandwiched by the facing sheets (2, 5). The plaster in the slurry is allowed to react with the water in the slurry to form gypsum (calcium sulfate dihydrate). This is known as "setting". Then, the excess water is removed via drying in a kiln (not shown).

[0003] As the extruder plate (7) forms a pinch point for the slurry, an accumulation of slurry (6) can typically be observed upstream of the extruder plate (7). This slurry accumulation is typically referred to as the "head" of the slurry. During the process, it is important to keep the height or size of the head stable. Indeed, instabilities of the head can lead to voids in the plasterboard core and/or density variations, thus leading to a plasterboard with surface defects or a plasterboard with a lack of matter in the edge or plasterboard having a reduced strength. Instabilities of the head can lead also to a facing sheet break and a decrease of the machine productivity. The stability and uniformity of the head may be improved using specific board forming devices, such as described in US patent 8,834,145. Moreover, the head of the slurry is typically monitored continuously via a monitoring system, and a number of process parameters are continuously adapted based on feedback from the monitoring system.

[0004] Nevertheless, it is preferred that adaptations to the process parameters are kept to a minimum. Accordingly, there remains a need for solutions for improving the control of the head of the slurry. The solutions should still allow for obtaining a good foam volume, foam stability, and/or plasterboard strength.

[0005] WO2004083146 describes an acoustical panel made of plaster using a foaming agent which comprises a mixture of alkyl ether sulfate and alkyl sulfate and 10 wt% of stabilizers made of amido amine type of amine oxide.

[0006] EP1328485 describes a light plasterboard composition made with a foaming agent comprising alkyl sulfate and presenting good mechanical properties.

SUMMARY OF THE INVENTION

[0007] The present inventors have found that plaster slurries comprising a combination of with one or more amine oxides and one or more alkyl sulfate can allow for improving the stability of the head of the slurry in the production of plasterboard. Moreover, it was found that in particular embodiments, an improved foam volume (foamability) and foam stability can be obtained, and even the compressive strength of the resulting plasterboards may be improved. The plaster slurries described herein may further allow for the manufacture of plasterboards of which the surface has a better appearance (less blisters).

[0008] The present application is defined in the appended claims.

[0009] The above and other characteristics, features and advantages of the present invention will become apparent from the following detailed description which illustrates, by way of example, the principles of the invention. This description is given for the sake of example only, without limiting the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying Figure is provided by way of example only and should not be considered to limit the scope of the present invention.

[0011] **Fig. 1** Schematic illustration of a part of a process for the manufacture of plasterboard.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The present invention will be described with respect to particular embodiments.

[0013] It is to be noticed that the term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It is thus to be interpreted as specifying the presence of the stated features, steps or components as referred to, but does not preclude the presence or addition of one or

more other features, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

[0014] Throughout this specification, reference to "one embodiment" or "an embodiment" are made. Such references indicate that a particular feature, described in relation to the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, though they could. Furthermore, the particular features or characteristics may be combined in any suitable manner in one or more embodiments, as would be apparent to one of ordinary skill in the art. The following terms are provided solely to aid in the understanding of the invention.

[0015] When reference is made to weight percentage (wt%), this is to be understood, unless differently specified, as the weight of the component expressed as percentage over the total weight of the composition in which the component is present.

[0016] The term "gypsum" as used herein refers to calcium sulfate dihydrate (DH), i.e. $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. Gypsum which is present in plasterboards typically is obtained via the hydration of plaster.

[0017] The term "plaster" or "stucco" as used herein and in the generally accepted terminology of the art, refers to a partially dehydrated gypsum of the formula $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$, where x can range from 0 to 0.6. The term "plaster" is also referred to herein as "hydratable calcium sulfate". The term "dry weight" when referred to plaster in a plaster composition, refers to the weight of the calcium sulfate including hydration water (i.e. the $x\text{H}_2\text{O}$ of the above formula), but excluding any gauging water in the composition. Plaster can be obtained via the calcination of gypsum, i.e. the thermal treatment of gypsum in order to remove (a part of) the combined water. For the preparation of plaster, natural or synthetic gypsum may be used. Natural gypsum may be obtained from gypsum rock or gypsum sand. Synthetic gypsum typically originates from flue gas desulfurization (FGD) or phosphoric acid production.

[0018] Plaster wherein x is 0.5 is known as "calcium sulfate hemihydrate" (HH) or "calcium sulfate semihydrate" (SH), i.e. $\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O}$. Calcium sulfate HH can occur in different crystalline forms; known as α and β . Calcium sulfate HH is also known as "gypsum plaster" or "plaster of Paris".

[0019] Plaster wherein x is 0 is known as "calcium sulfate anhydrite" or "anhydrous calcium sulfate". "Calcium sulfate anhydrite III" (AIII) refers to a dehydrated HH with the potential of reversibly absorbing water or vapor. "Calcium sulfate anhydrite II" (AII) refers to the completely dehydrated calcium sulfate (CaSO_4). AII is formed at higher temperatures and is preferably not used for the preparation of plasterboard.

[0020] The terms "plasterboard" and "gypsum board" as used herein interchangeably and refer to a panel or board comprising a gypsum core, obtainable from a plaster slurry as described herein.

[0021] Accordingly, the term "plasterboard" refers to a board or panel which is obtainable via the setting (hydration) of plaster. The term "board" or "panel" as used herein refers to any type of wall, ceiling or floor component of any required size.

[0022] The term "alkyl" by itself or as part of another substituent, refers to a linear or branched saturated hydrocarbon group joined by single carbon-carbon bonds.

When a subscript is used herein following a carbon atom, the subscript refers to the number of carbon atoms that the named group may contain. Thus, for example, C₁₋₄alkyl means an alkyl of one to four carbon atoms. Examples of C₁₋₄alkyl groups are methyl, ethyl, propyl, isopropyl, butyl, isobutyl and tert-butyl.

The term "aryl", by itself or as part of another substituent, refers to a polyunsaturated, aromatic hydrocarbonyl group having a single ring (i.e. phenyl) or multiple aromatic rings fused together (e.g. naphthalene), or linked covalently; wherein at least one ring is aromatic. Typical aryl groups may contain 6 to 14 carbon atoms and are referred to as "C₆₋₁₄aryl". Aryl rings may be unsubstituted or substituted with from 1 to 4 substituents on the ring. Aryl may be substituted with halo, cyano, nitro, hydroxy, carboxy, amino, acylamino, alkyl, heteroalkyl, haloalkyl, phenyl, aryloxy, alkoxy, heteroalkoxy, carbamyl, haloalkyl, methylenedioxy, heteroaryloxy, or any combination thereof. Examples of C₆₋₁₀aryl include phenyl, naphthyl, indanyl, or 1,2,3,4-tetrahydro-naphthyl.

The term "arylene" by itself or as part of another substituent, refers to aryl groups that are divalent, i.e., with two single bonds for attachment to two other groups. For example, the term "C₁₋₆alkylC₆₋₁₀arylene", by itself or as part of another substituent, refers to a C₆₋₁₀aryl group as defined herein, wherein a hydrogen atom is replaced by a C₁₋₆alkyl as defined herein.

The term "aqueous" as used herein means that more than 50 wt% of the solvent of a solution is water, preferably more than 90 wt% of the solvent is water. The remainder of the solvent may be selected from alcohols or other solvents. Most preferably, the term "aqueous" means that the solvent is water.

The term "about" as used herein when referring to a measurable value such as a parameter, an amount, a temporal duration, and the like, is meant to encompass variations of +/-10% or less, preferably +/-5% or less, more preferably +/-1% or less, and still more preferably +/-0.1% or less of and from the specified value, insofar such variations are appropriate to perform in the disclosed invention. It is to be understood that the value to which the modifier "about" refers is itself also specifically, and preferably, disclosed.

[0023] Provided herein are plaster compositions suitable for the preparation of plasterboards. The plaster compositions provided herein are characterized in that they comprise a specific foaming agent composition, which was found to improve the stability of the head of the slurry in the production of plasterboard. In particular embodiments, the foaming agent compositions may provide improved foam properties such as foam volume and foam stability. Moreover, the

plaster compositions described herein may allow for an improved compressive strength of the resulting plasterboard.

More particularly, provided herein is a plaster composition comprising plaster, water, and a foaming agent composition; wherein the foaming agent composition comprises one or more foaming agents (also referred to herein as "surfactants") selected from the list consisting of alkyl sulfate; and one or more amine oxides. This will be explained further below.

The plaster composition or slurry described herein comprises plaster, (gauging) water, and a foaming agent composition as described above. The plaster composition typically is a plaster slurry.

[0024] The plaster composition described herein comprises plaster and water as its main components. Typically, the sum of plaster and water forms at least 90 wt% of the plaster composition, preferably at least 95 wt%, or even at least 98 wt%.

In preferred embodiments, the plaster composition will have a water/plaster ratio between 0.50 and 1.00. The water/plaster ratio refers to the weight of (free) water in the plaster composition divided by the dry weight of plaster in the plaster composition. With "free water" is meant all water which is not part of the hydrate, which typically corresponds to the gauging water. In preferred embodiments, the plaster composition described herein has a water/plaster ratio below 0.80. In further embodiments, the plaster composition has a water/plaster ratio below 0.75, below 0.70, below 0.65, or even below 0.60. When a low water/plaster ratio is desired, the plaster composition will typically comprise a fluidizer, as is known in the art.

The plaster contained in the plaster composition is a hydratable calcium sulfate, such as calcium sulfate hemihydrate. Preferably, the plaster contains at least 70 wt% calcium sulfate hemihydrate, or even at least 85 wt% calcium sulfate hemihydrate. The calcium sulfate hemihydrate may be in its α or β form, and preferably in the β form. The plaster is typically provided in powder form, as is known in the art.

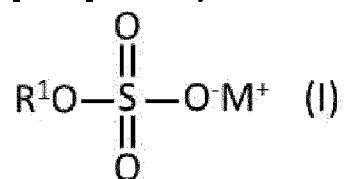
[0025] In addition to the water and plaster, the plaster composition described herein further comprises a foaming agent composition as described above. Accordingly, the plaster composition described herein comprises a mixture of plaster; water; one or more amine oxides; and one or more foaming agents selected from the list consisting of alkyl sulfate. Such foaming agents are used as surfactants in various technologies, and methods for the preparation of such foaming agents are well known.

[0026] Suitable cations which bind to the sulfonic groups are known in the art and include, but are not limited to, Na^+ , Mg^{2+} , K^+ , ammonium, and organic derivatives of ammonium such as monoethanolamine, diethanolamine, and triethanolamine. These cations are generally capable of generating foaming agents having an adequate water solubility. The skilled person will understand that bivalent cations such as Mg^{2+} will be associated with two sulfonic groups. In particular embodiments, ammonium (NH_4^+), Na^+ , or a mixture thereof is used.

[0027] The foaming agent is used for the manufacture of a foamed plaster composition, i.e. a plaster composition comprising (air) bubbles, as is known in the art. Accordingly, the plaster

composition described herein is typically foamed.

[0028] The alkyl sulfate is a compound of Formula (I):



wherein M^+ is a cation and

R^1 is a linear C_{8-12} alkyl.

[0029] Preferred cations M^+ include, but are not limited to: Na^+ ; K^+ ; ammonium, organic derivatives of ammonium such as monoethanolamine, diethanolamine, and triethanolamine.

Particularly preferred cations are Na^+ and ammonium.

In particular embodiments, the foaming agent composition may comprise a plurality of compounds of Formula (I), having different R^1 and/or M^+ .

Advantageously, the foaming agents of the foaming agent composition may comprise a mixture of n-octyl sulfate, n-decyl sulfate, and n-dodecyl sulfate. Combinations of these foaming agents can further improve the compressive strength of the resulting plasterboard. In particular embodiments, the one or more foaming agents comprise a mixture of sodium n-octyl sulfate, sodium n-decyl sulfate, and sodium n-dodecyl sulfate.

[0030] In particular embodiments, the plaster composition may comprise one or more other foaming agents other than an alkyl sulfate. In the present description, these other foaming agents (if present) will not be considered part of the foaming agent composition; in particular when referring to concentrations of foaming agents and amine oxides in the foaming agent composition. If present, the other foaming agents preferably are present in an amount less than 10 wt%, and preferably less than 5 wt%, with respect to the total amount of alkyl sulfates present in the plaster composition.

In other embodiments, the plaster composition does not comprise any other foaming agents than the foaming agents of the foaming agent composition. For example, the plaster composition may be essentially free of alkylethercarboxylates, ethoxylated alkylphenols, alkylpolysaccharides, and alkylsulfosuccinates. In particular embodiments, the plaster composition may further be essentially free of alkyl sulfonates, alkylether sulfonates, or alkylarylene sulfonates. In particular embodiments, the total amount of foaming agents selected from the group consisting of alkylethercarboxylates, ethoxylated alkylphenols, alkylpolysaccharides, alkylsulfosuccinates, alkyl sulfonates, alkylether sulfonates, and alkylarylene sulfonates; forms less than 0.1 wt% of the plaster composition.

In preferred embodiments, the one or more foaming agents comprise one or more alkyl sulfates. The present inventors found that the combination of alkyl sulfates with amine oxides provided particularly good results. In further embodiments, the foaming agent composition

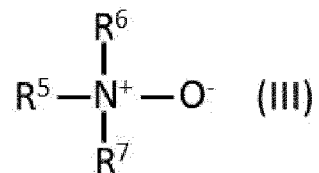
comprises one or more alkyl sulfates and is (essentially) free from alkylether sulfates. In particular embodiments, the foaming agents of the foaming agent composition contain at least 95 wt% alkyl sulfates, at least 97 wt% alkyl sulfates, or even at least 99 wt% alkyl sulfates. A class of particularly suitable alkylsulfate based foaming agents is described in European patent application EP1328485.

[0031] In particular embodiments, the foaming agents consist of one or more sulfates selected from the list consisting of n-octylsulfate (e.g. sodium n-octylsulfate), n-decylsulfate (e.g. sodium n-decylsulfate), and n-dodecylsulfate (e.g. sodium n-dodecylsulfate). In preferred embodiments, the foaming agents comprise 0-30 wt% n-octylsulfate, 50-75 wt% n-decylsulfate, and 10-50 wt% n-dodecylsulfate. In specific embodiments, the foaming agents comprise 0-15 wt% n-octylsulfate, 55-75 wt% n-decylsulfate, and 18-37 wt% n-dodecylsulfate. In particular embodiments, the foaming agents of the foaming agent composition comprise a mixture of sodium alkylsulfates and ammonium alkylsulfates.

[0032] The amount of foaming agent composition added to the plaster composition may depend on the specific type and relative amounts of foaming agent compounds and amine oxides used, and the desired density of the plasterboard to be produced. Typically, an amount ranging from 0.005 wt% to 0.1 wt% (relative to the dry plaster weight) is used. In particular embodiments, the plaster composition may comprise the foaming agent composition in an amount ranging from 0.01 wt% to 0.1 wt% (relative to the dry plaster weight). In particular embodiments, the plaster composition may comprise the foaming agent composition in an amount ranging from 0.02 wt% to 0.05 wt% (relative to the dry plaster weight).

[0033] The foaming agent composition in the plaster composition described herein comprises one or more amine oxides. The present inventors surprisingly found that the combination of one or more amine oxides with one or more foaming agents as described above can significantly improve the stability of the head of the slurry during the manufacture of plasterboards; Moreover, this combination may improve the foam volume and foam stability, and can even improve the compressive strength of plasterboard.

[0034] The one or more amine oxides are compounds of Formula (III):



wherein R^5 is C_{6-16} alkyl; and R^6 and R^7 are independently C_{1-3} alkyl or hydrogen. In preferred embodiments, R^6 and R^7 are C_{1-3} alkyl. Most preferably, R^6 and R^7 are methyl.

[0035] In specific embodiments, the one or more amine oxides are selected from the list consisting of octyldimethylamine oxide, decyldimethylamine oxide, and dodecyldimethylamine oxide. Preferably, the one or more amine oxides contain alkyl groups R^5 have a similar length as the alkyl groups of the one or more alkyl sulfates in the foaming agent composition.

In particular embodiments, the foaming agent composition comprises:

- one or more foaming agents selected from the list consisting of octylsulfate, decylsulfate, and dodecylsulfate; and
- one or more amine oxides selected from the list consisting of and octyldimethylamine oxide, decyldimethylamine oxide, and dodecyldimethylamine oxide.

[0036] The foaming agent composition of the plaster composition described herein typically comprises the one or more foaming agents as the main component(s) and the one or more amine oxides as minority component(s).

The foaming agent composition comprises between 95 wt% and 99 wt% of the one or more foaming agents; and between 1.0 wt% and 5.0 wt% of the one or more amine oxides. The present inventors have found that when used in these ratios, the combination of amine oxides and foaming agents can provide an improved stability of the head of the slurry, while still providing a good foamability and foam stability, and still allowing for obtaining an excellent compressive strength of the final plasterboard. It was further found that in these ratios, a good bond between the gypsum core and the facer could be obtained.

[0037] In yet further embodiments, the foaming agent composition comprises:

- between 95 wt% and 99 wt% of one or more foaming agents selected from the list consisting of octylsulfate, decylsulfate, and dodecylsulfate; and
- between 1.0 wt% and 5.0 wt% one or more amine oxides selected from the list consisting of and octyldimethylamine oxide, decyldimethylamine oxide, and dodecyldimethylamine oxide.

[0038] The plaster composition described herein may further comprise one or more additives such as fluidizers, pigments, fillers, accelerators, retardants, and starches. The use of such additives is well known in the art and will not be discussed further herein.

[0039] Further provided herein is the use of a plaster composition as described above, for the manufacture of plasterboard; and a related method for the manufacture of a plasterboard. More particularly, provided herein is a method for the manufacture of a plasterboard, using a plaster composition as described above. Methods for the manufacture of a plasterboard based on a given plaster composition or slurry are well known in the art. More particularly, the method described herein may comprise:

1. (a) providing a plaster composition as described herein,
2. (b) forming said plaster composition into a panel; and
3. (c) allowing said panel to set.

[0040] In step (a), a plaster composition as described above is provided. The plaster composition may be prepared by mixing plaster with water and foaming agent composition, and optionally one or more additives, in a mixer (or in multiple stages in different mixers) as is known in the art. Typically, plaster will be mixed with gauging water to prepare a slurry. Then, the slurry is mixed with foam, which is prepared in a foam generator after mixing the foaming agent(s) and amine oxide(s) with water. Various additives such as fluidizers may be added directly to the gauging water, or to the slurry before addition of the foam, may be present in the foam, or may be added to the slurry after the addition of foam.

[0041] The foaming agent composition is prepared by mixing the foaming agent(s) with the amine oxide(s). Typically, the foaming agent composition will be prepared by mixing one or more (aqueous) foaming agent solutions with one or more (aqueous) amine oxides. The present inventors have found that mixing amine oxides and foaming agents as described herein at high concentrations can be difficult at an industrial scale. This can be avoided by sufficiently diluting at least one of the foaming agents and amine oxides before mixing. Preferably, the amine oxide(s) are added to a sufficiently dilute solution of foaming agents. In particular embodiments, the amine oxide(s) are added to a dilution comprising 0.05 wt% to 1.0 wt% of foaming agent(s).

[0042] Thus, in particular embodiments, step (a) of the method of manufacturing a plasterboard provided herein may comprise:

(a1) mixing the one or more foaming agents with the one or more amine oxides, wherein said foaming agents and/or said oxides are provided as a dilute aqueous solution prior to mixing, thereby obtaining a foaming solution;

(a2) preparing foam from said foaming solution; and

(a3) mixing said foam with a plaster slurry.

[0043] In step (b) the plaster composition is formed into a panel. This can be done using known methods. Typically, the plaster composition is deposited between two facers or liners, i.e. sheets of covering material. Then, the slurry is formed or pressed into a panel. Preferably, the facers comprise or are made of paper or cardboard. However, also facers comprising a non-woven fabric comprising mineral, glass, or polymer fibers may be used.

The panel produced in step (b) is of indefinite length, and will be cut to the required size.

[0044] In step (c), the panel obtained in step (b) is allowed to set. More particularly, the plaster composition in the panel is allowed to set. This is well known in the art. Typically, the method described herein will also comprise the step of drying the panel. Drying is typically performed after setting of the panel, at an elevated temperature. Typically, the panel is dried in an oven at a temperature between 100°C and 250°C.

[0045] Further provided herein is a plasterboard obtained by or obtainable by setting of a plaster composition as described above. More particularly, the plasterboard may be obtained by the method for the manufacture as described above.

The plasterboard will typically comprise a gypsum core obtained via the setting of a plaster composition as described above, wherein at least one side of the core is provided with a facer or liner. Preferably, both sides of the core are provided with a facer. The facers of the opposing sides of the gypsum board may be identical or not. Preferably, the one or more facers comprise or are made of paper or cardboard. However, also facers comprising a non-woven fabric comprising mineral, glass, or polymer fibers may be used.

The gypsum core of the plasterboard is obtained or obtainable by setting of a plaster composition as described above, and therefore comprises a foaming agent composition as described above. Typically, the plasterboard, and more particularly the plasterboard core, may comprise between 0.005 wt% to 0.5 wt% of the foaming agent composition. In particular embodiments, the plasterboard, and more particularly the plasterboard core, may comprise between 0.01 wt% to 0.5 wt% of the foaming agent composition. In particular embodiments, the plasterboard, and more particularly the plasterboard core, may comprise between 0.015 wt% to 0.25 wt% of the foaming agent composition. In specific embodiments, the foaming agent composition present in the plasterboard comprises between 95 wt% and 99 wt% of one or more alkyl sulfates; and between 1.0 wt% and 5.0 wt% of one or more amine oxides of Formula (III), wherein R^5 , R^6 , and R^7 are as defined above.

[0046] The plasterboard provided herein typically is a light-weight plasterboard. As described above, such densities can be obtained by manufacturing the plasterboard from a foamed gypsum slurry. In particular embodiments, the gypsum core of the plasterboard may have a density below 1000 g/cm³, preferably below 850 g/cm³. In particular embodiments, the gypsum core may have a density between 450 kg/m³ and 800 kg/m³.

Typical plasterboards have a thickness of about 12.5 mm. However, the present plasterboards are not limited to such thickness. In certain embodiments the plasterboard thickness may range from 5 mm to 50 mm.

The use of foaming agent compositions as described herein allows for the preparation of light-weight plasterboards having a relatively high compressive strength. In particular embodiments, the core of the plasterboard provided herein has a compressive strength of at least 2.2 MPa. The compressive strength of plasterboards can be measured according to the ASTM C473-12 standard.

[0047] Further provided herein is a foaming agent composition for use in a plaster composition as defined in claim 9. In yet further embodiments, the foaming agent composition comprises:

- between 95 wt% and 99 wt% of one or more foaming agents selected from the list consisting of octylsulfate, decylsulfate, and dodecylsulfate; and
- between 1.0 wt% and 5.0 wt% one or more amine oxides selected from the list consisting of octyldimethylamine oxide, decyldimethylamine oxide, and dodecyldimethylamine oxide.

[0048] The foaming agent composition may be provided as such, or dissolved in an appropriate solvent such as water. Accordingly, further provided herein is an aqueous solution of a foaming agent composition as described herein. The skilled person understands that the concentrations of foaming agents and amine oxides referred to herein refer to the amount of these compounds in the foaming agent composition when excluding solvents.

[0049] Further provided herein is the use of a foaming agent composition as defined in claim10 for controlling and/or stabilizing the head of a slurry in the manufacture of plasterboard. As mentioned above, the head of the slurry is an accumulation of slurry prior to a pinch point, in particular formed by one or more extrusion plates (7) as shown in Fig. 1. The stabilization of the head of the slurry involves stabilizing the height of the head of the slurry, i.e. reducing the amount and/or size of the fluctuations of the height.

The use provided herein involves adding the foaming agent composition to the slurry, as described above, preferably in an amount of 0.005 wt% to 0.1 wt% relative to the dry plaster weight of the slurry.

EXAMPLES

[0050] The following examples are provided for the purpose of illustrating the present invention and by no means are meant and in no way should be interpreted to limit the scope of the present invention.

A. Foamability

[0051] The "foamability", i.e. the volume of foam produced, and the foam stability were tested for a number of combinations of foaming agent and co-surfactant. Specifically, a number of foaming solutions were prepared containing various amounts of foaming agent and co-surfactant. The following foaming agents were tested:

FA1

mixture of linear sodium octyl sulfate, sodium decyl sulfate, and sodium dodecyl sulfate as described in EP1328485.

FA2

sodium *n*-decyl sulfate (Empicol® 0758, available from Huntsman)

FA3

alkyl ether sulfate (Millifoam® H, available from Huntsman)

FA4

STEOL ® DES32-IS (alkyl ether sulfate based surfactant, available from Stepan)

[0052] Each of the foaming agents was mixed with 5 wt%, 10 wt%, and 20 wt% (relative to the weight of foaming agent) of the following co-surfactants:

CS1

lauramine oxide (dodecyldimethylamine oxide), available under the trade name Empigen® OB (Huntsman Performance Products)

CS2

C8-10alkyl polyglucoside available under the trade name Glucoapon 215® (comparative example)

[0053] For each mixture, foamability (foam volume) and foam stability were measured after one minute of foam generation with an Ultra Turrax system at 8200 rpm.

[0054] It was found that only CS1 was able to significantly increase the foamability of the foaming agents. Moreover, even low amounts of CS1 were found to be sufficient. The results of the mixtures of foaming agent + CS1 are summarized in Table 1.

Table 1 - Effect of CS1 (lauramine oxide) on the foamability

Foaming agent	% CS1*	Foam volume (mL)	Foam volume increase (%)	Half-life (s)	Half-life increase (%)
FA1	0	560	0	371	0
FA1	5	582	4	400	8
FA1	10	582	4	426	15
FA1	20	571	2	475	28
FA2	0	530	0	347	0
FA2	5	562	6	371	7
FA2	10	599	13	412	11
FA2	20	588	11	504	36
FA3	0	580	0	416	0
FA3	5	590	1.7	404	-3
FA3	10	590	1.7	420	1
FA3	20	600	3.4	416	0
* wt% relative to the total amount of foaming agent and co-surfactant					

[0055] The results show that the addition of CS1 is most effective with foaming agents providing a lower initial foam volume (i.e. without CS1). No significant increase of the foam volume was observed with CS2.

[0056] Also the foam stability was tested, by measuring the foam half-life, i.e. the amount of

time it takes to recover one half of the original volume of liquid from a measured volume of foam. The results are summarized in Table 1. CS1 was found to provide the highest foam stability improvement, in particular for FA1 and FA2. No significant improvement was observed for FA3. CS2 was found to provide a very limited increase in foam stability.

B. Plasterboard

[0057] Preliminary tests showed that the addition of 1-5 wt% (with respect to the total amount of foaming agent + co-surfactant) of amine oxides to FA1 provides an improved volume and stability of the foam when used in plaster slurry. Although the addition of such low amounts of amine oxides was found to lower the compressive strength, this loss of compressive strength remains acceptable. Above 10 wt% of amine oxides, the advantage of the increase of foamability and foam stability was generally considered barely outweighing the loss of compressive strength.

[0058] Based on the preliminary tests, plant trials were performed for the manufacture of plasterboard, using FA1 as foaming agent and CS3 (lauramine oxide available from Solvay under the trade name Mackamine®) as co-surfactant. Also plasterboard with FA4 (without co-surfactant) was produced as a reference. Various concentrations of amine oxides were used (1 wt%, 3 wt%, and 5 wt%; with respect to the total amount of foaming agent + amine oxide).

[0059] In the plant trials, a significant improvement of the head stability was observed immediately upon the use of foam comprising amine oxides, even at low amounts.

Table 2 - Boards prepared in plant test

Foaming agent	% CS3*	Dry Weight (kg/m ²)	Compression (MPa)
FA4	0	9.00	2.51
FA1	0	9.00	3.83
FA1	1	9.00	3.41
FA1	1	8.70	2.51
FA1	3	9.00	3.38
FA1	5	9.00	3.25

[0060] The produced plasterboards had a thickness of 12.5 mm and a weight ranging from 8.7 to 9 kg/m². The compressive strength of the boards was measured according to ASTM C473-12. A summary of the board composition and parameters is provided in Table 2. The results show that, with similar dry weight of the boards, the use of FA1 + CS3 as foaming agent composition provides a much higher compressive strength compared to the use of FA4, although the compressive strength is lower compared to the use of FA1 only. It was further observed that even with a reduced dry weight (8.7 kg/m²), the use of FA1 + CS3 allows for

reducing the dry weight of the boards, while maintaining the same compression strength of heavier boards (9.0 kg/m²) comprising only FA4.

[0061] In a further test, the present inventors surprisingly found that the stability of the head of the slurry also improved when adding CS3 to FA4, even though this did not yield an increased foam volume. Moreover, in contrast with the combination of alkylsulfate + amine oxide, the combination of alkylether sulfate + amine oxide did not result in a significant decrease of the compressive strength.

[0062] The above results show that the addition of amine oxides to alkyl sulfate and alkylether sulfate foaming compounds improves the stability of the head of the slurry during the manufacture of plasterboard; while keeping an excellent compressive strength for the resulting plasterboard. It is further noted that, although the use of FA1 typically increases the risk of blisters on the plasterboard surface, no blisters were observed on the plasterboards produced using FA1 + amine oxide.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

- [US8834145B](#) **[0003]**
- [WO2004083146A](#) **[0005]**
- [EP1328485A](#) **[0006]** **[0030]** **[0051]**

Patentkrav

1. Gipssammensætning til fremstilling af en gipsplade, omfattende:

- gips;

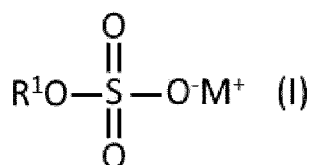
5 - vand; og

- en skummiddelsammensætning omfattende

- 95 til 99 vægtprocent af et eller flere skummidler valgt fra listen bestående af alkylsulfat; og

- 1 til 5 vægtprocent af en eller flere aminosider,

10 hvor alkylsulfater har formel (I):

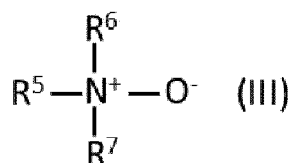


hvor R¹ er lineært C8-12-alkyl; og

M⁺ er en monovalent kation,

og hvor

15 nævnte ene eller flere aminosider har formel (III):



hvor R⁵ er C₆₋₁₆-alkyl; og

R⁶ og R⁷ er uafhængigt C₁₋₃-alkyl eller hydrogen.

20 2. Gipssammensætningen ifølge krav 1, hvor nævnte ene eller flere skummidler omfatter en blanding af natriumoctylsulfat, natriumdecylsulfat og natriumdodecylsulfat.

3. Gipssammensætningen ifølge krav 2, hvor nævnte ene eller flere aminosider er
25 valgt fra listen bestående af octyldimethylaminoxid, decyldimethylaminoxid og dodecyldimethylaminoxid.

4. Gipssammensætningen ifølge et hvilket som helst af kravene 1 til 3, omfattende nævnte skummiddelsammensætning i en mængde i området fra

0,005 til 0,1 vægtprocent i forhold til den tørre gipsvægt.

5. Gipsplade omfattende en gipskerne som kan opnås ved at hærde en gipssammensætning ifølge et hvilket som helst af kravene 1 til 4.

5

6. Gipspladen ifølge krav 5, hvor nævnte gipskerne har en densitet på mellem 450 kg/m^3 og 800 kg/m^3 .

7. Gipspladen ifølge krav 5 eller 6, hvor gipskernen af nævnte gipsplade har en trykstyrke på mindst 2,2 MPa.

8. Fremgangsmåde til fremstillingen af en gipsplade, omfattende:

(a) at tilvejebringe en gipssammensætning ifølge et hvilket som helst af kravene 1 til 4,

15 (b) at forme nævnte gipssammensætning til et panel; og

(c) at lade nævnte panel hærde.

hvor trin (a) omfatter:

(a1) at blande nævnte ene eller flere skummidler med nævnte ene eller flere aminoxider, hvor nævnte skummidler og/eller nævnte oxider er tilvejebragt som

20 en fortyndet vandig opløsning forud for blanding, for derved at opnå en skumopløsning;

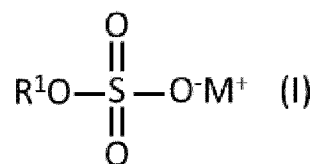
(a2) at fremstille skum fra nævnte skumopløsning; og

(a3) at blande nævnte skum med en gipsopslæmning.

25 9. Skummiddelsammensætning bestående af:

- mellem 95 og 99 vægtprocent af et eller flere skummidler valgt fra listen bestående af alkylsulfat;

hvor alkylsulfater har formel (I):

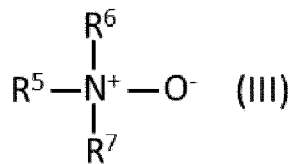


30 hvor R^1 er lineært C8-12-alkyl; og

M^+ er en monovalent kation.

og

- mellem 1,0 og 5,0 vægtprocent af en eller flere aminosider, idet nævnte ene eller flere aminosider har formel (III):



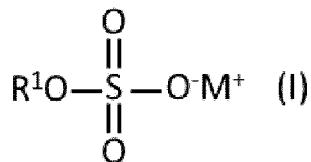
hvor R⁵ er C₆₋₁₆-alkyl; og

5 R⁶ og R⁷ er uafhængigt C₁₋₃-alkyl eller hydrogen.

10. Anvendelsen af en skummiddelsammensætning bestående af:

- 95 til 99 vægtprocent af et eller flere skummidler valgt fra listen bestående af alkylsulfat

10 hvor alkylsulfater har formel (I):

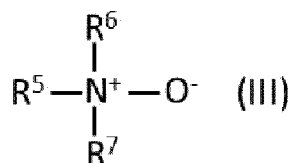


hvor R¹ er lineært C₈₋₁₂-alkyl;; og

M⁺ er en monovalent kation,

; og

15 - 1 til 5 vægtprocent af en eller flere aminosider, idet nævnte ene eller flere aminosider har formel (III):



hvor R⁵ er C₆₋₁₆-alkyl; og

R⁶ og R⁷ er uafhængigt C₁₋₃-alkyl eller hydrogen

20 til at stabilisere hovedet af en opslæmning i fremstillingen af en gipsplade.

DRAWINGS

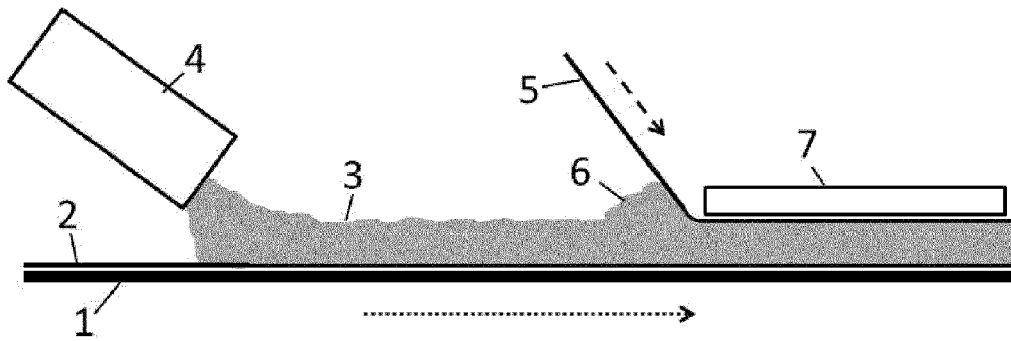


Fig. 1