Claims

1. Process for the preparation of an aqueous solution comprising at least one earth alkali hydrogen carbonate, the process comprising the steps of:

a) providing water,

b) providing at least one substance comprising at least one earth alkali carbonate and optionally at least one earth alkali hydroxide in a minor amount in respect to the earth alkali carbonate, the at least one substance being in a dry form or in an aqueous form,

c) providing CO_2,

d) combining either:

(i) the water of step a), the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) and the CO_2 of step c), or

(ii) the water of step a) and the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) in order to obtain an alkaline aqueous suspension of the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide, and subsequently combining the alkaline aqueous suspension with the CO_2 of step c)

in order to obtain a resulting suspension **S** having a pH of between 6 and 9, the resulting suspension **S** containing particles,

e) filtering at least a part of the resulting suspension **S** by passing at least a part of the resulting suspension **S** through a filtering device in order to obtain the aqueous solution comprising at least one earth alkali hydrogen carbonate,

f) subjecting at least a part or all of the particles of the resulting suspension **S** to a particle dividing step,

wherein step f) can take place before and/or parallel to and/or after step e),

wherein the particles of the resulting suspension **S** that are obtained in step d) represent a total particle surface area (SSA_{total}) that is at least 1 000 m^2/tonne of the resulting suspension **S**, and
with the proviso that an addition of the CO_2 of step c) does not take place before an addition of the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b).

2. Process according to claim 1, characterized in that the particles of the resulting suspension **S** represent a total particle surface area (SSA_{total}) that is in the range of 5 000 – 5 000 000 m^2/tonne of the resulting suspension **S**, preferably in the range of 10 000 – 5 000 000 m^2/tonne of the resulting suspension **S**, and more preferably in the range of 70 000 – 500 000 m^2/tonne of the resulting suspension **S**.

3. Process according to claim 1or 2, characterized in that the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) is selected from the group comprising marble, limestone, chalk, half burnt lime, burnt lime, dolomitic limestone, calcareous dolomite, half burnt dolomite, burnt dolomite, and precipitated earth alkali carbonates such as precipitated calcium carbonate.

4. Process according to any one of claims 1 to 3, characterized in that the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) has a weight median particle size (d_{50}) in the range of 0.1 μm to 1 mm, and preferably in the range of 0.7 μm to 100 μm.

5. Process according to any one of claims 1 to 4, characterized in that the at least one substance comprising at least one earth alkali carbonate and the optional

at least one earth alkali hydroxide of step b) has a specific surface area (SSA) in the range of 0.01 to 200 m^2/g, and preferably in the range of 1 to 100 m^2/g.

6. Process according to any one of claims 1 to 5, characterized in that the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) has a hydrochloric acid (HCl) insoluble content from 0.02 to 90 wt.%, preferably from 0.05 to 15 wt.%, based on the total weight of the dry substance.

7. Process according to any one of claims 1 to 6, characterized in that the resulting suspension S that is obtained in step d) has a solids content in the range from 1 to 80 wt.%, preferably in the range of 3 to 50 wt.%, more preferably in the range of 5 to 35 wt.%, based on the total weight of the resulting suspension S.

8. Process according to any one of claims 1 to 7, characterized in that the water of step a) is selected from distilled water, tap water, desalinated water, brine, treated wastewater or natural water such as ground water, surface water or rainfall.

9. Process according to any one of claims 1 to 8, characterized in that the CO_2 of step c) is selected from gaseous carbon dioxide, liquid carbon dioxide, solid carbon dioxide or a gaseous mixture of carbon dioxide and at least one other gas, and is preferably gaseous carbon dioxide.

10. Process according to any one of claims 1 to 9, characterized in that the amount of CO_2 used, in mol, to produce 1 mol of the at least one earth alkali hydrogen carbonate in the aqueous solution is in the range of 0.5 to 4 mol, preferably in the range of 0.5 to 2.5 mol, more preferably in the range of 0.5 to 1.0 mol, and most preferably in the range of 0.5 to 0.65 mol.

11. Process according to any one of claims 1 to 10, characterized in that the particle dividing step f) is a grinding and/or crushing step, and preferably is a grinding step.

12. Process according to any one of claims 1 to 11, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate and that is obtained in step e) or step f) has a hardness from 5 to 130 °dH, preferably from 10 to 60 °dH, most preferably from 15 to 50 °dH.

13. Process according to any one of claims 1 to 12, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate and that is obtained in step e) or step f) has a pH in the range of 6.5 to 9, preferably in the range of 6.7 to 7.9, and most preferably in the range of 6.9 to 7.7, at 20°C.

14. Process according to any one of claims 1 to 13, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate and that is obtained in step e) or step f) has a calcium concentration, as calcium carbonate, from 1 to 700 mg/l, preferably from 50 to 650 mg/l, and most preferably from 70 to 630 mg/l.

15. Process according to any one of claims 1 to 14, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate that is obtained in step e) or step f) has a magnesium concentration, as magnesium carbonate, from 1 to 200 mg/l, preferably from 2 to 150 mg/l, and most preferably from 3 to 125 mg/l.

16. Process according to any one of claims 1 to 15, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate that

is obtained in step e) or step f) has a turbidity value of lower than 1.0 NTU, preferably of lower than 0.5 NTU, and most preferably of lower than 0.3 NTU.

17. Process according to any one of claims 1 to 16, characterized in that at least step d) is carried out at a temperature that is in a range of 5 to 55°C, and preferably in a range of 20 to 45°C.

18. Process according to any one of claims 1 to 17, characterized in that the aqueous solution obtained in step e) or in step f) comprises:

(x) a calcium hydrogen carbonate, preferably with a calcium concentration of 25 to 150 mg/l, as calcium carbonate, or

(xx) a magnesium hydrogen carbonate, preferably with a magnesium concentration of > 0 to 50 mg/l, or

(xxx) a mixture of a calcium and a magnesium hydrogen carbonate, preferably in a total calcium and magnesium concentration of 25 to 200 mg/l, as calcium carbonate and magnesium carbonate.

19. Process according to claim 18, characterized in that the aqueous solution obtained in step e) or in step f) comprises:
a calcium hydrogen carbonate with a calcium concentration of 45 mg/l, as calcium carbonate, or
a mixture of a calcium and a magnesium hydrogen carbonate with a calcium concentration of 80 to 120 mg/l, as calcium carbonate, and a magnesium concentration of 20 to 30 mg/l, as magnesium carbonate.

20. Process according to any one of claims 1 to 19, characterized in that it is a continuous process.

21. Process according to any one of claims 1 to 19, characterized in that the filtering device of step e) is a membrane filter, and preferably a tube membrane filter with a pore size of between 0.02 µm and 0.2 µm.

22. Use of an aqueous solution comprising at least one earth alkali hydrogen carbonate obtained by the process according to any one of claims 1 to 21 for the production of a precipitated earth alkali carbonate and/or hydromagnesite, and in particular for the production of a precipitated calcium carbonate and/or hydromagnesite.

23. Use of an aqueous solution comprising at least one earth alkali hydrogen carbonate obtained by the process according to any one of claims 1 to 21 for the mineralization of water.

24. Process for the mineralization of water comprising the following steps:

I) providing feed water,

II) providing an aqueous solution comprising at least one earth alkali hydrogen carbonate, and

III) combining the feed water of step I) and the aqueous solution comprising at least one earth alkali hydrogen carbonate of step II) in order to obtain mineralized water.

25. Process according to claim 24, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate of step II) has a hardness that is at least 3 °dH, and preferably at least 5 °dH higher than the hardness of the feed water of step I).

26. Process according to claim 24 or 25, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate of step II) has a hardness of at least 15 °dH.

27. Process for the production of a precipitated earth alkali carbonate, the process comprising the following steps:

IV) providing an aqueous solution comprising at least one earth alkali hydrogen carbonate, and

V) heating the aqueous solution comprising at least one earth alkali hydrogen carbonate of step IV) in order to obtain the precipitated earth alkali carbonate, and/or

VI) adding at least one earth alkali hydroxide or earth alkali oxide to the solution of step IV) to obtain the precipitated earth alkali carbonate.

28. Process according to claim 27, characterized in that the precipitated earth alkali carbonate is selected from among an amorphous earth alkali carbonate, such as amorphous calcium carbonate or magnesium carbonate, crystalline calcium carbonate in the calcitic, the aragonitic or the vateritic form, magnesite and hydromagnesite, or is a mixture of the aforementioned.

Claims

1. Process for the preparation of an aqueous solution comprising at least one earth alkali hydrogen carbonate, the process comprising the steps of:

a) providing water,

b) providing at least one substance comprising at least one earth alkali carbonate and optionally at least one earth alkali hydroxide in a minor amount in respect to the earth alkali carbonate, the at least one substance being in a dry form or in an aqueous form,

c) providing CO_2,

d) combining either:

(i) the water of step a), the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) and the CO_2 of step c), or

(ii) the water of step a) and the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) in order to obtain an alkaline aqueous suspension of the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide, and subsequently combining the alkaline aqueous suspension with the CO_2 of step c)

in order to obtain a resulting suspension **S** having a pH of between 6 and 9, the resulting suspension **S** containing particles,

e) filtering at least a part of the resulting suspension **S** by passing at least a part of the resulting suspension **S** through a filtering device in order to obtain the aqueous solution comprising at least one earth alkali hydrogen carbonate, wherein the aqueous solution obtained after filtration has a turbidity value of lower than 1 NTU and has a calcium concentration, as calcium carbonate, from 50 to 650 mg/l,

f) subjecting at least a part or all of the particles of the resulting suspension **S** to a particle dividing step,

wherein step f) can take place before and/or parallel to and/or after step e),
wherein the particles of the resulting suspension **S** that are obtained in step d) represent a total particle surface area (SSA_{total}) that is at least 1 000 m^2/tonne of the resulting suspension **S**, and
wherein the resulting suspension **S** that is obtained in step d) has a solids content in the range from 1 to 35 wt.%, based on the total weight of the resulting suspension **S**,
with the proviso that an addition of the CO_2 of step c) does not take place before an addition of the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b),
wherein the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) has a weight median particle size (d_{50}) in the range 0.1 μm to 1mm, and wherein the particle dividing step f) is a grinding and/or crushing step.

2. Process according to claim 1, characterized in that the particles of the resulting suspension **S** represent a total particle surface area (SSA_{total}) that is in the range of 5 000 – 5 000 000 m^2/tonne of the resulting suspension **S**, preferably in the range of 10 000 – 5 000 000 m^2/tonne of the resulting suspension **S**, and more preferably in the range of 70 000 – 500 000 m^2/tonne of the resulting suspension **S**.

3. Process according to claim 1or 2, characterized in that the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) is selected from the group comprising marble, limestone, chalk, half burnt lime, burnt lime, dolomitic limestone, calcareous dolomite, half burnt dolomite, burnt dolomite, and precipitated earth alkali carbonates such as precipitated calcium carbonate.

4. Process according to any one of claims 1 to 3, characterized in that the at least one substance comprising at least one earth alkali carbonate and the

optional at least one earth alkali hydroxide of step b) has a weight median particle size (d_{50}) in the range of 0.7 μm to 100 μm.

5. Process according to any one of claims 1 to 4, characterized in that the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) has a specific surface area (SSA) in the range of 0.01 to 200 m^2/g, and preferably in the range of 1 to 100 m^2/g.

6. Process according to any one of claims 1 to 5, characterized in that the at least one substance comprising at least one earth alkali carbonate and the optional at least one earth alkali hydroxide of step b) has a hydrochloric acid (HCl) insoluble content from 0.02 to 90 wt.%, preferably from 0.05 to 15 wt.%, based on the total weight of the dry substance.

7. Process according to any one of claims 1 to 6, characterized in that the resulting suspension **S** that is obtained in step d) has a solids content in the range of 3 to 35 wt.%, more preferably in the range of 5 to 35 wt.%, based on the total weight of the resulting suspension **S**.

8. Process according to any one of claims 1 to 7, characterized in that the water of step a) is selected from distilled water, tap water, desalinated water, brine, treated wastewater or natural water such as ground water, surface water or rainfall.

9. Process according to any one of claims 1 to 8, characterized in that the CO_2 of step c) is selected from gaseous carbon dioxide, liquid carbon dioxide, solid carbon dioxide or a gaseous mixture of carbon dioxide and at least one other gas, and is preferably gaseous carbon dioxide.

10. Process according to any one of claims 1 to 9, characterized in that the amount of CO_2 used, in mol, to produce 1 mol of the at least one earth alkali

hydrogen carbonate in the aqueous solution is in the range of 0.5 to 4 mol, preferably in the range of 0.5 to 2.5 mol, more preferably in the range of 0.5 to 1.0 mol, and most preferably in the range of 0.5 to 0.65 mol.

11. Process according to any one of claims 1 to 10, characterized in that the particle dividing step f) is a grinding step.

12. Process according to any one of claims 1 to 11, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate and that is obtained in step e) has a hardness from 5 to 130 °dH, preferably from 10 to 60 °dH, most preferably from 15 to 50 °dH.

13. Process according to any one of claims 1 to 12, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate and that is obtained in step e) has a pH in the range of 6.5 to 9, preferably in the range of 6.7 to 7.9, and most preferably in the range of 6.9 to 7.7, at 20°C.

14. Process according to any one of claims 1 to 13, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate and that is obtained in step e) has a calcium concentration, as calcium carbonate, from 70 to 630 mg/l.

15. Process according to any one of claims 1 to 14, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate that is obtained in step e) has a magnesium concentration, as magnesium carbonate, from 1 to 200 mg/l, preferably from 2 to 150 mg/l, and most preferably from 3 to 125 mg/l.

16. Process according to any one of claims 1 to 15, characterized in that the aqueous solution comprising at least one earth alkali hydrogen carbonate that is obtained in step e) has a turbidity value of lower than 0.5 NTU, and preferably of lower than 0.3 NTU.

17. Process according to any one of claims 1 to 16, characterized in that at least step d) is carried out at a temperature that is in a range of 5 to 55°C, and preferably in a range of 20 to 45°C.

18. Process according to any one of claims 1 to 17, characterized in that the aqueous solution obtained in step e) comprises:

(x) a calcium hydrogen carbonate, preferably with a calcium concentration of 25 to 150 mg/l, as calcium carbonate, or

(xx) a magnesium hydrogen carbonate, preferably with a magnesium concentration of > 0 to 50 mg/l, or

(xxx) a mixture of a calcium and a magnesium hydrogen carbonate, preferably in a total calcium and magnesium concentration of 25 to 200 mg/l, as calcium carbonate and magnesium carbonate.

19. Process according to claim 18, characterized in that the aqueous solution obtained in step e) comprises:
a calcium hydrogen carbonate with a calcium concentration of 45 mg/l, as calcium carbonate, or
a mixture of a calcium and a magnesium hydrogen carbonate with a calcium concentration of 80 to 120 mg/l, as calcium carbonate, and a magnesium concentration of 20 to 30 mg/l, as magnesium carbonate.

20. Process according to any one of claims 1 to 19, characterized in that it is a continuous process.

21. Process according to any one of claims 1 to 19, characterized in that the filtering device of step e) is a membrane filter, and preferably a tube membrane filter with a pore size of between 0.02 μm and 0.2 μm.

22. Use of an aqueous solution comprising at least one earth alkali hydrogen carbonate obtained by the process according to any one of claims 1 to 21 for

the production of a precipitated earth alkali carbonate and/or hydromagnesite, and in particular for the production of a precipitated calcium carbonate and/or hydromagnesite.

23. Use of an aqueous solution comprising at least one earth alkali hydrogen carbonate obtained by the process according to any one of claims 1 to 21 for the mineralization of water.