

CLAIMS

1. An integrated process for carbon dioxide capture, sequestration and utilisation, which comprises:

- a) providing an aqueous slurry comprising an aqueous liquid and a particulate solid comprising an activated magnesium silicate mineral;
 - b) in a dissolution stage, contacting a CO₂-containing gas stream with the aqueous slurry at a first pressure to dissolve magnesium from the mineral to provide a slurry comprising a magnesium ion enriched carbonated aqueous liquid and a magnesium depleted solid residue; and
 - c) in a precipitation stage, precipitating magnesium carbonate from magnesium ions dissolved in step b) by multiple successive stage-wise reductions in pressure, with each stage being at a lower pressure than the preceding stage;
- wherein each successive stage-wise reduction in pressure releases CO₂ which is correspondingly stage-wise compressed and recycled back into the dissolution stage.

2. The integrated process according to claim 1, wherein the magnesium ion enriched carbonated aqueous liquid is produced by dissolving the activated magnesium silicate mineral in one or more reactors fed by an input CO₂-containing gas stream above atmospheric pressure and thereafter, in two or more precipitation stages, inducing a pH shift in the liquid by the removal of dissolved CO₂ through reducing the pressure to the liquid thereby precipitating the magnesium carbonate.

3. The integrated process according to claim 1, wherein the magnesium ion enriched carbonated aqueous liquid is produced by dissolving the activated magnesium silicate mineral in one or more reactors fed by an input CO₂-containing gas stream near, at or above atmospheric pressure and thereafter, in two or more separate precipitation stages, inducing a pH shift in the solution by the removal of dissolved CO₂ through the application of a partial vacuum or sub-atmospheric pressure in at least one of the precipitation stages thereby precipitating the magnesium carbonate.

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4. The integrated process according to any one of claims 1 to 3, wherein the dissolution stage is performed in a dissolution reactor and slurry exiting the dissolution reactor is subjected to a separation process in a separator that substantially separates solids from liquids, thus separating the slurry into a slurry stream comprising the magnesium ion enriched carbonated aqueous liquid and a slurry stream comprising the magnesium depleted solid residue.

5. The integrated process according to any one of claims 1 to 4, wherein the pressure in each dissolution stage is in the range 100-20000 kPa and the temperatures is in the range 20 °C-185 °C.

6. The integrated process according to any one of claims 1 to 5, wherein a stream comprising CO₂ released from any stage-wise reduction in pressure is compressed and blended with a stream comprising CO₂ released from any preceding stage before being further compressed and recycled back into the dissolution stage.

7. The integrated process according to claim 6, wherein a stream comprising CO₂ that has been compressed is cooled before being blended with a stream comprising CO₂ released from any preceding stage before being further compressed and recycled back into the dissolution stage.

8. The integrated process according to claim 7, wherein the cooling condenses entrained water vapour.

9. The integrated process according to claim 8, wherein the condensed water is recycled back to the process.

10. The integrated process according to claim 4, wherein the magnesium depleted solid residue is subjected to a wet magnetic separation process to extract an iron-rich portion therefrom.

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11. The integrated process according to claim 4, wherein the magnesium depleted solid residue is subjected to chemical processing to purify silica contained therein.

12. The integrated process according to claim 11, wherein the chemical processing is acid leaching.

13. A reactor system adapted to perform the processes of claim 1, the reactor system comprising two or more precipitation reactors that are each adapted to provide the stage wise reduction in pressure and recover precipitated magnesium carbonates.