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Claims: (March 6, 2015)

1. A process for alumina and carbonate production from aluminium rich materials with integrated CO₂ utilization, comprising the following steps:

- 5 I. crushing and milling of the Al-rich materials,
- II. leaching of the crushed materials in acid to produce a metal chloride solution
- III. separation of the unreacted solid and the metal chloride solution
- IV. separation of Al³⁺ from the metal chloride solution by crystallization of AlCl₃·6H₂O
- V. production of Al₂O₃ by calcination of AlCl₃·6H₂O with HCl recovery
- 10 VI. utilization of CO₂ to precipitate metal carbonates from the metal chloride solution coming from the Al³⁺ separation step
- VII. regeneration of HCl and the extractive amine

characterized in:

- leaching the material in step II with a concentrated mineral acid which is predominantly HCl,
 - 15 - separating the Al³⁺ in step IV by precipitation of AlCl₃·6H₂O by increasing the HCl concentration in the metal chloride solution
 - calcination in step V the AlCl₃·6H₂O in two sub-steps: First by indirect heating at temperature between 400 and 600°C to generate a HCl-rich gas followed by a second calcination at a temperature above 600°C to produce Al₂O₃
 - 20 - mixing in step VI the Al-lean metal chloride solution with an organic solution containing a selected amine and contacting the mixture with a CO₂-containing gas, in order to extract HCl by formation of an ammonium chloride salt complex and to precipitate a metal carbonate.
 - separating the metal carbonate in step VI, the remaining metal chlorides containing aqueous phase and the organic solution containing ammonium chloride.
 - 25 - processing thermally or chemically the organic solution in step VII to regenerate the amine for recirculation in the process.
2. Process according to claim 1, wherein the leaching is performed at a temperature in the range 80-180 °C, acid concentration is under 13M and a pressure below 10 bars, more preferably a concentration under 11M and a pressure not exceeding 5 bars.
- 30 3. Process according to claim 1, wherein a leaching time in the range from 0.5 to 24 hours is employed, more preferred from 1 to 10 hours, most preferred from 1 to 5 hours.
4. Process according to claim 1, wherein the crushing and milling is performed to a particle size smaller than 20 mm, more preferred to a size equal or under 0.5 mm.

5. Process according to claim 1, wherein Fe rich materials are removed by magnetic separation or optical sorting before step ii.
6. Process according to claim 1, wherein unreacted materials after leaching are separated by filtration and washed with a solution, chosen among acidic solution and water, in one or several repetitions, to recover metal chlorides and unreacted acid and increase the SiO₂ purity.
7. Process according to claim 1, wherein AlCl₃·6H₂O is precipitated from the Al-rich metal chloride solution by bubbling a HCl-containing gas, filtered and washed with a solution chosen among acidic solution and water.
8. Process according to claim 1, wherein AlCl₃·6H₂O is crystallized from the Al-rich metal chloride solution by mixing with a concentrated HCl solution, filtered and washed with a solution chosen among acidic solution and water.
9. Process according to claim 1, wherein the precipitated AlCl₃·6H₂O and impurities is partially redissolved with a solution, chosen among hydrochloric aqueous solution and water, filtered and recycled to the crystallization step iv.
10. Process according to claim 1, where the Al-lean metal chloride solution after the crystallization step is treated by liquid/liquid organic extraction to reduce the iron content.
11. Process according to claim 1, where the Al-lean metal chloride solution after the crystallization step is treated by distillation or other existing concentrating process for recovery of the free acid and increase of the metal chlorides concentration in the solution.
12. Process according to claim 1, wherein metal carbonate is precipitated by contacting the Al-lean solution with a pressurized CO₂ containing gas and an organic solution containing a tertiary or a quaternary amine diluted in at least one organic solvent.
13. Process according to claim 12 wherein the HCl is regenerated from the organic solution by thermal treatment at temperature above 80°C to produce a HCl containing gas that can be recirculated in the process.
14. Process according to claim 12, where alternatively, the amine is regenerated by contacting the organic phase with a concentrated basic solution and recirculated into the precipitation step.
15. Process according to claim 1 wherein the precipitated metal carbonate can be calcium carbonate, magnesium carbonate, sodium carbonate, sodium bicarbonate.