CLAIMS

What is claimed is:

1. A system for the treatment of aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, said system comprises:
   - at least one reservoir;
   - solid-liquid separation means;
   - concentration means;
   - agitation means;
   - inlet for solid and liquid reagent addition;

   wherein said system consumes said aqueous alkaline waste solution; and

   wherein said system produces a regenerated aqueous alkaline solution, comprising reduced amount of dissolved hydroxide ions of metal A or wherein said system produces a regenerated aqueous alkaline solution free of dissolved hydroxide ions of metal A.
2. The system of claim 1, wherein said metal A is aluminum and said dissolved hydroxide ions of metal A are aluminate $[Al(OH)_4^-]$ ions.
3. The system of claim 1, wherein said system further produces metal A-containing solid products.
4. The system of claim 3, wherein said metal A-containing solid products comprise aluminum-containing solid products comprising ATH, LDH or a combination thereof.
5. The system of claim 1, further comprising temperature control means; distillation and reflux means; membrane separation means or a combination thereof.
6. The system of claim 1, wherein the source of said aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, is a chemical waste solution from a chemical process comprising oxidation of metal A or wherein the source of said aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, is spent electrolyte from an electrochemical process comprising oxidation of metal A.
7. The system of claim 1, wherein said system is modified to operate in a corrosive solution environment and in the presence of an organic co-solvent to perform the desired operations defined in claim 1.
8. The system of claim 1, wherein said system is located on-board a vehicle.
9. The system of claim 1, wherein said system is off-board a vehicle.

10. A method for the treatment of aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, said method comprising:
    - providing a system comprising:
        - at least one reservoir;
        - solid-liquid separation means;
        - concentration means;
        - agitation means;
        - inlet for solid and liquid reagent addition;
    - introducing, aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A into said system;
    - producing and separating solid metal A hydroxides, LDH or a combination thereof from said waste solution and reducing the amount of dissolved hydroxide ions of metal A in said waste solution, thus producing a regenerated aqueous alkaline solution, comprising reduced amount of dissolved hydroxide ions of metal A or free of dissolved hydroxide ions of metal A.
11. The method of claim 10, wherein said metal A is aluminum and said hydroxide ions of metal A is aluminate $[Al(OH)_4^-]$ and said solid metal A hydroxides is ATH $[Al(OH)_3]$.
12. The method of claim 10, wherein the source of said aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, is a chemical waste solution from a chemical process comprising oxidation of metal A or wherein the source of said aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, is spent electrolyte from an electrochemical process comprising oxidation of metal A.
13. The method of claim 12, wherein during said chemical or electrochemical process, metal A is dissolved in an alkaline solution such that said metal A forms dissolved metal A ions in said alkaline solution.
14. The method of claim 10, wherein said producing solid metal A hydroxides from said waste solution comprises separating, or precipitating and separating, said solid metal A hydroxides from said solution.
15. The method of claim 14, wherein said precipitating said solid metal A hydroxides is done using an electrolysis process, a dialysis process, a hydrolysis process, osmosis, phoresis or a combination thereof.
16. The method of claim 15, wherein said hydrolysis process comprises adding water to said waste solution, thus causing precipitation of solid metal A hydroxides.

17. The method of claim 10, wherein said producing solid metal A hydroxides involves the removal of dissolved hydroxide ions of metal A from said solution by decomposition of said dissolved hydroxide ions of metal A to solid metal A hydroxides and to free alkali hydroxides.
18. The method of claim 10, wherein said producing and separating LDH from said waste solution comprises:
    - adding a metal B ions to said waste solution in said reservoir to induce precipitation of LDH;
    - separating said LDH from said waste solution; and
    - optionally drying said LDH.
19. The method of claim 18, wherein, prior to said addition of metal B ions said waste solution undergoes re-digestion, wherein said re-digestion comprises heating and agitating said waste solution to re-dissolve metal A solid hydroxide precipitate.
20. A method for the treatment of aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A and metal B ions, said method comprising precipitating LDH from said aqueous alkaline waste solution.
21. The method of claim 20, wherein said precipitation occurs spontaneously.
22. The method of claim 20, wherein the source of said aqueous alkaline waste solution comprising hydroxide ions of metal A, and metal B ions, is a metal alloy comprising metal A and metal B.
23. The method of claim 20, wherein said aqueous alkaline waste solution comprising hydroxide ions of metal A, and metal B ions, is formed from said metal alloy comprising metal A and metal B by a chemical or by an electrochemical process.
24. The method of claim 23, wherein during said chemical or electrochemical process, metal A and metal B are dissolved in an alkaline solution such that said metal A forms metal A ions and said metal B forms metal B ions in said alkaline solution.
25. The method of any one claims 18-24, wherein said metal B ion is selected from a group consisting of Ca, Mg, Ba, Sr and compounds of thereof.
26. The method of claim 20, wherein said electrochemical process is the operation of a metal-air battery.
27. The method of claim 20, wherein said metal-air battery comprises a cathode, an anode and an electrolyte solution, wherein said anode comprising said metal alloy comprising metals A and B.

28. The method of claims 18 and 20, wherein said metal B ions comprise Mg^{2+} ions.
29. The method of any one of claims 10, 18 and 20, wherein said waste solution comprising NaOH, KOH, NH_4OH, LiOH or organic base hydroxides (e.g. choline base).
30. The method of claim 29, wherein the concentration of said KOH or NaOH solution varies between 20 and 45 wt%.
31. The method of claims 10 and 20, wherein said method further comprises filtration, centrifugation, solids cake compression, washing and dewatering and drying, solvent evaporation, or a combination thereof.
32. The method of claims 10 and 20, wherein said LDH comprises Al.
33. The method of claim 27, wherein said LDH comprises meixnerite, hydrotalcite (HTC), c or a combination thereof.
34. The method of claims 10 and 20, wherein said separating step comprises filtration, centrifugation, washing, solvent evaporation, compression, decanting, or a combination thereof.
35. A system for production of energy, said system comprises an energy production unit and the solution treatment system of claim 1, wherein said energy production unit comprises a cathode, an anode and an electrolyte solution, wherein said anode comprising a metal or a metal alloy and wherein said alloy comprises metals A and B.
36. The system of claim 35, wherein said energy production unit and said solution treatment system comprise inlets and outlets for introduction and transfer of materials to and from said units.
37. The system of claim 35, wherein said energy production unit is a hydrogen generator or an aluminum-air battery.
38. The system of claim 37, wherein said energy production unit utilizes oxygen from said air.
39. The system of claim 35, wherein during operation energy is produced by said energy production unit while solid LDH is produced in said energy production unit, solution treatment system or a combination thereof.

CLAIMS

What is claimed is:

1. A system for the treatment of aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, said system comprises:
    - at least one reservoir;
    - solid-liquid separation means;
    - concentration means;
    - agitation means;
    - inlet for solid and liquid reagent addition;

    wherein said system consumes said aqueous alkaline waste solution; and

    wherein said system produces a regenerated aqueous alkaline solution, comprising reduced amount of dissolved hydroxide ions of metal A or wherein said system produces a regenerated aqueous alkaline solution free of dissolved hydroxide ions of metal A, and

    wherein the system further produces metal A-containing solid products, and wherein said metal A-containing solid products comprise LDH.
2. The system of claim 1, wherein said metal A is aluminum and said dissolved hydroxide ions of metal A are aluminate $[Al(OH)_4^-]$ ions.
3. The system of claim 2, wherein said metal A-containing solid products comprise aluminum-containing solid products comprising LDH and optionally ATH.
4. The system of claim 1, further comprising temperature control means; distillation and reflux means; membrane separation means or a combination thereof.
5. The system of claim 1, wherein the source of said aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, is a chemical waste solution from a chemical process comprising oxidation of metal A or wherein the source of said aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, is spent electrolyte from an electrochemical process comprising oxidation of metal A.
6. The system of claim 1, wherein said system is modified to operate in a corrosive solution environment and in the presence of an organic co-solvent to perform the desired operations defined in claim 1.
7. The system of claim 1, wherein said system is located on-board a vehicle.
8. The system of claim 1, wherein said system is off-board a vehicle.
9. A method for the treatment of aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, said method comprising:
    - providing a system comprising:
        - at least one reservoir;
        - solid-liquid separation means;

- concentration means;
- agitation means;
- inlet for solid and liquid reagent addition;

- introducing, aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A into said system;
- producing and separating metal A-containing solid products comprising, LDH and optionally comprising solid metal A hydroxides from said waste solution and reducing the amount of dissolved hydroxide ions of metal A in said waste solution, thus producing a regenerated aqueous alkaline solution, comprising reduced amount of dissolved hydroxide ions of metal A or free of dissolved hydroxide ions of metal A,

wherein said producing and separating LDH from said waste solution comprises:

- adding a metal B ions to said waste solution in said reservoir to induce precipitation of LDH;
- separating said LDH from said waste solution; and
- optionally drying said LDH.

10. The method of claim 10, wherein said metal A is aluminum and said hydroxide ions of metal A is aluminate [$Al(OH)_4^-$] and said solid metal A hydroxides is ATH [$Al(OH)_3$].
11. The method of claim 10, wherein the source of said aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, is a chemical waste solution from a chemical process comprising oxidation of metal A or wherein the source of said aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A, is spent electrolyte from an electrochemical process comprising oxidation of metal A.
12. The method of claim 12, wherein during said chemical or electrochemical process, metal A is dissolved in an alkaline solution such that said metal A forms dissolved metal A ions in said alkaline solution.
13. The method of claim 10, wherein said producing solid metal A hydroxides from said waste solution comprises separating, or precipitating and separating, said solid metal A hydroxides from said solution.
14. The method of claim 14, wherein said precipitating said solid metal A hydroxides is done using an electrolysis process, a dialysis process, a hydrolysis process, osmosis, phoresis or a combination thereof.
15. The method of claim 15, wherein said hydrolysis process comprises adding water to said waste solution, thus causing precipitation of solid metal A hydroxides.
16. The method of claim 10, wherein said producing solid metal A hydroxides involves the removal of dissolved hydroxide ions of metal A from said solution by decomposition of said dissolved hydroxide ions of metal A to solid metal A hydroxides and to free alkali hydroxides.

17. The method of claim 10, wherein, prior to said addition of metal B ions said waste solution undergoes re-digestion, wherein said re-digestion comprises heating and agitating said waste solution to re-dissolve metal A solid hydroxide precipitate.
18. A method for the treatment of aqueous alkaline waste solution comprising dissolved hydroxide ions of metal A and metal B ions, said method comprising precipitating LDH from said aqueous alkaline waste solution.
19. The method of claim 20, wherein said precipitation occurs spontaneously.
20. The method of claim 20, wherein the source of said aqueous alkaline waste solution comprising hydroxide ions of metal A, and metal B ions, is a metal alloy comprising metal A and metal B.
21. The method of claim 20, wherein said aqueous alkaline waste solution comprising hydroxide ions of metal A, and metal B ions, is formed from said metal alloy comprising metal A and metal B by a chemical or by an electrochemical process.
22. The method of claim 23, wherein during said chemical or electrochemical process, metal A and metal B are dissolved in an alkaline solution such that said metal A forms metal A ions and said metal B forms metal B ions in said alkaline solution.
23. The method of claim 10, wherein said metal B ion is selected from a group consisting of Ca, Mg, Ba, Sr and compounds of thereof.
24. The method of claim 20, wherein said electrochemical process is the operation of a metal-air battery.
25. The method of claim 20, wherein said metal-air battery comprises a cathode, an anode and an electrolyte solution, wherein said anode comprising said metal alloy comprising metals A and B.
26. The method of claim 10, wherein said metal B ions comprise Mg^{2+} ions.
27. The method of claim 10, wherein said waste solution comprising NaOH, KOH, NH_4OH, LiOH or organic base hydroxides (e.g. choline base).
28. The method of claim 29, wherein the concentration of said KOH or NaOH solution varies between 20 and 45 wt%.
29. The method of claim 10, wherein said method further comprises filtration, centrifugation, solids cake compression, washing, decanting, dewatering, drying, solvent evaporation, or a combination thereof.
30. The method of claim 10, wherein said LDH comprises Al.
31. The method of claim 20, wherein said LDH comprises meixnerite, hydrotalcite (HTC), or a combination thereof.
32. A system for production of energy, said system comprises an energy production unit and the solution treatment system of claim 1, wherein said energy production unit comprises a

cathode, an anode and an electrolyte solution, wherein said anode comprising a metal or a metal alloy and wherein said alloy comprises metals A and B.

33. The system of claim 35, wherein said energy production unit and said solution treatment system comprise inlets and outlets for introduction and transfer of materials to and from said units.
34. The system of claim 35, wherein said energy production unit is a hydrogen generator or an aluminum-air battery.
35. The system of claim 37, wherein said energy production unit utilizes oxygen from said air.
36. The system of claim 35, wherein during operation energy is produced by said energy production unit while solid LDH is produced in said energy production unit, solution treatment system or a combination thereof.
37. The method of claim 20, wherein said metal B ion is selected from a group consisting of Ca, Mg, Ba, Sr and compounds of thereof.
38. The method of claim 20, wherein said metal B ions comprise Mg^{2+} ions.
39. The method of claim 20, wherein said waste solution comprising NaOH, KOH, NH_4OH, LiOH or organic base hydroxides (e.g. choline base).
40. The method of claim 20, wherein said method further comprises filtration, centrifugation, solid cake compression, washing, decanting, dewatering, drying, solvent evaporation, or a combination thereof.
41. The method of claim 20, wherein said LDH comprises Al.
42. The method of claim 10, wherein said LDH comprises meixnerite, hydrotalcite (HTC), or a combination thereof.