CLAIMS

1. A method of regenerating $Mg(OH)_2$ in a process that reduces the amount of CO_2 contained in a gas stream, comprising:

   (a) reacting $MgCl_2$ containing material with steam in a first admixture to form step(a) products comprising Mg(OH)Cl and HCl, where the $MgCl_2$ containing material comprises a water to $MgCl_2$ ratio of less than about 2.5:1;

   (b) reacting Mg(OH)Cl with steam in a second admixture to form step(b) products comprising HCl and magnesium-containing products comprising mostly $Mg(OH)_2$;

   (c) reacting $Mg(OH)_2$ with CO_2, $CaCl_2$, and steam to form step (c) products comprising $MgCl_2$ and $CaCO_3$.

2. The method of claim 1, passing a gaseous outflow from the second admixture to the first admixture, where the gaseous outflow comprises HCl and steam to react with the $MgCl_2$ containing material.

3. The method of claim 1, where step (c) comprises

   admixing $Mg(OH)_2$ from step (b) with CO_2 contained in the gas stream in a third admixture to form first step (c) products comprising $MgCO_3$ and H_2O, and

   admixing the $MgCO_3$ from first step (c) products with $CaCl_2$ in a fourth admixture to form a second step (c) products comprising $CaCO_3$ and $MgCl_2$.

4. The method according to claim 1, wherein the step (c) product are in a liquid phase and a solid phase and where the liquid phase is at least 50% by weight of $MgCl_2$.

5. The method of claim 1, where a ratio of water to $MgCl_2$ in the fourth admixture is about 4 to 1.

6. The method of claim 1, where a major portion of $MgCl_2$ formed in step (c) is in the form of $Mg.Cl_2$ tetrahydrate.

7. The method of claim 5, further comprising separating at least a portion of the $CaCO_3$ from the second step (c) products and removing a portion of the water from the remaining second step (c) products so the ratio of water to $MgCl_2$ is about 2 to 1.

8. The method of claim 7, wherein a major portion of the water in the remaining second step (c) products is present in the form of $MgCl_2$ dihydrate.

9. The method according to claim 7, wherein the remaining step (c) product is at least 50% by weight of aqueous $MgCl_2$.

10. The method according to claim 1, wherein the molar ratio of water to $MgCl_2$ in the step (c) products is 5 or less.

11. The method of claim 10, wherein the $MgCl_2$ hydrate of step (c) is MgCl2.4H2O.

12. The method according to claim 11, wherein the $MgCl_2$ of step (c) is greater than 90% by weight $MgCl_2.4(H_2O)$.

13. The method of claim 1, wherein the first step (a) product comprises greater than 90% by weight Mg(OH)Cl.

14. The method of claim 7, further comprising transferring heat from the gas stream to a first recycling heating fluid and transferring heat from the first recycling heating fluid to the first admixture.

15. The method of claim 14, further comprising transferring heat from the gas stream to a second recycling heating fluid and transferring heat from the second recycling heating fluid to the second admixture.

16. The method of claim 15, further comprising transferring heat from the gas stream to a third recycling heating fluid and transferring heat from the third recycling heating fluid to the remaining step (c) product to facilitate the removal of water.

17. The method of claim 16, where a temperature of the third recycling heating fluid is less than the second recycling heating fluid and the second recycling heating fluid is less than the first recycling heating fluid

18. The method of claim 1, wherein suitable reacting conditions of step (a) comprise a temperature from about 250°C. to about 350°C.

19. The method of claim 1, wherein reacting conditions of step (a) comprise a temperature from about 260°C. to about 300°C.

20. The method of claim 1, wherein reacting conditions of step (b) comprise a temperature from about 350°C. to about 500°C.

21. The method of claim 1, wherein reacting conditions of step (b) comprise a temperature from about 370°C. to about 430°C.

22. The method of claim 1, wherein the reacting conditions of step (c) comprise a temperature from about 140°C to about 220°C.

23. The method of claim 1, wherein the reacting conditions of step (c) comprise a temperature from about 150°C to about 200°C.

24. A system for regenerating $Mg(OH)_2$ in a process that reduces the amount of CO_2 contained in a gas stream, comprising:

a first decomposition reactor configured to react $MgCl_2$ containing material with steam to form first reactor products comprising Mg(OH)Cl and HCl, where the $MgCl_2$ containing material comprises a water to $MgCl_2$ ratio of less than about 2.5:1;

a second decomposition reactor configured to react Mg(OH)Cl from the first decomposition reactor with steam to form HCl and magnesium-containing products comprising mostly $Mg(OH)_2$;

a first absorption reactor configured to react $Mg(OH)_2$ from the second decomposition reactor with CO_2, $CaCl_2$, and steam to form products comprising $MgCl_2$ and $CaCO_3$.

25. The system of claim 24, further comprising a gaseous feed line configured to pass a gaseous outflow from the second decomposition reactor to the first decomposition reactor, where the gaseous outflow comprises HCl and steam to react with the $MgCl_2$ containing material.

26. The system of claim 24, further comprising a second absorption reactor, wherein

the first absorption reactor is configured to admix $Mg(OH)_2$ from the second decomposition reactor with CO_2 contained in the gas stream and form $MgCO_3$ and H_2O, and

the second absorption reactor is configured to admix the $MgCO_3$ from the first absorption reactor with $CaCl_2$ and form $CaCO_3$ and $MgCl_2$.

27. The system according to claim 24, wherein the first absorption reactor products are in a liquid phase and a solid phase and where the liquid phase is at least 50% by weight of $MgCl_2$.

28. The system of claim 24, where the first absorption reactor contains a liquid phase comprising a ratio of water to $MgCl_2$ of about 4 to 1.

29. The system of claim 28, where a major portion of $MgCl_2$ in the liquid phase that exits the first absorption reactor is in the form of $MgCl_2$ tetrahydrate.

30. The system of claim 28, further comprising solid liquid separator configured to separate at least a portion of the $CaCO_3$ from the liquid phase.

31. The system of claim 30, further comprising a dryer configured to remove a portion of the water from the liquid phase so the ratio of water to $MgCl_2$ is about 2 to 1.

32. The system of claim 30, wherein the dryer configured to form $MgCl_2$ dihydrate.