CLAIMS

1. A method for recovering a valuable substance, for recovering a valuable substance from a lithium ion secondary battery, the method comprising:

thermally treating a lithium ion secondary battery, to obtain a thermally treated product, the lithium ion secondary battery is thermally treated at a temperature of 750°C or higher;

classifying a pulverized product that is obtained by pulverizing the thermally treated product, to obtain a coarse-grained product and a fine-grained product both containing the valuable substance;

performing water leaching of immersing the fine-grained product in water, to obtain a water-leached slurry;

performing wet magnetic sorting of the water-leached slurry, to sort the water-leached slurry into magnetically attractable materials and a slurry of non-magnetically attractable materials; and

performing acid leaching of adding an acidic solution to either or both of the slurry of the non-magnetically attractable materials recovered by the wet magnetic sorting and the non-magnetically attractable materials obtained by solid-liquid separation of the slurry of the non-magnetically attractable materials, to adjust pH to 0 or higher and 3.5 or lower and leach the non-magnetically attractable materials, and subsequently performing solid-liquid separation to obtain an acid leaching liquid and an acid leaching residue.

2. The method for recovering a valuable substance according to claim 1,

wherein the acid leaching residue obtained in the acid leaching is a carbon (C) concentrate having a carbon (C) grade of 80% or higher.

3. The method for recovering a valuable substance according to claim 1 or 2,

wherein a magnetic field intensity in the wet magnetic sorting is 1,500 G or higher and 8,000 G or lower.

4. The method for recovering a valuable substance according to any one of claims 1 to 3,

wherein a solid-liquid ratio of the water-leached slurry obtained in the water leaching is 5% or higher and 67% or lower.

5. The method for recovering a valuable substance according to any one of claims 1 to 4,

wherein the wet magnetic sorting is performed after a dispersant is added to the water-leached slurry.

6. The method for recovering a valuable substance according to any one of claims 1 to 5,

wherein in the water leaching, a dispersion treatment by ultrasonic waves or by stirring is performed.

7. The method for recovering a valuable substance according to any one of claims 1 to 6,

wherein the wet magnetic sorting is performed over multiple stages.

8. The method for recovering a valuable substance according to any one of claims 1 to 7,

wherein a cobalt (Co) grade in the magnetically attractable materials recovered in the wet magnetic sorting is higher than 10%, and a recovery rate of cobalt (Co) into the magnetically attractable materials is 50% or higher.

9. The method for recovering a valuable substance according to any one of claims 1 to 8, comprising

neutralizing the acid leaching liquid with an alkali.

10. The method for recovering a valuable substance according to any one of claims 1 to 9, comprising after the wet magnetic sorting,

performing solid-liquid separation of the slurry of the non-magnetically attractable materials into a filtrate and a filtration residue,

wherein the method comprises neutralizing a mixture liquid, in which the filtrate obtained in the solid-liquid separation and the acid leaching liquid obtained in the acid leaching are mixed, with an alkali.

11. The method for recovering a valuable substance according to claim 9 or 10,

wherein the alkali contains a calcium compound.

12. The method for recovering a valuable substance according to any one of claims 9 to 11,

wherein the alkali contains calcium hydroxide.

13. The method for recovering a valuable substance according to any one of claims 9 to 12,

wherein the acidic solution used in the acid leaching is sulfuric acid, and

in the neutralizing, the acid leaching liquid or the mixture liquid is neutralized until an amount of sulfuric acid ions in a liquid obtained by neutralization becomes 10.0 g/L or less.

14. The method for recovering a valuable substance according to any one of claims 1 to 13,

wherein a sulfuric acid ion concentration in the acid leaching liquid obtained in the acid leaching is 50,000 mg/L or lower.

15. The method for recovering a valuable substance according to any one of claims 9to 14, comprising

performing calcium solidification removing of solidifying calcium ions in a liquid obtained by solid-liquid separation of a slurry obtained in the neutralizing, to separate the calcium ions from the liquid.

16. The method for recovering a valuable substance according to claim 15,

wherein the calcium solidification removing is performed by adding a substance containing carbon dioxide.

17. The method for recovering a valuable substance according to claim 16,

wherein the substance containing carbon dioxide is a carbonate of an alkali metal.

18. The method for recovering a valuable substance according to any one of claims 15 to 17,

wherein a liquid temperature of the liquid that is a target of the calcium solidification removing is 40°C or lower, and a lithium concentration in the liquid is lower than 5,000 mg/L.

19. The method for recovering a valuable substance according to any one of claims 9 to 18,

wherein ion adsorption removing using either or both of an anion exchange resin and a cation exchange resin is performed after the neutralizing.

20. The method for recovering a valuable substance according to any one of claims 15 to 19,

wherein calcium adsorption removing using a cation exchange resin is performed after the neutralizing or the calcium solidification removing.

21. The method for recovering a valuable substance according to claim 20,

wherein before the calcium adsorption removing or after the calcium adsorption removing, a liquid from which cations have been removed by adsorption is subjected to preparatory concentration by electrodialysis.

22. The method for recovering a valuable substance according to claim 21,

wherein a substance containing carbon dioxide is supplied to a liquid obtained by the preparatory concentration to crystallize lithium carbonate, and solid-liquid separation is performed subsequently to obtain lithium carbonate and a post-crystallization liquid.

23. The method for recovering a valuable substance according to any one of claims 20 to 22,

wherein the liquid from which calcium has been removed by solidification or

the liquid from which calcium has been removed by adsorption is heated to decrease solubility of lithium carbonate, and solid-liquid separation is performed subsequently to recover lithium carbonate and a post-crystallization liquid.

24. The method for recovering a valuable substance according to any one of claims 20 to 23,

wherein the liquid from which calcium has been removed by solidification or the liquid from which calcium has been removed by adsorption is evaporatively concentrated, and solid-liquid separation is performed subsequently to recover lithium carbonate and a post-crystallization liquid.

25. The method for recovering a valuable substance according to any one of claims 22 to 24,

wherein the post-crystallization liquid is repeatedly subjected to neutralizing, to ultimately crystallize lithium carbonate derived from the post-crystallization liquid.

26. The method for recovering a valuable substance according to any one of claims 1 to 25,

wherein cobalt sulfate or nickel sulfate is refined from the magnetically attractable materials, and lithium carbonate or lithium hydroxide is recovered from a post-recovery liquid from which cobalt sulfate or nickel sulfate has been recovered.