[0008] A problem to be solved by the present invention is to remove, from wastewater containing fluorine ions and tetrafluoroborate ions as fluorine-based substances, the fluorine ions and the tetrafluoroborate ions efficiently and effectively at a low cost.

MEANS FOR SOLVING THE PROBLEMS

[0009] One aspect of the present invention relates to ~~A~~a water treatment method ~~of an embodiment is~~being a treatment method of wastewater containing fluoride ions and tetrafluoroborate ions, the method including: a first step of adding a water-insoluble calcium-containing inorganic substance to the wastewater in a reaction tank to convert the fluoride ions contained in the wastewater into calcium fluoride; and a second step of enabling solid-liquid separation of the wastewater containing the calcium fluoride in a solid-liquid separation ~~tank~~device, and removing the calcium fluoride from the wastewater to obtain first treated water. The method further includes: a third step of adding a pH regulator to the first treated water in a pH regulating tank to regulate a pH of the first treated water to an acidic region; and a fourth step of passing the first treated water through a container filled with aminopolyol-based chelate resins, and adsorbing and removing the tetrafluoroborate ions from the first treated water to obtain second treated water.

[0009a] Another aspect of the invention relates to a water treatment apparatus being a treatment apparatus of wastewater containing fluoride ions and tetrafluoroborate ions, the water treatment apparatus comprising:a reaction tank for adding a water-insoluble calcium-containing inorganic substance to the wastewater to convert the fluoride ions contained in the wastewater into calcium fluoride; a solid-liquid separation device for enabling solid-liquid separation of the wastewater containing the calcium fluoride, and removing the calcium fluoride from the wastewater to obtain first treated water; a pH regulating tank for adding a pH regulator to the first treated water to regulate a pH of the first treated water to an acidic region; and a container filled with aminopolyol-based chelate resins, used for passing the first treated water therethrough, and adsorbing and removing the tetrafluoroborate ions from the first treated water to obtain second treated water.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] [FIG. 1] is a schematic configuration diagram of a water treatment apparatus in a first embodiment.

[FIG. 2] is a schematic configuration diagram of a water treatment apparatus in a second embodiment.

DETAILED DESCRIPTION

[0011] (First embodiment)

FIG. 1 is a diagram illustrating a schematic configuration of a water treatment apparatus of the present embodiment. A water treatment apparatus 10 illustrated in FIG. 1 has: a reaction tank 11 for removing fluoride ions in water to be treated W0 such as wastewater; a solid-liquid separation tank (planar filtering device) 12 positioned at a downstream side of

baffle plate or the like in the reaction tank 11 so that a shortcut of the water to be treated W0 from a supply port toward the pipe 22 can be prevented.

[0020] Further, in the reaction tank 11 and the pH regulating tank 13, an agitator 111 and an agitator 131 are provided.

[0021] Next, a water treatment method using the water treatment apparatus 10 illustrated in FIG. 1 will be described. First, as the water to be treated W0, wastewater containing fluoride ions and tetrafluoroborate ions is supplied into the reaction tank 11 through the pipe 21 being a water supply line, and a water-insoluble calcium-containing inorganic substance is added into the reaction tank 11, thereby converting the fluoride ions contained in the water to be treated W0 into calcium fluoride in the reaction tank 11. At this time, the water to be treated W0 and the calcium-containing inorganic substance in the reaction tank 11 are mixed by the agitator 111.

[0022] In the present embodiment, the term "water-insoluble calcium-containing inorganic substance" indicates a calcium-containing inorganic substance whose solubility in water is 10 g or less per 1000 ml (at 25°C).

[0023] Further, as the calcium-containing inorganic substance, a substance which does not have a hydrate or hydroxyl group is preferable. This is because a substance having the hydrate or hydroxyl group has a characteristic that it is softer than the other substances, and thus is sometimes clogged in a hole of filter.

[0024] Concretely, there can be cited a natural ore such as aragonite, ulexite, merrillite, omphacite, uvarovite, scheelite, perovskite, hedenbergite, zoisite, apophyllite, dolomite, creedite, piemontite, spurrite, gypsum dihydrate, titanite, charoite, anorthite, diopside, ~~hedenbergite,~~ johannsenite, tremolite, rhodonite, pigeonite, hornblende, augite, pectolite, vesuvianite, henmilite, calcite, ~~aragonite,~~ montmorillonite, actinolite, epidote, clinozoisite, and apatite. Further, there can be cited a calcium compound obtained through synthesis and generation steps, such as calcium carbonate, calcium sulfite, calcium hydroxide, calcium sulfate, calcium titanate, and calcium tungstate.

[0025] Among the above, calcium carbonate whose solubility in water is low, and the ore

CLAIMS

1. A water treatment method being a treatment method of wastewater containing fluoride ions and tetrafluoroborate ions, the water treatment method comprising:

a first step of adding a water-insoluble calcium-containing inorganic substance to the wastewater in a reaction tank to convert the fluoride ions contained in the wastewater into calcium fluoride;

a second step of enabling solid-liquid separation of the wastewater containing the calcium fluoride in a solid-liquid separation device~~tank~~, and removing the calcium fluoride from the wastewater to obtain first treated water;

a third step of adding a pH regulator to the first treated water in a pH regulating tank to regulate a pH of the first treated water to an acidic region; and

a fourth step of passing the first treated water through a container filled with aminopolyol-based chelate resins, and adsorbing and removing the tetrafluoroborate ions from the first treated water to obtain second treated water.

2. The water treatment method according to claim 1,

wherein, in the first step, an additional pH regulator is added into the reaction tank to regulate the pH of the wastewater to the acidic region.

3. The water treatment method according to claim 1 or 2,

wherein the solid-liquid separation device is a horizontal filtering device.

4. The water treatment method according to any one of claims 1 to 3,

wherein the calcium-containing inorganic substance is calcium carbonate.

5. The water treatment method according to any one of claims 1 to 4,

wherein the pH regulator is sulfuric acid.

6. The water treatment method according to any one of claims 2 to 5,

wherein the additional pH regulator is sulfuric acid.

7. The water treatment method according to any one of claims 1 to 6, further comprising

a fifth step of supplying alkaline desorption liquid into the container to desorb the tetrafluoroborate ions adsorbed in the aminopolyol-based chelate resins.

8. The water treatment method according to claim 7,

wherein the desorption liquid is aqueous solution of sodium hydroxide.

9. A water treatment apparatus being a treatment apparatus of wastewater containing fluoride ions and tetrafluoroborate ions, the water treatment apparatus comprising:

a reaction tank for adding a water-insoluble calcium-containing inorganic substance to the wastewater to convert the fluoride ions contained in the wastewater into calcium fluoride;

a solid-liquid separation device~~tank~~ for enabling solid-liquid separation of the wastewater containing the calcium fluoride, and removing the calcium fluoride from the wastewater to obtain first treated water;

a pH regulating tank for adding a pH regulator to the first treated water to regulate a pH of the first treated water to an acidic region; and

a container filled with aminopolyol-based chelate resins, used for passing the first treated water therethrough, and adsorbing and removing the tetrafluoroborate ions from the first treated water to obtain second treated water.

10. The water treatment apparatus according to claim 9,

wherein the solid-liquid separation device is a horizontal filtering device.