Solution to Problem

[0006a] In one aspect, there is provided a subsurface soil purification method including: injecting a cleaning liquid into an injection well provided in the ground to separate a contaminant in subsurface soil from the subsurface soil, the cleaning liquid comprising a temperature higher than the temperature of a groundwater; pumping up the groundwater comprising the cleaning liquid, in which the contaminant separated from the subsurface soil has been dissolved, from a pumping well that is provided in the ground so as to be spaced apart from the injection well; and injecting an activator liquid that stimulates decomposition microorganisms to decompose the contaminant into the injection well, the activator liquid comprising a temperature higher than the temperature of the groundwater; wherein the activator liquid is injected into the injection well after injecting the cleaning liquid into the injection well.

[0007] In a first approach, a subsurface soil purification method includes injecting a cleaning liquid, that separates a contaminant in subsurface soil from the subsurface soil and that has been warmed to a higher temperature than a groundwater temperature, into an injection well provided in the ground, and pumping up groundwater containing the cleaning liquid, in which the contaminant separated from the subsurface soil has been dissolved, from a pumping well that is provided in the ground so as to be spaced apart from the injection well.

[0008] In the first approach, the cleaning liquid is injected into the injection well, enabling the contaminant that is fixed to soil particles in the subsurface soil to be separated from the subsurface soil. The groundwater containing the cleaning liquid in which the contaminant that has been separated from the subsurface soil is dissolved is pumped up through the pumping well, thereby enabling the separated contaminant to be purged from the subsurface soil so as to purify the subsurface soil. Warming the cleaning liquid to a higher temperature than the groundwater temperature enables separation of the contaminant from the subsurface soil to be promoted. This enables the efficiency of purification of the subsurface soil to be improved.

[0009] In a second approach, the subsurface soil purification method of the first approach, wherein after injecting a cleaning liquid, an activator liquid that stimulates decomposition microorganisms to decompose the contaminant and that has been warmed to a higher temperature than the groundwater temperature is injected into the injection well, or decomposition microorganisms that decompose the contaminant are injected into the injection well together with the activator liquid, or a purifying liquid that decomposes the contaminant and that has been warmed to a higher temperature than the groundwater temperature is injected into the injection well.

[0010] In the second approach, the contaminant separated from the subsurface soil by injecting a cleaning liquid is decomposed by decomposer microorganisms stimulated by the activator liquid, or is decomposed by the purification liquid, thereby enabling the subsurface soil to be purified.

[0011] Injecting the activator liquid that has been warmed to a higher temperature than the groundwater temperature into the injection well enables the decomposer microorganisms to be further stimulated, thereby promoting decomposition of the contaminant, compared to cases in which the activator liquid is injected into the injection well at or below the groundwater temperature.

[0012] Moreover, injecting decomposer microorganisms through the injection well enables

triptone, yeast extract, humic acid, plant oils, and the like.

[0044] Examples of pH adjusters that may be employed include sodium or potassium carbonates or bicarbonates such as sodium bicarbonate, sodium carbonate, and the like, ammonium hydroxide, ammonium carbonate, sodium tripolyphosphate, sodium diphosphate, Trisodium Phosphate, and the like.

[0045] Examples of micronutrients that may be employed include vitamin B12, vitamin B1, pantothenic acid, biotin, folate, and the like.

[0046] Examples of trace elements that may be employed include Co, Zn, Fe, Mg, Ni, Mo, B, and the like.

[0047] Note that the activator liquid 42 is basically a compound containing at least one out of the organic substances and at least one out of the micronutrients described above as activators. However, other known purification agents may also be added to the activator liquid 42. The TOC concentration of a culture solution of the purification agent is preferably from 50 mg/L to 5000 mg/L, and is more preferably from 100 mg/L to 300 mg/L. However, the TOC concentration does not necessarily need to be within these values.

[0048] It is sufficient to warm the activator liquid 42 to a higher temperature than the normal groundwater temperature. The temperature of the activator liquid 42 is preferably from 20°C to 60°C, and more preferably from 20°C to 35°C.

[0049] In the contaminant decomposition process performed by the contaminant-decomposing purification system 12, the activator liquid 42 generated and warmed to a higher temperature than the normal groundwater temperature in the conditioning tank 40 is injected into the injection well 24. The activator liquid 42 is fed into the contaminated soil 18, and decomposer microorganisms present in the contaminated soil 18 (subsurface soil) are stimulated by the activator liquid 42. Contaminants separated from the contaminated soil 18 (subsurface soil) in the first process are then decomposed by the decomposer microorganisms that have been stimulated by the activator liquid 42 (a third process).

[0050] Explanation follows regarding operation and advantageous effects of the subsurface soil purification method according to the present exemplary embodiment of the present disclosure.

[0051] In the flushing process of the flushing purification system 10 of the present exemplary embodiment, as illustrated in Fig. 1, the cleaning liquid 38 is injected into the injection well 24 and the cleaning liquid 38 flows into the contaminated soil 18, thereby enabling contaminants that are fixed to soil particles in the contaminated soil 18 (subsurface soil) to be separated from the contaminated soil 18 (subsurface soil). The groundwater 44

CLAIMS

1. A subsurface soil purification method comprising:

injecting a cleaning liquid into an injection well provided in the ground to separate a contaminant in subsurface soil from the subsurface soil, the cleaning liquid comprising a temperature higher than the temperature of a groundwater;

pumping up the groundwater comprising the cleaning liquid, in which the contaminant separated from the subsurface soil has been dissolved, from a pumping well that is provided in the ground so as to be spaced apart from the injection well; and

injecting an activator liquid that stimulates decomposition microorganisms to decompose the contaminant into the injection well, the activator liquid comprising a temperature higher than the temperature of the groundwater;

wherein the activator liquid is injected into the injection well after injecting the cleaning liquid into the injection well.

2. The subsurface soil purification method of Claim 1, further comprising injecting additional decomposition microorganisms that decompose the contaminant into the injection well together with the activator liquid.

3. The subsurface soil purification method of Claim 1, further comprising injecting a purifying liquid that decomposes the contaminant into the injection well, wherein the purifying liquid has been warmed to a temperature that is higher than the temperature of the groundwater.

4. The subsurface soil purification method of Claim 2, wherein the activator liquid and the decomposition microorganisms are injected into the injection well after injecting the cleaning liquid into the injection well.

5. The subsurface soil purification method of Claim 3, wherein the purifying liquid is injected into the injection well after injecting the cleaning liquid into the injection well.

6. The subsurface soil purification method of Claim 1, wherein the cleaning liquid is warmed to a temperature of 20°C to 80°C.

7. The subsurface soil purification method of Claim 1, wherein the cleaning liquid is warmed to a temperature of 25°C to 60°C.

8. The subsurface soil purification method of Claim 1, wherein the activator liquid is warmed to a temperature of 20°C to 60°C.

9. The subsurface soil purification method of Claim 1, wherein the activator liquid is warmed to a temperature of 20°C to 35°C.

10. The subsurface soil purification method of Claim 1, wherein the activator liquid comprises an activator selected from the group consisting of a hydrogen sustained release agent, an organic substance, a pH adjuster, and trace elements.

11. The subsurface soil purification method of Claim 1, wherein the cleaning liquid comprises a surfactant.