Development of Synthesis Method of Environmental Purification Material that uses Desulfurization Gypsum and Waste Gypsum Board − Optimization of Synthesis Method of Hydroxyapatite, and its Adsorption Abilities for Many Harmful Substances −

Background

The amount of waste gypsum board has expanded because the waste treatment method was changed from inert type landfill to the controlled type landfill by the notice of the Ministry of the Environment in June 2006. Because recycling usages of waste gypsum board are mostly cement raw material and gypsum board raw material, which are rivals to usage of the desulfurization gypsum, it is feared that this will take away demand for the desulfurization gypsum from electricity utilities. A method for synthesizing hydroxyapatite from gypsum that can adsorb the harmful substances in soil and water is developed for the expansion of the gypsum demand (Fig. 1).

Objectives

The present study aims to optimize the synthesis method of hydroxyapatite, to decrease the difference of the chemical composition, to achieve high level purity, and to evaluate the adsorptive performance regarding harmful substances.

Principal Results

1. Optimization of synthesis method

(1) Approximate expression of water quality composition of phosphorus solution extracted from sewage sludge ash
The linear relationship was shown between the phosphorus concentration of the extracted solution and P_2O_5 content of the sewage sludge ash. And, it was confirmed that the molar ratio of the main dissolved matter (phosphorus and aluminum) in the extracted solution became a fixed value.

(2) Rate of chemical reactions and optimum time for synthesis
The change in the content of phosphorus in the hydroxyapatite according to the reaction time was investigated. The reaction velocity constant of this synthesis method became 10-44 times the reported value obtained by an existing synthesis approach. Moreover, it is necessary to make the raw materials react for 80℃ in temperature and 6 hours or more to obtain hydroxyapatite with high purity.

(3) Influence that pH gives to purity of hydroxyapatite
The kind of the by-product material contained in hydoxyapatite has changed by the pH during the reaction. And, range (pH13.5-13.8) of the pH where the amounts of impurities decrease most was clarified by using the thermodynamics equilibrium calculation.

2. Evaluation of adsorptive performance to harmful substances

The adsorption test of hydroxyapatite was executed. As a result, hydroxyapatite adsorbed fluorine, cadmium, lead, nickel, zinc, and selenium (IV). The synthesized hydroxyapatite showed twice or more the amount of adsorption for fluorine (range 1-100 mg/L) compared with the charcoal bone (adsorbent that carbonized the bone) that was a rival material (Fig.2).

As for fluorine and lead, there are a lot of reported cases of soil contamination in the country. The synthesized hydroxyapatite shows high adsorption ability for both substances. Therefore, application to the stabilization treatment for heavy metal contaminated soil can be expected.

Future Developments

The test of stabilization treatment using the hydroxyapatite for heavy metal contaminated soil gathered in the locale will be executed.

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Reference

S. Yasuike et al., 2007, “Development of the synthesis method of environmental purification materials using desulfurization gypsum and waste gypsum board (Part 2) -Optimization of the synthesis method of the hydroxyapatite, and its adsorption abilities for many harmful substances-”, CRIEPI Report V06009 (in Japanese)

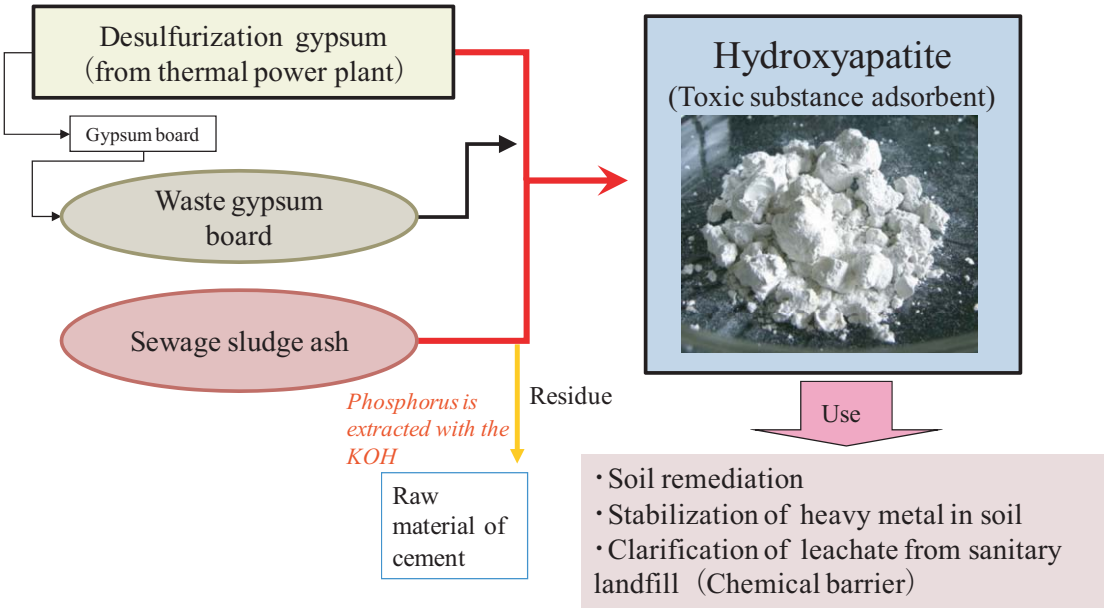

Fig.1 Schematic representation of hydroxylapatite synthesis

The hydroxylapatite that adsorbs toxic substances such as heavy metals is manufactured by using the desulfurization gypsum (Or, waste gypsum board) and the sewage sludge ash as a raw material.

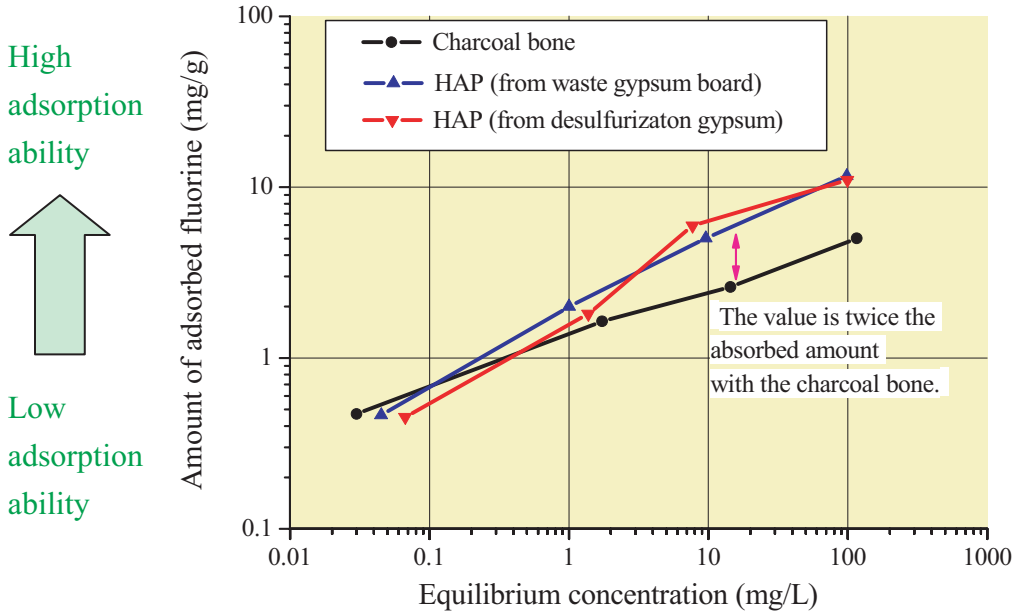

Fig.2 Adsorption isotherm concerning fluorine adsorption of hydroxylapatite (HAP)

The absorbed amount of the hydroxyapatite is about twice that of charcoal bone in a high concentration domain (equilibrium concentration 10mg/L or more). An excellent adsorption ability to the fluorine of the hydroxyapatite was confirmed as a result.