Basic Study on the Technologies for Usable Material Recovery from Sewerage Facilities		
Whole term	1992.10～1997.3	

(Purpose)

Sewerage systems have been performing important roles in the improvement of the living environment and the preservation of public water bodies. However, recently, the roles demanded of the sewerage systems have been diversified under the present situations where global scale environmental issues, such as energy and resource impoverishment or global warming, are getting more and more obvious.

Effective utilization technologies of sewage can be classified into three categories, namely material conversion, energy conversion and material recovery. For material conversion, technologies for composting and producing building materials from incineration ash or melted slag are already made practicable, and for energy conversion, technologies for heat recovery from sewage and power generation and sludge drying by digestion gas are also made practicable. For material recovery, however, practical technologies are not yet available.

It can be said that, sewerage accumulates resources discharged from urban activities. Therefore, sludge, which is generated from the sewage treatment, can be regarded as a concentrate of the resources. Concentrated usable materials are often detected in the sludge, even though they cannot be detected in the influent sewage as being below the detection limit. However, the components of the usable materials have been hardly investigated because the contents of overall components are too small, or there have been still fewer studies which examine usable material recovery.

Based on these circumstances, this study investigated usable material recovery from sewerage facilities.

(Results)

In 1996, a basic study and a series of bench-scale experiments were conducted on the technology for phosphorus recovery from incineration ash and fly ash slag along with the recovery processes, regulations regarding plant construction and recovery process design (tentative) and were evaluated based on the discussion on the results of the year before and on the marketability of the technology.

1. Methodology

As a recovery process, it followed the industrial process for phosphoric acid considering its operational simplicity, high recovery rate and the content unmixed with impurities, such as heavy metals. (acid leaching →settling separation→solvent extraction→back extraction→concentration)

2. Basic and bench-scale serial experiment

(1) Basic experiment

[acid leaching process]

The optimal conditions for fly ash slag and incineration ash were found to be 210 minutes leaching and 5% solid-liquid ratio for the former, and 90 minutes leaching and 10% solid-liquid ratio for the latter. On the other hand, the optimal conditions for mixing speed, reaction pH and the temperature were found to be 300rpm slow mixing, pH =1 and 80℃, respectively for both the fly ash slag and the incineration ash.

Under these conditions, and keeping their particle diameters same, the leaching rates of phosphoric acid were approximately 40% for fly ash slag and 90% for incineration ash, and no rise in the leaching rate of was observed for fly ash slag. In order to obtain high performance and to keep the operation stable, it turned out to be necessary to control the particle diameters.

[solvent extraction]

The leaching rate of sulfuric acid was found to be the highest compared to those of hydrochloric acid and acetic acid, and no influence by sulfate ions was observed. Considering the solvents, tributyl phosphate was selected, because it showed the highest phosphorus recovery rate compared to n-hexane and dichloromethane. As to the ratio of acid leachate to solvent, phosphorus recovery increased when the solvent ratio was high, and the reason behind was considered to be the partition to phosphoric acid in the acid leachate being the rate limiting factor. Accordingly, the target was set at 20% phosphoric acid recovery rate for present considering the economy, and the solvent extraction ratio was set at acid leachate:solvent=1:5.

(2) Bench-scale serial experiment

Under the conditions same as the basic experiment, the phosphoric acid recovery rate to the acid leachate was approximately 21-22% and stable both for incineration ash and fly ash slag.

3. Discussion on the regulations regarding plant construction

The following regulations are concerned with the phosphorus recovery plants; Factory Location

Law, Law Concerning the Improvement of Pollution Prevention Systems in Specific Factories, Poisonous and Deleterious Substances Control Law, Fire Prevention and Extinction Law, Waste Disposal and Public Cleansing Law and PL Law.

4. Economy evaluation

The recovery cost of phosphoric acid from incineration ash in a test calculation and fly ash slag was approximately 25-27 times higher than that of industrial phosphoric acid (75% content).

5. Future tasks

・Recovery of phosphoric acid with higher quality is desired through decreasing the impurities, such as heavy metals and at the same time, higher recovery rate is required. Furthermore, to make the technology practicable at actual plants, investigation for small scale plants is also needed.

・The phosphorus recovery process (tentative) was considered effective as a phosphorus recovery technology, considering the possible impoverishment of phosphorus ore in the future, though there are still some problems about its economic viability. Therefore, further research is needed to reduce the cost, for example, a discussion on the solvents, as well as the improvement of quality.

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