

# Expanded Use of Sewage Sludge Resources as Fertilizer as Part of Food Security

SANNOMIYA Takashi , Director, Water Quality Control Department

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## 1. Introduction

Among the three elements (nitrogen, phosphorus, potassium) which are indispensable for raising agricultural products, Japan depends almost entirely on imports for phosphorus (ammonium phosphate), and production is unevenly distributed to China and certain other countries. In addition, the price of those imports has also fluctuated violently in recent years<sup>1)</sup>. Against the background of import price fluctuations, competition to procure supplies has intensified as a result of the global destabilization of food production accompanying climate change, the ongoing crisis in the Russia-Ukraine situation, etc., as well as growing demand for food, and it is also recognized that there are large challenges in the Japanese government's basic policies of strengthening domestic food security and promoting the sustained growth of the agricultural, forestry and fisheries industry.

At the first meeting of the Headquarters on Measures to Secure Stable Supply of Food and Strengthen the Agriculture, Forestry and Fisheries Industries (Prime Minister's Office of Japan) in September 2022, one instruction given by the Prime Minister was to draw up an emergency package to respond to the urgent issue of rapidly rising food prices, to be led by the Minister of Agriculture, Forestry and Fisheries. This is an effort to achieve domestic production and a stable supply of fertilizer by expanding the use of the unused resources of sewage sludge, compost, etc., in cooperation with the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), etc.

## 2. Current Status and Issues for Use of Sewage Sludge in Fertilizer

Until now, the uses of sewage sludge have included use of the ash remaining after incineration in construction materials, use as energy, either as biogas generated by the digestion process or solid fuels produced by drying or carbonization, and use as a fertilizer or soil conditioner at green farms. Sewage sludge has high contents of phosphorus, nitrogen, and other elements, and the amount of phosphorus contained in sewage sludge in Japan is thought to be approximately 50 000 tons<sup>2)</sup>. Although this is seen as a phosphorus source that can be procured domestically, only about 10 % of the sewage sludge generated in Japan is currently being used in fertilizer.

To promote use, it will be necessary to overcome

technical issues and issues related to distribution. Use of sewage sludge in fertilizer can be broadly divided into composting to produce fertilizer and phosphorus recovery methods, in which phosphorus is recovered from the sludge treatment process (MAP method for obtaining magnesium ammonium phosphate, HAP method for obtaining calcium hydroxyapatite, etc., referred to hereinafter as "phosphorus recovery.") The composting method accounts for the majority of sewage sludge used in fertilizer. Issues for composting include the risk that compost may be contaminated with heavy metals, a negative image (which includes those contaminants), and the difficulty of securing distribution channels owing to a lack of know-how regarding spreading and fertilizer application methods. On the other hand, the issues for phosphorus recovery include high facility control costs and large variations in the recovered phosphorus content.



Fig.-1 Uses of sewage sludge (clockwise from upper left: a phosphorus recovery facility (Kobe City), fertilizer using recovered phosphorus, sewage sludge compost, and a sewage sludge composting facility (Saga City)<sup>2)</sup>

## 3. Demonstration Research of Fertilizer Use Technologies for Sewage Sludge

Based on the fact that technologies for producing fertilizer from sewage sludge were included in the Supplementary Budget for FY 2022, and were selected as a B-DASH Project (Breakthrough by Dynamic Approach in Sewage High Technology Project) for FY 2023, the

National Institute for Land and Infrastructure Management (NILIM) is conducting demonstrations, evaluations, etc. of technologies as research commissioned by the B-DASH Project,<sup>3)</sup> focusing mainly on solving technical problems.

For use of sewage sludge as fertilizer, a joint research group consisting of Kubota Corporation, Mitsubishi UBE Cement Corporation, Chubu Ecotec Co., Ltd., Shimane Prefecture and the Japan Sewage Works Agency is carrying out demonstration research on high-speed fermentation and drying, also blending biomass other than sewage sludge as submaterials, using a vertical closed fermentation technology which has a proven track record in composting up to the present. In this technology, adjustment of the charging rate, control of the air supply rate, etc. are controlled corresponding to the condition in the fermenter, aiming at stable treatment and labor-saving. As features of the technology, since the material is fermented in a closed, heat-insulated vessel, thermal efficiency is high, an external heat source is not necessary for drying, and countermeasures for odor can be implemented easily (Fig.-2).

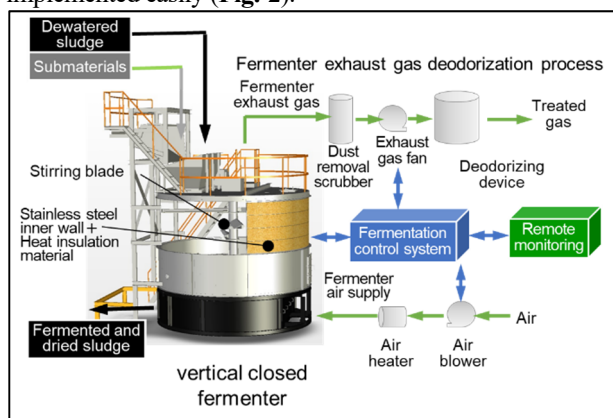


Fig.-2 Technology for production of fertilizer from sewage sludge by vertical closed fermenter<sup>3)</sup>

For phosphorus removal, demonstration research on a technology for recovering magnesium ammonium phosphorus (MAP) from digestion sludge (joint research group of Swing Engineering Corporation and Kobe City) is being carried out with the aim of stably achieving higher recovery efficiency than is possible with the conventional technology. Demonstration research on a technology for recovering MAP from the separated liquid when digestion sludge is dewatered (joint research group of JFE Engineering Corporation and Yokohama City), considering labor-saving and energy-saving by utilizing measurement and control technology, is also underway. For a technology for recovery of calcium phosphate from the separated liquid when dewatering is performed without a digestion process (joint research group of Taiheiyo Cement Corporation, Metawater Co., Ltd, and the Bureau of Sewerage, Tokyo Metropolitan Government), demonstration research on optimum control for securing stable quality through the four seasons is being conducted by following changes in the water quality of the separated

dewatering liquid with addition of phosphorus recovery materials just the right amount.

To use sewage sludge incineration ash as a raw material, a joint research group of SANKI ENGINEERING CO., LTD., Akita Prefecture, and the above-mentioned Tokyo Metropolitan Bureau of Sewerage is carrying out a study on a technology for reducing heavy metals from sewage sludge incineration ash and granulating the ash in an easy-to-use form.

On completion of this demonstration research, we will prepare guidelines for each of the technologies, and hope that sewage treatment plants will use the technology best suited to their individual needs.

#### 4. Conclusion

Use of sewage sludge, a domestically-available resource, in fertilizer will contribute to building a sustainable resource-recycling society, and since Japan depends on imports for the majority of its fertilizer, it is also attractive for obtaining a raw material that is easily affected by international market conditions and trends in exports by producing nations. As targets for 2030, the “Food Security Reinforcement Policy Framework,” which was approved by the government in December 2022, mentions doubling the use of compost and sewage sludge resources and increasing the share of domestic resources in total fertilizer use (phosphorus base) from 25 % in 2021 to 40 %.

Distribution is one major challenge for achieving these goals. In this area, the Ministry of Agriculture, Forestry and Fisheries, MLIT and other related parties are working to improve consumer understanding. As one concrete move, in December of 2023, the Tokyo Metropolitan Government and JA ZEN-NOH (National Federation of Agricultural Cooperative Associations) signed a partnership agreement to use phosphorus extracted from sewage sludge in Tokyo as fertilizer.

Since the mission of NILIM includes policy support and technology management for MLIT, we also intend to play an active role in these moves without delay.

For more information:

- 1) Ministry of Agriculture, Forestry and Fisheries (MAFF): Situation Surrounding Fertilizer, May 11, 2023:  
[https://www.maff.go.jp/j/seisan/sien/sizai/s\\_hiryu/attach/pdf/HiryokuMeguiR5-5b.pdf](https://www.maff.go.jp/j/seisan/sien/sizai/s_hiryu/attach/pdf/HiryokuMeguiR5-5b.pdf)
- 2) Ministry of Land, Infrastructure, Transport and Tourism (MLIT): Expansion of the Use of Sewage Sludge as Fertilizer:  
[https://www.mlit.go.jp/mizukokudo/sewerage/mizukokudo\\_sewerage\\_tk\\_000555.html](https://www.mlit.go.jp/mizukokudo/sewerage/mizukokudo_sewerage_tk_000555.html)
- 3) National Institute for Land and Infrastructure Management, MLIT:  
<https://www.nilim.go.jp/lab/ccg/bdash/bdash.htm>