MATERIAL CYCLES and WASTE MANAGEMENT RESEARCH

Vol. 35 No.2 May, 2024

Abstracts

【Special Issues: Latest Technologies and Challenges in High-moisture Organic Waste Treatment】

1. Movement and Direction of Efforts on Biomass Utilization

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Abstract

The Basic Act on Promotion of Biomass Utilization was legislated in June 2009. Based on the Act, the Cabinet committed to the Basic Plan for Promoting Biomass Utilization in December 2010 and then to a third Basic Plan in September 2022. In this third Basic Plan, *The Basic Policy on Measures for Promoting Biomass Utilization and Goals for National Government*, among others, have been defined.

Efforts are being taken by Biomass Industry Cities, a regional group aiming to establish economically efficient towns and villages that are environment-friendly and disaster-resilient; it focuses on construction of integrated systems to promote greater biomass utilization. There have also been efforts between local agencies and organizations to expand utilization of sewage sludge resources for fertilizer, which has been brought into the spotlight in more recent years. In summary, in order to further promote Biomass Utilization, the concerned agencies and organizations continue to steadily work on this issue based on pertinent policies, such as the Basic Plan for Promoting Biomass Utilization.

Keywords: biomass, The Basic Act on Promotion of Biomass Utilization,
The Basic Plan for Promoting Biomass Utilization, the biomass industry cities,
sewage sludge resources

2. Efforts toward Biomass Waste Utilization and Future Initiatives for its Widespread Adoption

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Abstract

This study investigates the current state and challenges of biomass waste utilization by examining workshops conducted over the past 20 years by the Biomass Waste Research Group of the Waste Management Society of Japan, annual presentations related to biomass utilization at conferences, and academic papers published in the English journal of the Society, JMCWM. At present, implementation of biomass utilization technologies remains limited. Challenges that have been identified as hindrances to the widespread adoption of the technologies include ensuring a homogeneous and sufficient supply of raw materials, developing efficient and economically viable conversion technologies, and addressing various issues to ensure economic feasibility. Additionally, efforts to overcome these challenges and advance the utilization of biomass waste involve research into novel conversion technologies. This encompasses the application of molecular biology to analyze and optimize complex microbial systems, such as composting and anaerobic digestion. Other focal points include microbial fuel cells designed for the direct production of electrical energy from biomass waste and the production of bio-jet fuels utilizing oil-producing algae. This study summarizes the comprehensive investigations, inclusive of economic feasibility and environmental impact assessments, which have been conducted not only on these technologies but also on the research associated with them.

Keywords: biomass waste, conversion technologies, social implementation, economic feasibility, environmental impact assessment

3. Recent Trends in Methane Fermentation Technology

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Abstract

There is a critical need for the development and widespread utilization of renewable energy technologies as a sustainable energy source in order to reduce greenhouse gas emissions and achieve the sustainable development goals (SDGs). Anaerobic digestion is an established technology for the treatment of wastes and wastewater to produce biogases such as methane. Methane fermentation technology has been extensively studied over the years, gaining sufficient data to establish it as a proven renewable energy technology. In recent times, advancements in low-cost and advanced next-generation sequencing technologies have led to a deeper understanding of electron transfer mechanisms between microorganisms in methane fermentation processes. This progress is expected to drive further developments in the field of methane fermentation.

This review focuses on modern applications for methane biotechnology, delving into the innovative aspects of methane fermentation technology Furthermore, the current review also discusses the vertical dry methane fermentation system, affordable small-scale methane fermentation systems, additives to enhance cost-effectiveness of methane fermentation system, using catalysts to improve fermentation efficiency, and the role of voltage application and hydrogen utilization in biomethanation.

Keywords: methane fermentation, small affordable system, additives, direct interspecies electron transfer, voltage application

4. Utilization of Organic Wastes into Fertilizer

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Abstract

According to the Green Food System Strategy, the Ministry of Agriculture, Forestry, and Fisheries aims to expand the organic market, and increase the ratio of organic farming to 25% (1 million hectares) of Japan's cultivated land by 2050. There will be a focus on domestic production and securing of fertilizers, and especially on the effective utilization of unused organic resources as fertilizers, in order to achieve this increment. In response to these matters, Komasuya Co., Ltd. has introduced a recycling technology that processes organic waste, conducts compost manufacturing, and uses fertilizers. The company strives to develop advanced knowledge to help people utilize compost and fertilizers appropriately.

Keywords: recycler, compost, fertilizer, quality control, suction aeration composting

5. Production, Utilization, and Evaluation of Organic Waste Recycling: Highlighting the Role of Nitrogen

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Abstract

Increased importation of nitrogen (N) through food, feed, and fertilizer, as well as the effect of N release into the environment, has become a hot topic of discussion in Japan. To enhance N use, N cycling, and reduction of the negative impact of N, it is important to obtain an accurate estimation of the amount of organic waste that originates from livestock production, the food industry, composted material, and daily human activities. The amount of compost generated in Japan has been estimated at 3.3-6.5 Tg N per year. This amount approaches or exceeds the national demand for chemical N fertilizer. To utilize this compost, it is necessary to consider balancing the other nutrient ingredients within Japan and to address the uneven distribution and variety of the compositions of organic wastes. The methods for evaluating N, and other nutrient ingredients, include nutrient balance, use efficiency, and a numerical model for predicting N infiltration. Although organic agriculture is thought to be one method for enhancing the use of composts, we should guard against its unrealistic expectations as crop productivity and the demand for nutrients by food and feed crops are not dissimilar to those of conventional agriculture. Effective actions for utilization of compost must include estimation of local fertilizer resources and ensuring the optimal use of organic waste.

Keywords: agricultural use, food waste, livestock waste, sewage sludge, nitrogen

6. Present State of Phosphorus Recovery Technology from Organic Wastes with High Water Content

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Abstract

Although phosphorus is one of the most important resources for fertilizer and industrial materials, the amount of phosphorous ore production is decreasing year by year. For Japan, which is completely dependent on phosphorus ore imports from abroad, the recovery of phosphorus from wastes in Japan is becoming more and more important under the destabilized international situation. Phosphorus is recovered from sewage sludge as a raw material of fertilizer through the following technologies: MAP production from digested sludge before dewatered or its filtrate; Recovery with a calcium silicate-based agent; Direct use of sewage sludge incineration ash; Calcium phosphate production by acid extraction/crystallization from the ash. Phosphorus is also recovered from livestock dung as a raw material through: Carbonization of compost; Direct use of incineration ash from compost or raw dung; Calcium phosphate production by acid extraction/crystallization from the ash. In order to develop future phosphorus recovery technologies, improvement in the collection systems of livestock dung and response to population decline will need to be taken into consideration.

Keywords: phosphorus resources, phosphorus recovery, sewage sludge, livestock dung

7. Solid Fuel Reprocessing from High Moisture Content Organic Waste: Technological Trends in Sludge Drying and Carbonization

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Abstract

This article outlines two sludge conversion technologies known as drying and carbonization, both of which are used to convert organic sludge into solid fuels. Because of the large amount of water it contains, the key to converting sludge into solid fuel is how to efficiently remove the water while improving the quality (calorific value) of the fuel without losing the combustible content (organic matter) in the sludge. At present, solid fuel conversion is not a major technology for sludge utilization, but is fundamental to the effective utilization of all components of the entire sludge amount. In recent years, various equipment and processes have been developed to improve energy efficiency during solid fuel conversion, and new drying and carbonization processes that integrate conventional processes are now being proposed. This article introduces those technologies.

Keywords: sludge, solid fuel, drying, carbonization