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Abstract

論文内容の要旨 (博士)

Title of Thesis 博士学位論文 名	Development and Assessment of Integrated System for Promotion of Biomass Utilization (バイオマス利活用の促進に向けた複合型システムの開発および評価)
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(Approx. 800 words)

(要旨 1,200 字程度)

The rapidly growing population and urbanization are accompanied by the increase of waste generation, which is well beyond the nature's assimilative capacity. Green technologies, namely anaerobic digestion and composting are among the emerging approaches to utilize the organic fraction of the waste, in order to achieve energy and nutrients recovery, as well as to establish a sustainable society. However, the application of such green technologies are not as wide as anticipated. Among the common constraints, such as technical, political and economic, the lack of public interest is considered as the most vital factor. Currently most of the studies focused on improving the performance or efficiency of each technology. But if the technologies do not attract, or benefit the public in a more direct way, the public's perspectives towards the biomass utilization may remain the same. A different approach, which can serve as a stimulus for the public interest, is therefore essential.

The main objective of this thesis is to propose an integrated system that not only utilizes the biomass but also results into the production of crops using the by-products from the biomass utilization. Differ from typical approach such as anaerobic digestion, where the main concern is to produce biogas as the result, under the integrated system the CO₂ that contains inside the biogas and emits during the combustion of biogas is used for CO₂ enrichment in seaweed cultivation and greenhouse, respectively. The latter is hence presented as an extra value for implementation of anaerobic digestion. The crops produced can be served as the direct benefit back to the public, who generate the biomass at the first place. It is anticipated that the awareness towards the benefits of biomass utilization can be improved under such integrated system.

This thesis consists of 3 main parts, with the first and second part discussed about the integration of anaerobic digestion with land-based seaweed cultivation and greenhouse, respectively. The CO₂, as a result of purification or combustion of biogas, is usually discharged into atmosphere without further utilization. By introducing land-based seaweed cultivation to be integrated with anaerobic digestion, the CO₂ that dissolved in the water upon purification of biogas, can be used to promote the seaweed growth. In the case of commercializing the land-based seaweed cultivation, the cost of

transporting seawater was estimated to be a major concern.

In the second part, the greenhouse was introduced to be integrated with anaerobic digestion, in which the CO₂ emitted during the combustion of biogas was utilized as the source of CO₂ enrichment in greenhouse. Based on the investigations, the injection of such CO₂ into the greenhouse did not only enhance the plants growth, but also could be served as the solution to prevent CO₂ depletion that would instead affect the plants growth in typical greenhouse approach. All in all, instead of discharging the CO₂ into the atmosphere it is certainly more beneficial to direct the CO₂ into the greenhouse.

The third part focused on verifying the vacuum-type aeration system as the efficient composting method to overcome conventional problems faced by composting. Odor control and the difficulty in monitoring are the two major concerns regarding composting. By using the vacuum-type aeration system, the gases, including the odorous gases that emitted during the composting process are collected and directed to a chemical scrubber. Apart from reducing the odor emission to the air, as reported in other studies, the composition as well as concentration of those gases can be monitored easily, as showed from the investigations in this thesis. On the other hand, quinone profile analysis, which can effectively quantify the changes in microbes, was introduced as a supportive monitoring method. These would certainly help to manage the composting process in a more efficient and comprehensive way, and even can be the breakthrough point for beginners to utilize the biomass through composting.

Overall, the proposed integrated system presented a shift of perspectives towards waste management in this coming era. The concept of such integrated system is to not only dispose of the biomass safely but also creates straight and direct values, namely crops production, to the public simultaneously. By implementing the integrated system, as proposed in this study, the biomass treatment will no longer be seen as a public nuisance that brings no benefits at all. The idea of utilizing by-products particularly CO₂, which conventionally discharged into atmosphere, can certainly change the perspectives towards current approach of biomass treatment. It is highly anticipated that this concept could be the benchmark for further innovative prospects, where the possibility as well as the potential of biomass can be fully utilized, and hence promoting the biomass utilization especially in developing countries.

(769 words)