論文の内容の要旨

Abstract of Dissertation

Integrated Analytical System for Optimizing Design of Large-scale Composting and Development of Serial Self-turning Reactor System

（大規模コンポスト発酵槽を支援する統合数値解析システムと直列型自己切返し反応システムの開発

ボンコッゲサクル　ナタコーン

(Bongochgetsakul Nattakorn)

Composting is one of the biotechnological treatment methods for biodegradable solid waste. It is being widely applied in a larger scale treatment facility due to its advantage on the aspects of less energy consumption and low-level technologies. As the scale of composting becomes larger to be met the demand of growing city, problem with system design and handling method becomes more difficult. In large-scale composting system, growth environment becomes differed from location to location. The compost system that provides good system design and operations is necessary to control proper growth condition at each location for optimizing degradation activities. In the past few decades, engineers proposed various large-scale composting systems for treatment of large amount of waste generated. However, many of the composting facilities have failed by economical and environmental aspects. Technology that is more complicated has been introduced to control the composting processes, which consequently resulted in higher treatment cost compared to the other treatment methods. Some bad design composting facilities have very much impact on environment and finally have to be closed. Most of the compost systems designed in the past was lack of systematical approach on overall system designing. Most of system design was based on trial-and-error process of which cost more fund and it cannot be ensured performance of the designed system.

This research proposes a new concept in symmetrically designing approach of a large-scale composting system and operations based on a simulation tool aiming for optimization design of a large-scale composting system. A state-of-the-art simulation namely BioDuCOM tool has been developed to trace all primary mechanisms occurs inside the compost matrix including coupled mass and energy transport, biologically degradation reactions of microorganism under arbitrary growth environment, and physically treatment process (e.g. turning and shifting operation). Coupled mass and

energy models to describe heat, moisture and oxygen transport that are considered as the most important factors affecting the degradation process, are introduced based on 3D Finite Element method. A new model that describes biologically degradation process of microorganism on a given substrate under arbitrary growth condition specified by the mass and energy transport models has been proposed. A new concept of numerical treatment on common composting operations has been proposed to simulate turning and shifting processes that are indispensable in general composting system. With collaboration among these models, composting processes can be simulated with only input of compost reactor shape, size, substrate properties, compost properties, system boundary conditions, treatment operation, etc. As a result, designing of better compost facilities and daily operation without performing trail experiments becomes possible. The application of simulation tool is aiming at lower overall cost of the composting system (construction cost, operation cost, maintenance cost, energy cost, land cost), lower safety risk, more efficient process and higher quality of compost product.

In addition to the simulation tool, a new proposal on cutting-edge composting technology has been proposed. The new composting technology is designed on five primary keywords: large-scale, high-performance, automatic, low cost and ambient friendly. A new zero-energy consumption mixing and turning of compost material based on advanced concrete mixing technology has been developed. A so-called self-turning reactor system that is a combination of composting reactor and zero-energy turning unit has been proposed. It has ability to be extended to support large-scale composting as demanded by place to place. The new composting technology has been proposed to collaborate with the simulation tools to find a new key for designing of a better composting system.

Based on simulation results by the BioDuCOM, it shows a possibility in many aspects in new approach in simulation of composting process. It captured primary phenomena occurred during the composting with good tendency and reasonable results. With further development of models and improvement on analytical parameters, it is expected that this framework is able to apply practically. As a result, designing of better compost facilities and daily operation with high efficiency becomes possible. In addition, parallel development of the BioDuCOM while retrieving feedback information from the development serial self-turning reactor system shall results in a better composting system than ever before.