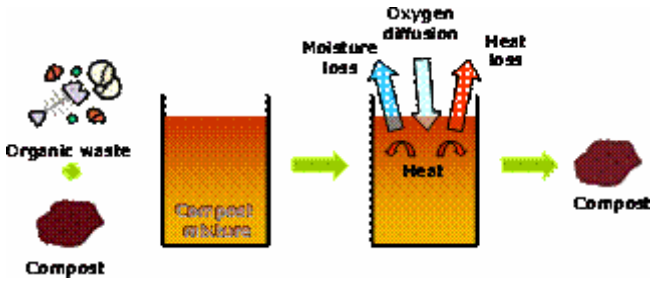
Integrated simulation system for organic waste decomposition process

Composting, besides incineration, landfill, and etc, is a treatment method for decomposition of organic-waste by utilizing microorganisms which being more popular in large-scale waste management system due to its advantage on energy consumption, low-level technologies, and environmental friendly aspects (for optimal process, by product of the composting process are only water and carbon dioxide). In order to obtain an optimal performance (means time cost, spatial cost, energy cost), all factors that are necessary for microbial decomposition process must be provided. However, composting that currently being applied to a large-scale treatment facility is lack of systematic approaching. As a result, quality of final product, time cost, energy cost and spatial cost are not as optimized as expected. Moreover, because of dealing with flammable byproducts, in case of the reaction turns to methanation process, from microbiological decomposition reaction under moderately high-temperature, safety of the facilities must be ensured.

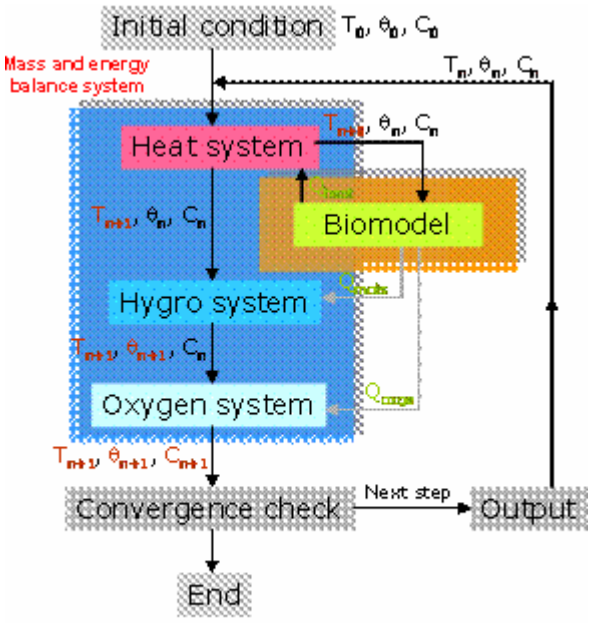
This research proposes a new approach to analyze systematically the biological decomposition process in the compost pile. Heat generation by the reaction, as well as water movement and oxygen consumption phenomena shall also be captured by proposed coupled mass and energy balance equations for each of those substances. A biological model for microbial decomposition process is proposed mathematically regarding all primary factors affecting the microbial activities, those are concentration and C/N ratio of substrate, microbial concentration, temperature, dissolved oxygen concentration, and moisture content. Basis of the analysis system has been designing to be applicable to all types of biodegradable solid waste. The analysis system is finally applied to designing a better composting system having lower cost, lower energy consumption, environmental friendly and safer than ever.



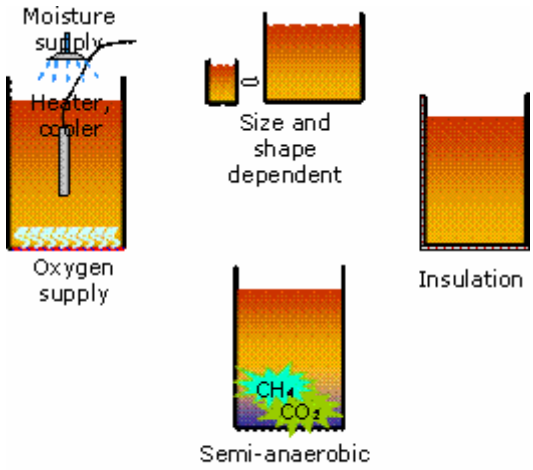
Approach and Methodology:

The mass and energy balance equations and Biomodel were integrated into an 3D FEM computer program based on the DuCOM technologies (Durability of Concrete Model, University of Tokyo), which is resulted in a total analysis program, namely BioDuCOM, that has ability to capture primary phenomena occurred inside compost pile. Analytical parameters regarding physical and microbiological properties of the compost are evaluated experimentally by series of tests.

With the aid of FEM, most of external treatment for controlling the composting conditions can also be simulated. For example, heat supply or drying by air blower/heater, water supply by sprinkle, water drainage, etc. Consequently, systematical designing of more complicated composting system becomes possible.

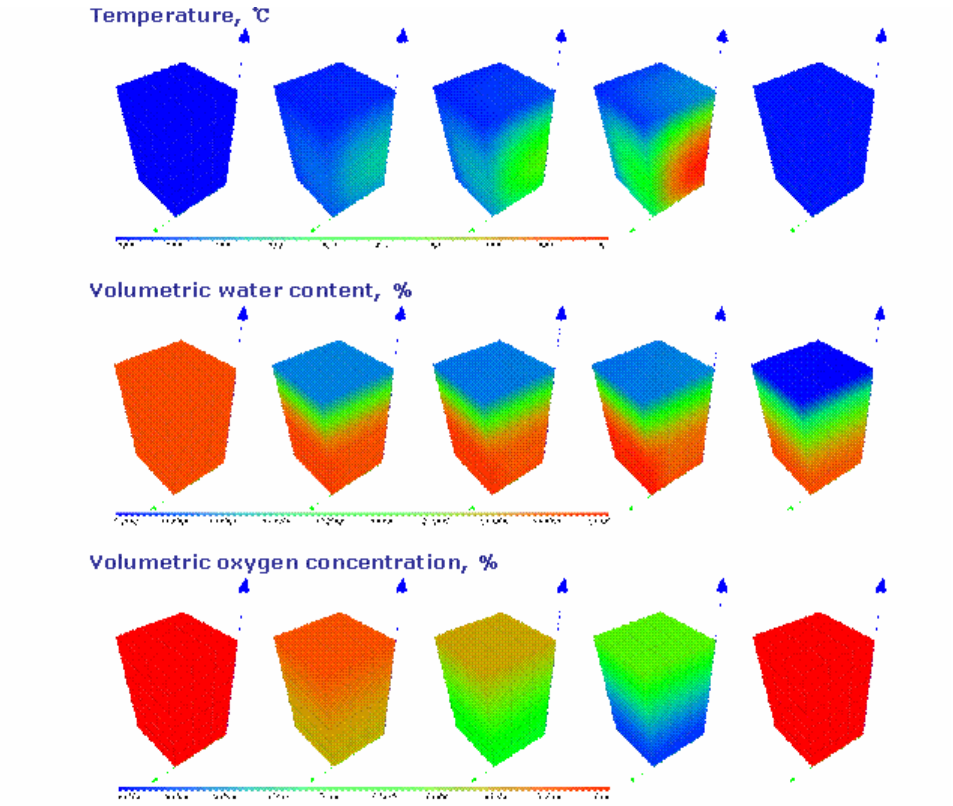


BioDuCOM framework



Applicable analytical simulation

Series of experiments having various initial conditions under various environmental conditions are performed and then verified with the analytical results. Physical and biological phenomena in the experiments are well simulated by the proposed analysis system. By such an accurate analysis system, we can introduce a better composting system having advantage on aspect of cost, energy, environment, spatial and safety to our earth for a better life in the future.



Analytical results for composting of distilled liquor waste in an insulated wooden box: ¼ modeling