（学位第３号様式）

学 位 論 文 要 旨

氏　名	Peng Wang
題　目	Study on Thermal Balance Model of Aqueous Biological Aerobic Treatment for Fertilizer Conversion (高水分バイオマスの肥料変換における液状好気性生物処理の熱収支モデルに関する研究)

Recycling high-moisture waste biomass as a stable and hygienic fertilizer is very essential towards sustainable agriculture production and circulation of biomass resources. Autothermal thermophilic aerobic treatment (ATAT) is assumed to be one of the most favourable technologies for stabilizing and sanitizing these into a biologically-safe, nutrient-rich and odour-free fertilizer product.

In this study, thermal balance analyses for the aerobic treatment including activated-sludge process (ASP) and ATAT were investigated to elucidate the thermodynamic process with exothermic reaction and to explore the potential of autothermal thermophilic operation for efficient utilization of high-moisture waste biomass as a fertilizer for agriculture production. From these results, a simple lab-scale instrument was developed to determine the specific biological heat yield in aerobic decomposition of organic matter to explore a practical ATAT condition by necessary organic removal level.

First step, to investigate the potential for heat generation by aerobic treatment, a thermal balance model for ASP was developed and validated with a full-scale ASP facility treating pig slurry. The ASP energy model could accurately simulate the heat budget of the reactor and its accuracy to estimate the reactor temperature was within 0.60 ^{o}C. The results showed that the heat was mostly gained from solar radiation and biological reaction, and mainly lost through slurry surface and slurry flow. Total heat gain had the potential to lead a reactor temperature rise of 3.87 to 5.15 ℃/d. It implies the need for effective thermal insulation of the reactor. Next step, for quantitative interpretation of ATAT operation, a thermal balance model for ATAT was developed and validated by a full-scale ATAT reactor treating human excreta. The ATAT energy model simulated the thermal dynamic changes in the reactor and the results showed that the biological heat yield in aerobic biodegradation (Q_{bio}) was the principal heat source for self-heating. The specific biological heat yield (Y_{bh}) by degrading 1 g of COD in human excreta was estimated at 12.1 kJ/g COD. The specific mean generation rate of Q_{bio} during self-heating phase was estimated at 1.190 MJ/h/t and 5.7 times higher than that after self-heating at 0.208 MJ/h/t. The heat loss from airflow, including sensible heat loss by airflow and latent heat loss by evaporation, was primarily responsible for the decrease in reactor temperature after self-heating.

To confirm the application potential of thermal balance modelling method, a lab-scale aerobic system was developed and this modelling method was examined to estimate Q_{bio} and Y_{bh} during aerobic treatment of artificial wastewater. Estimated Y_{bh} on volatile solids (VS) and COD removal basis were 16.98 ±1.53 kJ/g VS and 16.40 ±0.56 kJ/g COD, respectively.

These study results were successful in providing an important insight into the nature of aqueous biological aerobic treatments and were available as effective guidance for developing ATAT systems.