Restructure of the Wastewater Treatment and Sludge Recycling Systems to Achieve Both the Improvement in Business and Environment Performances

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[Abstract]

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In this research, simulation models were developed towards restructure of wastewater treatment and sludge recycling systems. For wastewater treatment system, an environmental fate model was built to estimate the effect of the improved sewage disposal rate on the ecological health of aquatic organism in rivers as receiving sources. In which, the rate can be improved by (1) increasing the number of households connecting to the sewage line in corresponding area, and (2) replacing the singular type of onsite water-purifier tank in households with combined type of tank. Based upon the sewage disposal rate of 70.5% (FY2015) in Gunma prefecture, three scenarios were considered including scenario A, the rate is improved to 75.2% in FY2030, scenario B to 88.2% and achieving medium target in FY2030, and scenario C to 100% in FY2040. The biochemical oxygen demand (BOD) estimation model was customized based on AIST-SHANEL ver.3.0, and BOD concentrations in river water were estimated for each scenario. Besides, ecological health of the river was evaluated using EPT (Ephemeroptera, Plecoptera, and Trichoptera) richness index - a substituted indicator for habitat environment quality. Improvement effect was then visualized according to EPT richness after an introduction of a correlation equation between BOD concentration and EPT richness index. The number of locations with improved habitat environment in research area through simulation and associated cost-effectiveness were evaluated. As for sludge recycling system, restructuring was based on two updated measures including (1) integration of sludge treatment function to a wastewater treatment plant (WWTP), and (2) integration of incineration function to a waste incineration plant (WIP). The results of total greenhouse gases emissions showed that a 59% reduction was reached by introducing both integration measures under a system where a high-efficiency sludge dewatering equipment was installed in a WWTP, and a 57% reduction was obtained under a system with anaerobic digestion. For supporting the preparation of proposed measures, the material balance model was built for a WWTP, and the heat balance model was developed for a WIP.

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