Integrated Assessment of Operational GWP and Resource Recovery Credits in Wastewater Treatment Plants in Korea

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ABSTRACT

Wastewater treatment plants (WWTPs) generate greenhouse gas (GHG) emissions from wastewater and sludge treatment. Electricity consumption also contributes to indirect GHG emissions. Resource recovery, however, can offset a portion of these emissions. This study quantified the operational global warming potential (GWP) of 610 public WWTPs in Korea based on the 2024 national sewerage statistics. Scope 1 and Scope 2 emissions were quantified at the facility level using the IPCC Tier 1 methodology. Net GWP was then evaluated by incorporating environmental credits from reclaimed water, biogas energy recovery, sludge composting, and solid recovered fuel (SRF) production. The operational GWP ranged from 0.236 to 0.762 ton CO_2 eq./m^3 across treatment processes. Electricity consumption and N_2O emissions from biological nitrogen removal were identified as major contributors to GWP. The membrane bioreactor (MBR) process showed the highest GWP. The combined activated sludge (AS), biofilm, and biological nutrient removal (BNR) process, by comparison, showed the lowest GWP. This variation reflects differences in the contributions of direct and indirect emissions among treatment processes and process combinations. Incorporating environmental credits reduced net GWP by 3.4–31.5%. The extent of this reduction depended on the implementation of resource recovery and the actual amount of resources recovered. Overall, the findings show that the operational GWP of WWTPs is influenced not only by treatment processes but also by direct emissions, electricity consumption, sludge management, and resource recovery. An integrated assessment of GHG emissions and environmental credits is therefore essential for developing effective GHG mitigation strategies for WWTPs.

Keywords: Wastewater treatment plant/ Global warming potential/ Greenhouse gas/ Resource recovery/ Environmental credit