EXPLORING INTERMITTENT CONTACT OXIDATION PROCESS FOR ENHANCED IN-SEWER PURIFICATION AT SEWER UPSTREAM

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ABSTRACT

The modern sewer was designed as a transportation tool of sewage, and wastewater treatment plant (WWTP) was constructed at the end of sewer to purify sewage. The sewer and WWTP system successfully protects public health and receiving water body. Such system, however, does not fulfill some criteria for environmental sustainability. A technology that reduces energy consumption for sewage treatment is the in-sewer purification technology, by actively utilizing biological reactions in sewer to purify sewage. Natural in-sewer purification can be enhanced by applying intermittent contact oxidation process (ICOP) in sewer. Application of ICOP is recommended at sewer upstream. Still, at sewer upstream the characteristics of sewage flow is poorly understood, and performance of ICOP under such condition remains unknown.

This study aims at exploring the potential of applying ICOP at sewer upstream for enhanced in-sewer purification to improve environmental sustainability in wastewater management. The aim encompasses three specific objectives. The first specific objective is to gain an understanding on in-sewer purification and sewer upstream by extensive literature review (Chapter 2). The second objective is to explore performance of ICOP under sewer upstream conditions with lab-scale experiment (Chapter 3). The third objective is to clarify contribution from in-sewer purification to environmental sustainability in wastewater management, through scenario analysis and discussion on wastewater management paradigm (Chapter 4).

The review in Chapter 2 summarized a timeline of in-sewer purification, and specifically focused on enhanced in-sewer purification and development of ICOP. For the application of in-sewer purification, sewer upstream was proposed. At sewer upstream, sewage quantity and quality is highly varied. Sewage flow pattern is characterized by intermittency, prevailing dry condition, and hydraulic instability.

In Chapter 3, a lab-scale ICOP reactor was constructed with sponge media installed in pipe. The sponge media retained microorganisms while being subject to intermittent water flow, so that oxygen supply was guaranteed. To reflect a sewer upstream condition, synthetic sewage and tap water was introduced into the reactor following a simplified flow pattern, including small volume of synthetic sewage flow, idle time with media exposure to air, large volume of tap water flow, and another idle time with media exposure to air. Under this pattern, organic matter removal efficiency was rather stable regardless of the extent of idle time. Explanation for the stable performance, even with extremely short sewage contact time, was attributed to the physical absorbance of sponge together with the carbon storage by microorganisms. The average organic matter removal rate was 2 gCOD/(L-sponge・d), based on which pollutant removal at sewer upstream was estimated. The estimated performance, as well as the stability observed in experiment, favored application of ICOP at sewer upstream.

As for Chapter 4, energy consumption for sewage treatment with ICOP was calculated, for a virtual community with high, medium, and low population density. The energy saving was up to 80% for area with medium to low population density. Thus, application of ICOP was proposed for cluster system with satellite WWTP. For the cluster system, water reuse could be adopted to form a closed water loop, which further reduced net water extraction from environment.

This study yielded an insight into application of ICOP at sewer upstream. The ICOP is suggested as a measure to enhance in-sewer purification, and as a choice for greater environmental sustainability in wastewater management.

Key words: intermittent contact oxidation process, sewer upstream, wastewater management, in-sewer purification