Respirometric evaluation of biodegradation kinetics for ultrasonic disintegrated domestic sludge

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ABSTRACT

This paper studied the suitability of an internal carbon source for nitrogen removal enhancement with mechanically disintegrated waste activated sludge (WAS) using ultrasonication. In this context, particle size distribution (PSD)-based chemical oxygen demand (COD) fractionation was performed, and denitrification rates of the total, particulate and soluble range of the disintegrated WAS sample were determined. The effect of ultrasonic disintegration on biodegradation characteristics of the domestic WAS was evaluated by respirometry. The ultrasound density of 1 W/mL was applied to the raw WAS, and the specific energy was calculated as 52.8 kJ/g TSS. Two thousand and eight hundred milligram per liter of COD, which corresponded to the 24% of the total COD, was released from the WAS. The PSD-based COD fractionation showed that the COD concentration at the particulate range (65.4%) was significantly high followed by the soluble range (15.5%), and 54% of the solubilized COD was accumulated at the <2 nm size range implying the remarkable effect of disintegration in terms of biodegradability. The maximum denitrification rate was determined as 18.2 mg N/g active VSS h, which is compatible with the results obtained for readily biodegradable fraction of the domestic wastewater. Model calibration results indicated that 33% of the total disintegrated WAS sample was biodegradable which corresponded to the total COD in the disintegrated WAS filtrate collected after 1,600 nm. The maximum hydrolysis rate for $X_{S1}$ was estimated as 5.2/d for the disintegrated samples verifying that ultrasonic disintegration increased the hydrolysis rate of the domestic WAS. The hydrolysis half-saturation constant for $X_{S2}$ was decreased from 0.26 to 0.10 g COD/g COD for the filtrates collected from 1,600-nm and 2-nm filters. The removal of nonbiodegradable COD fraction enhanced the hydrolysis process of the slowly hydrolyzable fraction in the remaining filtrate.

Keywords: Denitrification rate; Domestic waste activated sludge; Particle size distribution; Respirometric evaluation; Ultrasonic disintegration