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Pilot-scale study of hydraulic retention time and energy consumption in biological treatment of raw municipal wastewater by air micro-nanobubble aeration in different seasons

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ABSTRACT

The improvement of wastewater treatment plants is an environmental and economic priority. The highest energy consumption in wastewater treatment plants relates to aeration units with the current technologies. Microorganisms can use air micro-nanobubbles (AMNBs) for biological activity due to AMNB's high oxygen transfer rate, high stability in the aeration reactor, and increased contact surface. This study investigated the effect of aeration with AMNB on hydraulic retention time (HRT), energy consumption, chemical oxygen demand (COD), and nitrogen removal efficiency in the biological treatment of raw municipal wastewater without pretreatment for an extended time during cold and hot seasons. Suspended growth treatment and attached growth mode were studied by installing an active bio-curtain (ABC) as an improvement solution. In the presence of AMNB and ABC, effective micro-organisms significantly increased ten times as conventional activated sludges (CAS). Micro-nanobubble aeration helped the oxygen transfer and accelerated the aerobic layer formation, which took advantage of partial nitrification and denitrification for total nitrogen removal and resulted in total nitrogen removal by 99%. In comparison, 78% and 97% of COD removal in suspended and attached growth modes were achieved in the warm seasons at the optimum HRT of 9 h. In the cold seasons, with a decrease of about 5%, the COD removal yields 73% and 90% in the identical HRT (9 h), respectively. The aeration energy consumption in this study to eliminate the definite ratio of organic loads shows a reduction of about 40% compared to CAS. Excess sludge reduction has also been achieved by up to 70%. In conclusion, this research shows the potential and possibility of practical exploitation of the AMNB aeration and ABC to treat municipal wastewater.

Keywords: Air micro-nanobubbles; Raw municipal wastewater; Biological treatment; Aeration efficiency; Oxidation

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