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Case Study

Full-scale demonstration of step feed concept for improving an anaerobic/anoxic/aerobic nutrient removal process

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HIGHLIGHTS

- A WWTP with A/A/O process should be updated due to stringent effluent limits.
- The combination of step feed concept and carriers achieve desired effluent quality.
- The nitrified liquor recycling and sludge return pump were omitted.
- Annual electricity consumption of 245 MWh was saved as a result of these modifications.

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ABSTRACT

A small wastewater treatment plant (WWTP) failed to meet effluent requirements of the first-A discharge standard in China, with the anaerobic/anoxic/oxic (A/A/O) process treating municipal and partial industrial wastewater. Thus an A/O step feed process (Anoxic/oxic/anoxic/oxic/anoxic/oxic) with floating plastic carriers in aerobic units was proposed to improve nutrient removal within the existing WWTP. Four main reform strategies were applied: (1) the original influent was divided into three streams which led into corresponding anoxic units; (2) floating plastic carriers were placed in the second and third oxic units; (3) nitrified liquid recycling was omitted; (4) channel shapes and sizes were adjusted between adjacent units to prevent backflow. After these modifications were implemented, the total nitrogen and phosphorus concentrations in the effluent were reduced from 20.8 to 14.2 mg/L, and from 1.89 to 0.57 mg/L, respectively. Moreover, annual electricity consumption in the WWTP was reduced by 245 MWh as a result of these modifications.

1. Introduction

Municipal wastewater treatment facilities in China are facing increasingly stringent effluent quality standards, in response to the government's attempt to limit nutrient (particularly nitrogen and phosphorus) pollution of natural water bodies (Peng and Ge, 2011). Thus, there is a pressing demand amongst new and existing wastewater treatment plants (WWTPs) to implement more efficient and cost-effective biological nutrient removal (BNR) technologies to meet effluent quality standards.

Compared to the anaerobic/anoxic/oxic (A/A/O) process, the step feed BNR process has several advantages, such as greater carbon availability for denitrification, reduced bioreactor volumes due to higher sludge concentration, and has been successfully applied in many full-scale WWTPs (Adamski et al., 2000; Chang and Ouyang, 2000; Fujii, 1996; Ge et al., 2010; Gorgun et al., 1996; Larrea et al., 2001; Peng and Ge, 2011; Zhu et al., 2009b) .

In addition, temperature is a key parameter controlling the nitrification process as it affects the growth and metabolism of nitrifying bacteria and archaea. Generally, low temperatures result in overall nitrogen elimination by reducing the growth and activity of biomass involved in ammonification (Szpyrkowicz and Kaul, 2004). Generally, WWTPs in Northeastern China use process water near10 °C during the winter, thus nitrification is often the limiting step in the overall process of nitrogen removal. However, floating or fixed carriers have been suggested to enhance nitrification by allowing higher biomass concentrations (Guo et al., 2009; Kaindl, 2010). Here, a combined technology was proposed for upgrading a small WWTP in China, based on the step feed strategy and floating carriers.

Therefore, the objective of this study is to investigate the performance and feasibility of the step feed process with floating plastic carriers in a full-scale WWTP of China, based on the existing conventional A/A/O process. All upgrades in infrastructure were optimized while considering existing configurations and cost.

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