



Regular article

Effect of thermal hydrolysis sludge supernatant as carbon source for biological denitrification with pilot-scale two-stage anoxic/oxic process and nitrogen balance model establishment

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HIGHLIGHTS

- The optimal C-source recovery conditions for pilot-scale THP were determined.
- Thermal hydrolysis sludge supernatant was used as C-source for N removal.
- A pilot-scale THP combining an A/O/A/O process for denitrification was operated.
- Satisfied denitrification effects were achieved with hydrolysed sludge addition.
- N balance model was established for A/O/A/O process and showed satisfied accuracy.

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Waste activated sludge
Carbon source
Denitrification
Nitrogen balance model

ABSTRACT

To recover carbon source (C-source) from waste activated sludge (WAS) and enhance the nitrogen removal performance, a pilot-scale system consisting of two-stage anoxic/oxic (A/O) process and low-temperature thermal hydrolysis process (THP) was proposed. The C-source recovery parameters for pilot THP were determined by systematically considering the results of orthogonal jar experiment, hydrolyzed sludge biodegradability and actual pilot situation. The results showed that supernatant from WAS treated by pilot-scale THP showed desirable biodegradability ($BOD_5/SCOD$ 0.62) and C/N (18) at the condition of heating temperature of 80 °C, heating time of 90 min and sludge water content of 98%. The performances of two-stage A/O process for 35 days indicated that the effluent quality could comply with the preset discharge standard, and hydrolysed sludge supernatant could be utilised as C-source for biological denitrification. A nitrogen balance model was established for two-stage A/O process, which showed high simulation accuracy and could be applied to optimize the operation parameters to meet TN discharge standard.

1. Introduction

It is well known that the exceeded discharge of nutrients (N and P) to surface water bodies usually causes eutrophication. For many full-scale wastewater treatment plants (WWTPs), the removal efficiency of P could be markedly improved through flocculant addition [1]. However, N removal is still a challenge for many WWTPs due to insufficient C-source in the influent wastewater [2]. Therefore, C-source addition is essential to enhance N removal efficiency [3].

Waste activated sludge (WAS) produced from WWTPs contains large quantities of organics and can be applied as C-source for biological denitrification, which could achieve sludge reduction and recycle

simultaneously. Many researchers have studied the WAS pre-treatment methods for C-source recovery, such as alkaline fermentation [4–6], wet oxidation [7], thermal hydrolysis [8–10], fermentation [11], mechanical disintegration [12] and ionizing irradiation [13,14]. Among these methods, low-temperature thermal hydrolysis process (THP) is suitable for full-scale application and has attracted wide attention in recent years.

Two-stage A/O process has excellent performance for N removal due to twice nitrification and denitrification process, and has been widely used in many WWTPs worldwide. However, nitrification and denitrification processes have different requirements of microorganism species, dissolved oxygen (DO), pH and organics content. Meanwhile,

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