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Simultaneous enhancement of organics and nitrogen removal in drinking water biofilm pretreatment system with reed addition

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HIGHLIGHTS

- ▶ Nitrate removal efficiency was positively related with the influent C/N ratio.
- ▶ Nitrogen removal was enhanced via reed addition in drinking water biofilm pretreatment system.
- ▶ Combined with HRT regulation, low effluent nitrate and TOC concentrations were achieved.
- ▶ Bacteria diversity shifted significantly with the variation of the influent C/N ratio.

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ABSTRACT

A novel drinking water biofilm pretreatment process with reed addition was established for enhancement of simultaneously organics and nitrogen removal. Results showed that nitrate removal efficiency was positively related with the influent C/N ratio, reaching to 87.8 ± 2.8% at the C/N ratio of 4.7. However, the predicted trichloromethane (THM) levels based on total organic carbon (TOC) and UV_{254} were high with the increase of influent C/N ratio. Combined with the pollutants removal performance and microbial community variation, an appropriate C/N ratio via reed addition was determined at 2.2 for the continuous biofilm reactor. With adjustment of hydraulic retention time (HRT), the highest of nitrate removal efficiency (74.2 ± 1.4%) and organics utilization efficiency (0.63 mg NO_3^--N mg^{-1} TOC) were achieved at an optimum HRT of 18 h, with both low effluent NO_3^--N (0.88 ± 0.03 mg l^{-1}) and TOC (2.86 ± 0.67 mg l^{-1}).

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1. Introduction

In recent decades, nitrogen pollution has frequently appeared in natural waters due to wastewater discharge and non-point source of runoff, which poses a threat to public health through drinking water (Camargo and Alonso, 2006). Much attention has been paid to the polluted source water remediation and drinking water treatment, and biofilm treatment with fillers is a popular approach due to its low maintenance cost and effective nitrogen and organics removal (Farhadian et al., 2008; Qin et al., 2007).

It is well known that elector donors are essential to biological denitrification. However, the deficiency of electron donor is very common during the biological denitrification in wastewater and natural water (Calderer et al., 2010; Warneke et al., 2011). Thus, many studies have been carried out in external carbon addition for the treatment of polluted water with low C/N ratio. Previous studies have proved that organic compound type and level were important for determining the biofilm community and architecture. Srinandan et al. (2012) reported that different exogenous carbon sources (e.g. acetate, glucose and methanol) significantly affected the denitrifying activity, nosZ gene abundance and biofilm structure. What's more, several studies focusing on determination of nutrients limiting biofilm development in water treatment and distribution systems, have shown a positive relationship between biodegradable carbon source in water and bacterial growth in biofilm (Chandy and Angles, 2001; Vanderkooij, 1992). In order to enhance biofilm growth and denitrification efficiency for polluted water treatment, the addition of external carbon sources seems to be a very attractive way for nitrogen removal in ologitrophic environment.

Until now, using plant carbon source for denitrification has become more and more popular in the recent years because it is economic and effective (Park and Yoo, 2009). The agricultural by-products (wheat straw, rice husk, etc.) and plants in ecosystem (reed, *Typha latifolia*, *Elodea canadensis*, etc.) are very familiar plants used as extra carbon source (Gibert et al., 2008; Ovez

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