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# Biomass characteristics and simultaneous nitrification–denitrification under long sludge retention time in an integrated reactor treating rural domestic sewage

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## HIGHLIGHTS

- A novel integrated A/O biofilm reactor was proposed to treat rural domestic sewage.
- Sludge return and anoxic stir were needless in contrast with conventional A/O process.
- TN was removed efficiently by ideal SND under low C/N ratio and less sludge discharge.
- Wasted sludge in MBBR was disposed simply by intermittent discharge under long SRT.
- SRT of 42 ± 4 days promoted reduction and stabilization of aerobic biomass in MBBR.

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## ABSTRACT

In this work, a novel integrated reactor incorporating anoxic fixed bed biofilm reactor (FBBR), oxic moving bed biofilm reactor (MBBR) and settler sequentially was proposed for nitrogen removal from rural domestic sewage. For purposes of achieving high efficiency, low costs and easy maintenance, biomass characteristics and simultaneous nitrification–denitrification (SND) were investigated under long sludge retention time during a 149-day period. The results showed that enhanced SND with proportions of 37.7–42.2% tapped the reactor potentials of efficiency and economy both, despite of C/N ratio of 2.5–4.0 in influent. TN was removed averagely by 69.3% at least, even under internal recycling ratio of 200% and less proportions of biomass assimilation (<3%). Consequently, lower internal recycle and intermittent wasted sludge discharge were feasible to save costs, together with cancellations of sludge return and anoxic stir. Furthermore, biomass with low observed heterotrophic yields (0.053 ± 0.035g VSS/g COD) and VSS/TSS ratio (<0.55) in MBBR, simplified wasted sludge disposal.



## 1. Introduction

Nowadays, more and more developing countries face a great challenge of treating increasing number of decentralized domestic sewage with the popularity of water flushing toilets in rural areas. Taking China for instance, the proportions of domestic sewage treated are as low as 18.1% for county towns and 4.9% for rural villages by 2009. The discharge of those untreated wastewater containing excess nitrogen compounds, leads to the eutrophication of receiving waters especially the enclosed watersheds (e.g., slow moving rivers, lakes and reservoirs), and threatens the safety of drinking water resources potentially. Therefore, nitrogen removal from rural domestic sewage is a social concern. From the viewpoint of economics, biological nitrogen removal (BNR) has most interest presently. However, with the improvements of living quality and changes of lifestyle in China's rural areas, carbon to nitrogen (C/N) ratio decreased gradually because of the increasing nitrogen proportion of the domestic sewage, which made BNR much more difficult without carbon source dosage. On the other hand, with the formulation of increasingly strict discharge standards for sewage treatment by government, BNR is of great urgency.

To date, conventional nitrification–denitrification technology like anoxic–oxic (A/O) process, has been mature in municipal sewage treatment on account of rich practical experiences obtained during the long-term application and management (Luostarinen et al., 2006). Considering the shortage of expertise and intelligent control in rural areas, A/O process is supposed to be more suitable for BNR than other novel technologies (e.g., shortcut nitrification–denitrification and anaerobic ammonium oxidation).

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