



## Effects of packing rates of cubic-shaped polyurethane foam carriers on the microbial community and the removal of organics and nitrogen in moving bed biofilm reactors

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### HIGHLIGHTS

- ▶ Three MBBRs with 20%, 30% and 40% packing rates of PUF cubes were constructed.
- ▶ Packing rates of the PUF had little influence on the COD removal efficiency.
- ▶ Ammonium removal was affected by the packing rates.
- ▶ Microprofiles revealed that dense biofilm limits the DO and nitrate diffusion.
- ▶ The structure of the microbial community was influenced by the packing rates of PUF.

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### ABSTRACT

The effects of packing rates (20%, 30%, and 40%) of polyurethane foam (PUF) to the removal of organics and nitrogen were investigated by continuously feeding artificial sewage in three aerobic moving bed biofilm reactors. The results indicated that the packing rate of the PUF carriers had little influence on the COD removal efficiency (81% on average). However, ammonium removal was affected by the packing rates, which was presumably due to the different relative abundances of nitrifying bacteria. A high ammonium removal efficiency of 96.3% at a hydraulic retention time of 5 h was achieved in 40% packing rate reactor, compared with 37.4% in 20% packing rate. Microprofiles of dissolved oxygen and nitrate revealed that dense biofilm limits the DO transfer distance and nitrate diffusion. Pyrosequencing analysis of the biofilm showed that *Proteobacteria*, *Bacteroidetes* and *Verrucomicrobia* were the three most abundant phyla, but the proportions of the microbial community varied with the packing rate of the PUF carriers.

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### 1. Introduction

With the rapid rate of urbanization and enactment of more stringent legislation, wastewater treatment plants are increasingly required to improve treatment capacity and efficiently eliminate organic substrates and nitrogen from wastewater. One of the solutions is the application of moving bed biofilm reactors (MBBR), which combine the advantages of both the activated sludge process and a biofilm reactor by incorporating free-floating carriers that provide large surface areas for biomass growth with no need

for biomass recycling. Typical advantages of the MBBR system are the low head loss, absence of filter channeling, lack of prerequisite periodic backwashing, and provision of a large surface area for colonization and high specific biomass activity (McQuarrie and Boltz, 2011; Odegaard, 2006). To date, MBBRs have been successfully employed to treat sewage and industrial wastewater and upgrade small wastewater treatment plants (Loukidou and Zouboulis, 2001; Yang et al., 2009).

One of the key elements of the MBBR is the microbial carrier, which traditionally has a high specific area, surface roughness, high strength, porosity, and durability. Carriers are where the microorganisms accumulate to form a biofilm and enhance process effectiveness (Leenen et al., 1996). Biofilm carriers have included

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