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Influence of sludge retention time at constant food to microorganisms ratio on membrane bioreactor performances under stable and unstable state conditions

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HIGHLIGHTS

- Effect of SRT (20 and 50 d) at constant F/M ratio on MBR performances was assessed.
- Autotrophs and heterotrophs showed higher exogenous activities at SRT of 50 d.
- Higher soluble microbial products (SMP) release was observed at SRT of 50 d.
- SMP were composed at 49% of polysaccharides at SRT of 50 d.

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ABSTRACT

Food to microorganisms ratio (F/M) and sludge retention time (SRT) are known to affect in different ways biomass growth, bioactivities and foulants characteristics. Thus the aim of this study was to dissociate the effects of SRT from those of F/M ratio on lab-scale membrane bioreactors performances during stable and unstable state. Two acclimations were stabilized at a SRT of either 20 or 50 d with a constant F/M ratio of 0.2 $kg_{COD}\ kg_{MLVSS}^{-1}\ d^{-1}$. During stable state, a higher $N–NH_4^+$ removal rate (78%) was obtained at SRT of 50 d as an easier autotroph development was observed. Soluble microbial products (SMPs) release was double at 50 d with a majority of polysaccharides (49% of total SMP). The unstable conditions consisted in F/M ratio changes and operation without air and nutrient. Autotrophs were highly affected by the tested disturbances and SMP retention on membrane surface exhibited consistent changes during the performed stresses.

1. Introduction

The growth rate of membrane bioreactor (MBR) is higher (almost 10.9% per annum) compared to other advanced wastewater treatment technologies and more than any other membrane technologies (Drews, 2010). The MBR system has drawn a lot of attention because of the numerous advantages over the conventional wastewater treatment plant (WWTP), such as a smaller footprint, process flexibility and complete retention of the biomass. As sludge retention time (SRT) affects in the same time biomass characteristics (*e.g.* sludge structure and biomass activity) (Han et al., 2005), membrane biofouling (Grelier et al., 2006) and outlet effluent quality, SRT is considered as one of the target operating factors to control (Meng et al., 2009). Thus, in the past ten years the rate of publications on the SRT in MBR and its influence on bioactivities of microorganisms (Han et al., 2005; Huang et al., 2001), sludge structure (Laera et al., 2007), dissolved organic matter as well as ammonium removal efficiencies (Hocaoglu et al., 2011) and membrane fouling (Van den Broeck et al., 2012) has increased continuously.

In aerobic bioprocesses there are heterotrophic and autotrophic bacteria which prevail. Because the oxidation of inorganic material does not yield as much energy as the oxidation of organic carbon sources, autotrophs have a much slower growth rate than heterotrophs. Thus, it is preferable to work at a high sludge rate to achieve a high ammonium removal rate.

As far as membrane biofouling is concerned, the extracellular polymeric substances (EPS) in either bound or soluble form are currently considered as the predominant cause of fouling in MBRs (Le-Clech et al., 2006; Meng et al., 2009). Bound EPS consist of proteins, polysaccharides and humic substances, which are the main components, and lipids, nucleic and uronic acids in fewer proportions (Wingender et al., 1999). They are located at the cell surface or outside. Soluble microbial products (SMPs) can be defined as the pool of organic compounds that are released into the solution from

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