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Fouling characterization in aerobic granulation coupled baffled membrane separation unit☆

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ABSTRACT

Aerobic granular sludge treatment system performs better than the conventional aerobic wastewater treatment in terms of treatability, strong microbial structure, high biomass retention and excellent settling ability. However, the effluent produced has high suspended solid content above the discharge standards. Thus, membrane filtration could be an alternative post-treatment process. This study was conducted to treat high strength wastewater using aerobic granulation reactor coupled with baffled membrane separation unit and to evaluate the fouling potential of the supernatant of the granulation reactor. The results showed that aerobic granulation reactor could operate at high organic loading of 15 kg COD/(m^3 d) with crushed shell support media. Moreover, it was observed that the soluble polysaccharides (sPS) concentration in the supernatant of the granulation reactor (the most important fraction in soluble extracellular polymeric substances (sEPS) up to 84%) increased with an increasing organic load rate. The results suggest that irreversible adsorption of sEPS particularly sPS could be the main cause of membrane fouling.

1. Introduction

In recent years, application of aerobic granular sludge system is becoming an attractive wastewater treatment due to its compactness, regularity, high bioactivity, high biomass retention and excellent granule setting velocity. The granular sludge is 10 m/h, while the conventional-activated sludge is about 1 m/h [1,2] and the sludge volume index (SVI) is up to 12 mL/g [3]. In addition, the granule cultivated from crushed shell support media was more advantageous than non-support media granules in terms of compactness, settling ability and shock loading resistance [4]. Furthermore, granular sludge reactor promises a compact treatment system due to its high organic loading rate (OLR). OLR values as high as 9 kg COD/(m^3 d) [5] and 15 kg COD/(m^3 d) [6] is attainable, which is about sevenfold higher compared to the conventional-activated sludge process. The characteristics of aerobic granules measured by various researchers are summarized in Table 1.

Compared to anaerobic granular sludge, aerobic granular sludge process can be operated from low to high OLR. The treated water quality can have a lower effluent soluble organic concentration (low soluble BOD/COD) which is unachievable from the anaerobic process. Simultaneous nitrification denitrification has been proven to achieve up to 70% in a single aerobic reactor [7,8]. Furthermore, it can tolerate toxic substances such as phenol [9] and low operating temperature up to 8 °C [3]. Aerobic granule can be produced easier and faster than anaerobic granule resulting in shorter start-up period.

The advantages of a granular sludge over other media-based biotreatment processes (e.g. biological aerated flooded filter, biofilter, trickling filter, packed-bed reactor, etc.) are as follows: (1) granular sludge can be operated with or without a support media. If support media are used, they must be small, porous, circular and high settling properties; (2) aerobic granules are in homogenous movement in the reactor, resulting in higher removal efficiencies; (3) granular sludge is suitable for batch operation while media-based treatment process is preferable for continuous operation.

Aerobic granules can be easily cultivated in batch reactors after 1 month of operation with strong aeration and short settling time [1,10]. Short settling time allows granules to be retained in the reactor and the light fraction of suspended solids to flow through the effluent. The suspended solids concentration in the effluent depends on the operation parameters of the granulation system, namely loading rate, settling velocity, withdrawal time and characteristics of the influent such as suspended solids (SS),

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