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Short communication

Characterization of aerobic granular sludge at various organic loading rates

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ABSTRACT

Aerobic granular sludge was cultivated from activated sludge with two types of supports, namely bivalve shell carrier (BSC) and anaerobic granules (ANG). Granules were characterized at different organic loading rates (OLRs) ranging from 2.5 to 15 kg COD/m^3 d and these granules were observed to withstand high OLRs. The physico-chemical characteristics of the aerobic granules were better than those of seed sludge. The granule formation with ANG support was found to be similar to that of non-support cultivation, *i.e.* formation from activated sludge only. By contrast, BSC support showed better performance in terms of faster settleability, compactness and especially resistance against organic shock loading. It also enabled self-cleaning effect by removing biofilm attached on the reactor wall during the start-up phase resulting rapid granulation process.

1. Introduction

Aerobic granular sludge is recognized to be superior to conventional activated sludge in terms of settling ability, compactness, treatability, etc. It has a settling velocity greater than 10 m/h and sludge volume index (SVI) up to 30 mL/g [1]. Furthermore the granulation system could operate at high OLRs up to 15 kg COD/m^3 d [2]. Several researchers investigated aerobic granule formation from activated sludge [3–6]. However, studies on formation and characteristics of aerobic granule with supports are very limited. The support material allows the formation of biofilm on its crevices, pores and outer surface which is more advantageous compared to suspended growth due to operation at higher volumetric loading, increase in process stability, higher biomass retention, higher specific removal rate and simultaneous nitrification and denitrification. Moreover, as the sludge age is independent of the hydraulic retention time, slow growing microorganisms accumulate easily in the granular biofilm reactor [7].

One of the supports used to cultivate aerobic granules is basalt which is commonly found in solidified lava, a type of igneous rock mainly comprising of calcium-rich feldspar and pyroxene. This support material is porous, rough and with large surface area, has a good potential for biofilm development [8]. A wide variety of both natural and synthetic supports are available for microbial cell immobilization such as gravel, stone, sand, granulated clay, bivalve shell, basalt, power/granular activated carbon, sponge, etc. The support material for aerobic granulation should be spherical in shape, hard enough, should homogenously suspend with biomass, settle faster and have large surface area. Out of the two supports, bivalve shell carrier (BSC) has the characteristics similar to basalt with high porosity and surface area which could be ideal immobilized support for granular sludge cultivation. The BSC is readily available and easy to produce when compared to other support materials. In addition, anaerobic granule (ANG) was selected as organic support and compared to BSC, since it was found to be easily converted into aerobic granule after seeding into granulation reactor [1]. Moreover, the use of supports was found to enable the self-cleaning process as their movement could remove the biofilm layers attached on the walls of the reactor during the start-up phase. It was found that the biofilm formation on the reactor walls should be avoided for effective granulation process [3,6]. Thus, this study focuses on the characterization of aerobic granule with the two different supports at various OLRs.

2. Materials and methods

2.1. Synthetic wastewater and supports for granule formation

Glucose was used as the sole organic source of synthetic wastewater. The composition was as follows (mg/L): glucose (664), $NaHCO_3$ (450), NH_4Cl (150), KH_2PO_4 (43), $CaCl_2{\cdot}2H_2O$ (30), $MgSO_4{\cdot}7H_2O$ (12), $FeCl_3$ (3.6). 1 mL/L of trace elements were added as reported by Thanh et al. [6]. Initially, COD of this

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