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Kinetic, stoichiometric, and morphological assessment of aerobic granulation in a sequencing batch airlift reactor

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Aerobic granular sludge has recently become a promising environmental biotechnology process for wastewater treatment. Understanding the aerobic granulation process in all its facets is, therefore, of major importance.

In the present work, aerobic granulation of activated sludge was achieved in a sequencing batch airlift reactor (SBAR) fed with acetate as sole carbon source. Aerobic granulation process was followed by the assessment of the biomass kinetics and stoichiometrics through respirometric pulse experiments, and by the assessment of aggregates morphology through image analysis. The SBAR was operated in 4 hour cycles, with 2 minutes settling time that promoted the selection of biomass with a minimum settling velocity of 11 m/h. The average COD removal efficiency was always above 90 %. Biomass concentration increased from 2.4 ± 1.3 g MLVSS/L to 10.4 ± 3.5 g MLVSS/L. Biomass density increased from 3.4 ± 0.3 g/L to a maximum of 15.8 ± 1.4 g/L. Compact aggregates with granular characteristics were identified after 4 days of operation. Average diameter increased from 0.47 ± 0.01 mm to 1.3 ± 0.05 mm (Figure 1).

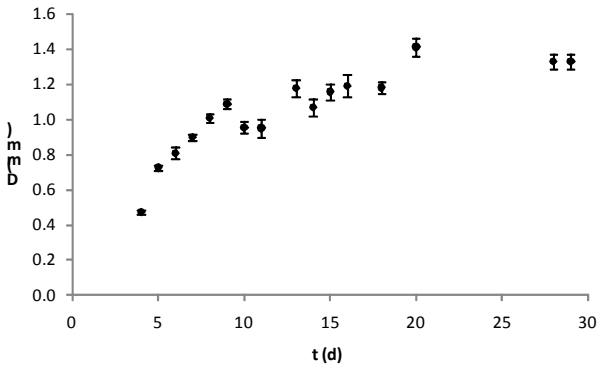

Figure 1. Time course of the aggregates average diameter during the aerobic granulation process.

Respirometric experiments were performed to total biomass, and, separately, to aggregates with diameter bigger than 0.25 mm, designated as granular biomass. Stoichiometric results showed a significant difference between the apparent growth yields and the true growth yields of the granular sludge, indicating that granular biomass was storing substrate at a significant extent likely as a response to the alternate feast-famine periods typical in SBR reactors. Substrate affinity constant (K_S) of the granules were higher than that of the total biomass, 43.4 and 31.3 h^{-1} respectively, this was attributed to the substrate diffusion through the granules. The predominance of granular biomass in the reactor was shown respirometrically by the significant contribution of the granular sludge to the total oxygen uptake rate (OUR).

This study contributes for a better understanding of the aerobic granulation process, focussing on the kinetic, stoichiometric, and morphological characteristics.

Keywords: aerobic granulation, respirometry, image analysis