Achievement of High Rate Nitritation with Aerobic Granular Sludge Reactors Enhanced by Sludge Recirculation Events

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ABSTRACT

A ratio control strategy has been used to demonstrate the feasibility of this automatic control procedure for the achievement of stable full and partial nitritation. The control strategy assured constant ratio between the dissolved oxygen (DO) and the total ammonia nitrogen (TAN) concentrations in the bulk liquid of aerobic granular sludge reactors operating in continuous mode. Three different set-ups with different reactor capacities were used (3, 110, and 150 L). High strength synthetic wastewaters and reject water were tested with similar performance. Achieved nitrogen loading rates ranged between 0.4 and 6.1 $kgN \cdot m^{-3} \cdot d^{-1}$, at temperatures between 20°C and 30°C. Granular sludge and nitritation were stable in the long term continuous operation of the reactors. Suitable stable effluent for Anammox has been obtained using the desired TAN setpoint (i.e. 50% of influent ammonium oxidation). An existing biofilm model developed incorporating the implemented control loops and validated in a previous publication was used to investigate the effects of the ammonium concentration of the influent and the biofilm density on the achievement of full nitritation. The model demonstrated how sludge recirculation events led to a stable and significant increase of the biomass concentration in the reactor, which in turn resulted in the achievement of high nitrogen loading rates, due to the action of the control strategy. The model predicted an enhancement of stable full nitritation at higher ammonium concentrations in the influent. Poor influence of the biofilm density in the achievement of full nitritation was predicted with the model.

KEYWORDS: Partial nitrification, Reject water, High strength ammonium wastewater, Closed-loop control

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