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Abstract of the doctoral dissertation entitled:

„Analysis of the impact of intermittent aeration on the course and efficiency of the nitrification process in moving bed reactors"

This dissertation focuses on the analysis of the course and efficiency of the nitrification process in moving bed biofilm reactors, with particular attention to the impact of different aeration strategies (defined by the ratio between non-aerated and aerated subphases' time, and dissolved oxygen concentration) and the form of biomass development in the reactors (biofilm vs. activated sludge). The research aimed to achieve the following key objectives: 1) to assess how aeration strategies influence the course and efficiency of the nitrification process in various moving bed reactor configurations (pure or hybrid); 2) to evaluate the effect of activated sludge development in a pure moving bed reactor on wastewater treatment efficiency; 3) to analyse the impact of different aeration strategies on energy use for aeration; 4) to investigate how temperature affects the rates of particular stages of the nitrification process; 5) to examine how mainstream-sidestream switching affected the activity and abundance of canonical nitrifiers and Comammox bacteria (shifting from a mainstream hybrid reactor for C, N, and P removal to a sidestream biofilm nitrification reactor). The experiments were conducted in laboratory-scale sequencing batch reactors with an active volume of 28 litres, using EvU-Pearl® moving bed media with a specific surface area of 600 m^2/m^3 as biomass carriers. The scope of the research included an analysis of wastewater influent and effluent quality (COD, N-NH_4^+, N-NO_2^-, N-NO_3^-, N_{og}, P_{og}, P-PO_4^{3-}, pH, alkalinity), ammonia utilization rate tests, nitrite utilization rate tests, N_2O emission measurements, quantitative polymerase chain reaction and next-generation sequencing. The results indicated that the aeration strategy was a key factor affecting the activity and abundance of particular groups of nitrifying microorganisms, enabling comparable nitrification performance at varying energy consumption for aeration, while also affecting N_2O emissions. It was demonstrated that Comammox bacteria play an important role in nitrification, dominating even the canonical AOB. Additionally, a temperature correction coefficient was proposed, applicable in hybrid wastewater treatment systems, which could be practically used in the design and optimization of wastewater treatment systems.

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