INSTITUTIONEN FÖR KEMI OCH MOLEKYLÄRBIOLOGI

Microbial communities in anammox- and nitrifying biofilms

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Abstract

Excess of nitrogen in water bodies causes eutrophication. One important source of nitrogen is the effluent from wastewater treatment plants (WWTPs). Nitrogen in wastewater is most commonly removed by nitrification-denitrification. During nitrification-denitrification, aerobic ammonia oxidizing bacteria (AOB) oxidize ammonium to nitrite, which is in turn oxidized to nitrate by their syntrophic partners; aerobic nitrite oxidizing bacteria. Heterotrophic denitrifiers can then convert the nitrate to harmless nitrogen gas. Partial nitritation-anammox (PNA) is an alternative process for nitrogen removal which is today used for treatment of warm and concentrated sidestreams (reject water after anaerobic sludge digestion) at WWTPs, with potential to be used also for the mainstream of wastewater. PNA relies on bacteria capable of anaerobic ammonium oxidation (anammox) using nitrite as electron acceptor. Together with AOB they convert ammonia to nitrogen gas. To increase retention of biomass in bioreactors, bacteria are often grown in biofilms, microbial communities attached to a surface. The overall aim of this thesis was to study nitrifying- and anammox communities in biofilms, using moving bed biofilm reactors as a model system. Reactor performance, microbial community dynamics and biofilm structure of PNA reactors operated a low temperature or low ammonium concentration were studied, showing community stability, but process instabilities. Differences in composition and ribosomal content between reject- and mainstream communities were investigated, showing that both abundance and bacterial activity are important for explaining differences in process rates. Basic question about biofilm ecology were also studied. Here, for the first time, predation of anammox bacteria in biofilms was demonstrated. Furthermore, it was shown how biofilm thickness influences nitrifying communities and biofilm functions, with differences in community composition and ecosystem function. Together these results help to unravel the link between community composition and bioreactor function for anammox and nitrifying biofilms, which can lead to development of new technologies and strategies for N-removal in wastewater.

Keywords: biofilms, AOB, anammox, partial nitritation-anammox, nitrification, wastewater