Monitoring Salinity Effects on Denitrification with a Rugged and Portable High-precision Membrane Inlet Mass Spectrometer

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Microbial aggregates were grown under 10‰-saline and non-saline conditions in upflow sludge blanket reactors, in order to assess the effect of salinity on denitrification and dissimilatory nitrate reduction.

Denitrification rates were determined with the ^{15}N-isotope pairing technique by incubating saline and non-saline grown aggregates at different salinities in a custom-designed Flow-Through Stirred Retention Reactor, which was directly connected to a rugged, portable Membrane Inlet Mass Spectrometer (GAM 200, InProcess Instruments).

Membrane Inlet Interfaces are generally characterized by a semi-permeable membrane, which is separating the liquid phase from the gas phase. The latter is passing through the membrane onto the ion source of a highly precise quadrupole mass spectrometer.

Saline grown aggregates showed an increase of the denitrification rate at salinities up to 15‰ above their growth salinity, whereas the denitrification rate of non-saline aggregates decreased down to approximately a third of the original rate at just 3.5‰ salinity. All rate measurements are based on at least 100 consecutive MIMS-based concentration measurements ($R^2 \geq 0.99$ in all cases, with one exception $R^2 = 0.98$), obtained within a single batch experiment, respectively.

Corresponding nitrite measurements showed a stronger accumulation of nitrite in non-saline grown microbial aggregates (non-saline 73µM - 99µM vs. saline 34µM - 59µM). Nitrite consumption decreased with increasing salinities in both aggregate types, but with a smaller rate in saline grown aggregates. Hence, dissimilatory nitrate reduction was only minimally affected by salinity for either of the two aggregate-types, resulting in an accumulation of toxic nitrite when activities of subsequent reactions were reduced.

Additionally, the surface of the saline grown microbial aggregates was identified as the source of the excess nitrite. Consequently, the surface-to-volume ratio is inferred to have a regulatory effect on the imbalance of nitrite production and consumption, beside other factors.