Ammonium removal by nitrification in drinking water treatment

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Overview of the nitrifying organisms

- Ammonia-oxidizing *Archaea* (AOA)
- Ammonia-oxidizing bacteria (AOB): *Beta*-, *Gammaproteobacteria*
- Heterotrophic nitrifiers
- Anammox bacteria: *Planctomycetales*
- Nitrite-oxidizing bacteria (NOB)

Important enzymes

- Ammonia monooxygenase (AMO), Cu-, Fe-dependent
- Hydroxylamine oxidoreductase (HAO) - heme P460
- Nitrite oxidoreductase (NXR) - iron-sulfur molybdoenzyme (*Nitrobacter winogradskyi*)

The main biochemical mechanisms

$$NH_3 + O_2 + 2H^+ + 2e^- \xrightarrow{AMO} NH_2OH + H_2O \xrightarrow{HAO} NO_2^- + 5H^+ + 4e^-$$

$$2NO_2^- + 2H_2O \xrightarrow{NXR} 2NO_3^- + 4H^+ + 4e^-$$

Factors affecting successful biological nitrogen removal

- Slow growth
- Dissolved oxygen
- Temperature
- pH
- Inorganic carbon
- Light

Removal of nitrate

- Denitrification to N_2
- Exogenous electron donor must be supplied

Conclusions

- Nitrification in many cases appear to be an efficient and cost-effective method for ammonium removal.
- The choice of a suitable colonization medium to support fixed biomass is important.
- The control of relevant environmental factors is required.