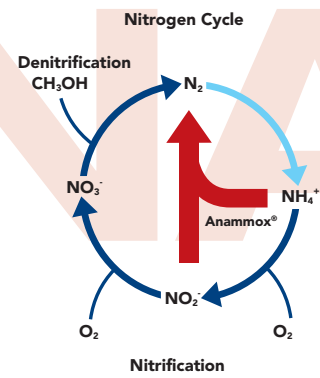


Cost-effective and sustainable nitrogen removal

The ANAMMOX® (Anaerobic Ammonium Oxidation) process is a new biological process representing a major breakthrough in nitrogen removal.

When preceded by partial nitrification, the ANAMMOX® process is a very cost-effective and sustainable way of removing ammonium from effluents and ammonia from waste gas. Compared to conventional nitrification/denitrification the operational costs are reduced by up to 90%, while CO₂ emission is reduced by 88%. Furthermore the plant requires only half the space taken up by nitrification/denitrification.

The ANAMMOX® conversion is an elegant shortcut in the natural nitrogen cycle. ANAMMOX® bacteria convert ammonium (NH₄⁺) and nitrite (NO₂⁻) into dinitrogen gas.



In close collaboration with the Delft University of Technology and the University of Nijmegen, Paques has developed this process for commercial purposes. In the summer of 2002 the first full-scale ANAMMOX® plant was started up in the Netherlands. This plant, with a capacity of 500 kg N per day, treats the rejection water of the sludge digestion of a municipal wastewater treatment plant. In the year 2006, a total of 4 full-scale ANAMMOX® plants are operational in diverse industries like the: tannery, food processing and semi-conductor industry.

Characteristics of the ANAMMOX® process

SUSTAINABLE

- no additional chemicals are required, such as methanol as electron donor
- CO₂ emission is reduced by 88% as compared to conventional nitrification/denitrification
- high nitrogen removal efficiency makes re-use of treated effluents possible
- high-rate process requiring 50% less space than nitrification/denitrification

COST-EFFECTIVE

- power consumption is reduced by up to 60% as compared to conventional nitrification/denitrification
- no methanol consumption
- operation under mild process conditions
- no production of excess sludge

Technology

The ANAMMOX® bacteria combine one unit of nitrite with one unit of ammonium to give dinitrogen gas. In order to produce nitrite, half of the ammonium has to be partially oxidized into nitrite by a partial nitrification process.



Because ANAMMOX® bacteria convert ammonium and nitrite into dinitrogen gas, full oxidation to nitrate has to be prevented. This can be done in several ways, e.g. by operating the process under oxygen-limiting conditions or by making use of the difference in growth rate between ammonium oxidizers and nitrite oxidizers. At temperatures above 20 °C ammonium oxidizers have a higher growth rate than nitrite oxidizers.

The ANAMMOX® process is based on energy conservation from anoxic ammonium oxidation with nitrite as the electron acceptor:



The process is carried out by a group of planctomycete bacteria of which *Candidatus* "Brocadia anammoxidans" was the first to be identified. The red-colored ANAMMOX® bacteria have a relatively low growth rate and biomass yield and also have excellent granulation capacity.

Paques' experience of more than twenty years in the design, construction and operation of biological wastewater treatment plants was crucial during the scale-up of the ANAMMOX® process. This resulted in a specially designed gas lift loop type ANAMMOX® reactor that combines very good biomass retention and granule formation with excellent mixing. Therefore effective conversion and stable operation are guaranteed.

Many industrial and other processes emit nitrogen compounds into the environment, thereby disturbing the nitrogen balance. This can lead to environmental problems such as eutrophication, acidification and the greenhouse effect. To reduce these problems nitrogen compounds such as ammonium and ammonia have to be removed from effluents and waste gases respectively. Up till now physical/chemical processes like stripping and precipitation and conventional biological nitrification/denitrification have been the processes most commonly applied for the removal of ammonium.

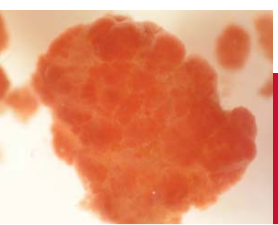
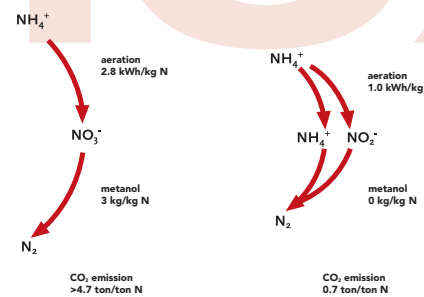
Applications

The ANAMMOX® process can be used for the removal of ammonium from all types of effluents with a relatively high ammonium concentration (NH₄⁺-N > 200 mg/l) and a relatively low COD concentration.

PROCESSES AND INDUSTRIES WHERE THESE EFFLUENTS ARE FOUND:

- municipal waste water treatment (rejection water from a sludge digester)
- organic solid waste treatment (landfills, composting, digestion)
- food industries
- manure processing industries
- fertilizer industries
- (petro)chemical industries
- metallurgical industries
- semi-conductor industry

Conventional biological treatment ANAMMOX®



PROCESS

Since the early 1980's, Paques has been developing and producing high-quality, cost-effective purification systems for water, gas and air, using innovative biotechnology. Our aim is to provide solutions to industrial and municipal problems with our extensive range of purification techniques. Most important are the added value factors of the treatment process, such as the re-use of water, the generation of energy by conversion of polluted components, and the reclamation of valuable substances from the waste water. In this way we bridge the gap between environmental responsibility and economic progress.

ANAMMOX[®]

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