Technology Review

WABAG BIODEN®

Nitrate removal
Biological denitrification of ground water

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Biological denitrification
of groundwater

Nitrates became a drinking water pollutant problem in the last quarter of the 20th century in many countries all over the world, particularly in areas of intensive agriculture with excessive use of fertilizers and/or as a result of insufficient wastewater treatment.

Nitrate (NO_3) is highly soluble in water and very mobile in the underground (Aquifer) and can not be removed by conventional drinking water treatment technologies such as filtration or flocculation.

The main strategies for dealing with this problem involve sanitation programs for the reestablishment of the sustainable equilibrium.

Unfortunately, sanitation is a long-term process, which lasts for decades and drinking water quality is already required in the interim period up to the accomplishment of sanitation effects. Therefore short-term solutions such as blending strategies and suitable nitrate removal technologies are essential.

In order to have the optimum solution for each individual situation, WABAG has developed different processes for nitrate removal from drinking water sources. The ENR® process uses electrodialysis for selective nitrate separation. The BIODEN® process applies heterotrophic denitrification for selective degradation of the pollutant. In the meantime, both processes have been in full-scale operation for more than a decade.

The BIODEN® process provides a targeted, environmentally compatible reduction in the nitrate content of drinking water.

The BIODEN® process has several strong points, the most important of which is the degradation of the pollutant. The fixed bed biofilter offers excellent retention of the denitrifying biomass and the loading of the subsequent aerobic post-treatment is accordingly low. The backwash water of the filters is clarified and can be directly recycled to the plant inlet because the clarified water only contains denitrifying biocenosis.

Thus water recovery of practically 100% is accomplished. The technology is based on standard filtration processes and does not need any special equipment. As compared to other nitrate removal technologies, the process is highly cost effective.

Czestochowa, Poland
Commissioning 2006, 12‘000 m^3/d

Obersiebenbrunn, Austria
Commissioning 1997, 4‘320 m^3/d

BIODEN® process

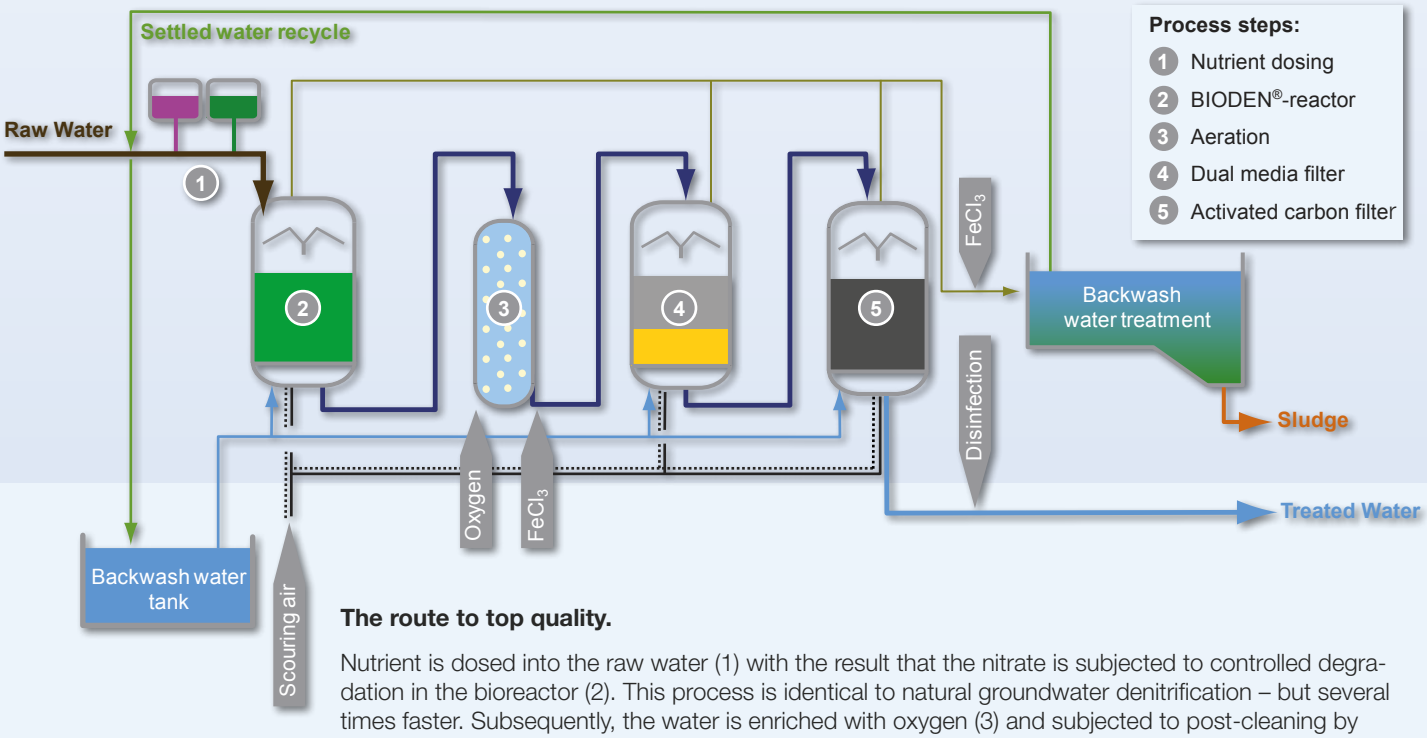
Biological denitrification
Nature as a model

The BIODEN® process is based on the natural process of biological denitrification, which takes place in soil and ground water. However, in the BIODEN® process, denitrification is enhanced under controlled conditions in a fixed bed biofilter. The process functions according to the principles of heterotrophic, biological denitrification with ethanol or acetic acid as a carbon source. Basically, it consists of nutrient dosage, a biological filter, subsequent aeration for oxygen enrichment, downstream flocculation filtration and final safety disinfection.

Biological Denitrification is the only process which really eliminates the nitrate ions whereas other processes (e.g. Reverse Osmosis, Ion Exchange, Elektrodialysis) only separate nitrate from the water and displace it into a saline wastewater stream (concentrate or spent brine).

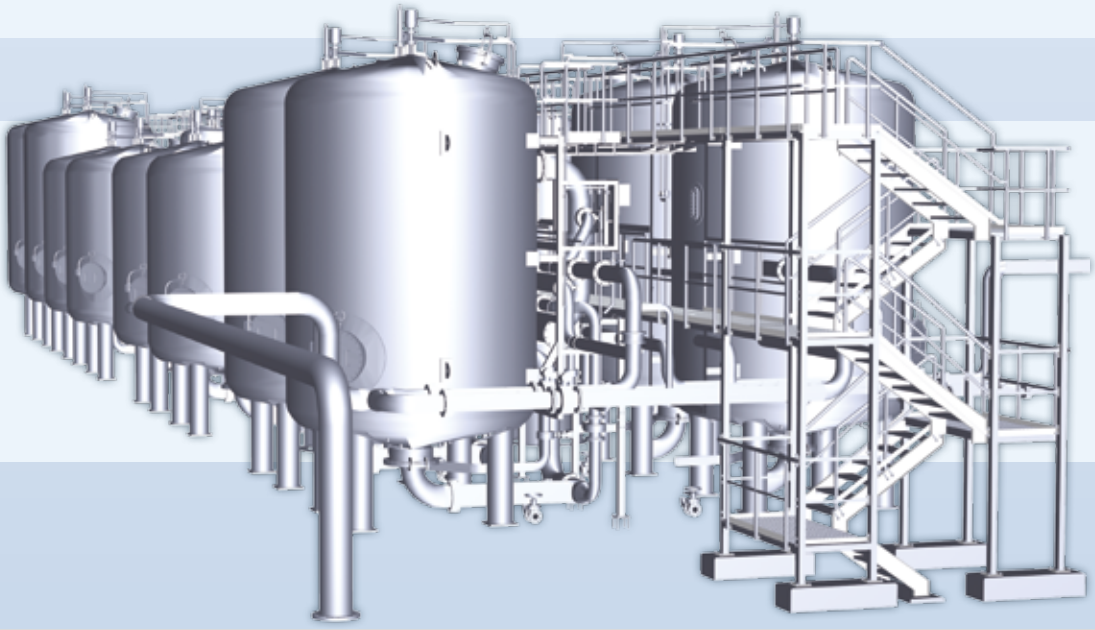
BIODEN® Process flow diagram

NO_3 + Nutrient → N_2 (+ Biomass)



The route to top quality.

Nutrient is dosed into the raw water (1) with the result that the nitrate is subjected to controlled degradation in the bioreactor (2). This process is identical to natural groundwater denitrification – but several times faster. Subsequently, the water is enriched with oxygen (3) and subjected to post-cleaning by means of flock and activated carbon filtration (4,5). Finally, the water is disinfected by e.g. UV radiation.



BIODEN® process
based on experience

The BIODEN® process was developed and tested in pilot operations. The first full-scale plant with a capacity of 180 m³/h was started up in Austria in 1997, since when it has been running with excellent results. Two treatment plants in Italy are also based on the BIODEN® process. A demonstration plant with a capacity of 50 m³/h was commissioned in 1997 and a further 540 m³/h plant started up in 2004.

A 500 m³/h BIODEN® plant went online during February 2006 in Czestochowa (Poland). The special requirement of the Czestochowa plant was 100% water recovery and for this reason, the plant was also equipped with a sludge dewatering unit.

Pilot tests in Mashhad, Iran have also shown that the process can be employed for the denitrification of saline ground water. For over three years, four high-performance processes for the removal of nitrates from drinking water, including the BIODEN® process, were tested in Mashhad. The BIODEN® process stands out due to its ability to provide selective nitrate removal and special environmental friendliness, owing to the fact that it does not produce any saline concentrates and that practically full water recovery can be achieved.

Furthermore, a 100,000 l/d containerised testing plant for biological denitrification with an upstream arsenic removal stage went online in summer 2007.

	Nitrate Concentration	
Project	Raw water	Treated water
Pilot plant Mashhad, Iran	120 mg NO_3/l	≤ 40 mg NO_3/l
Containerised testing plant	up to 200 mg/NO_3/l	≤ 40 mg NO_3/l
Czestochowa, Poland	up to 80 mg NO_3/l	5 mg NO_3/l
Obersiebenbrunn, Austria	65 mg NO_3/l	< 10 mg NO_3/l

Limit values for nitrate in drinking water:	
WHO*:	50 mg NO_3/l
EU:	50 mg NO_3/l

* WHO value relevant for short term exposure

BIODEN® Containerised testing plant
Commissioning 2007, 100 m³/d

BIODEN®
advantages in brief

The most important advantages of the process are:

- Degradation of pollutant.
- Virtually complete denitrification.
- Most selective process.
- Full water recovery.
- Excellent partial load capability.
- Plant stability and reliability.
- Easy adherence to all guide levels and maximum admissible concentrations.
- Flexible combination with other treatment processes e.g. for Arsen removal or softening.

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WABAG offers sustainable solutions for:

- Drinking water treatment
- Industrial and process water treatment
- Water reclamation
- Sea and brackish water desalination
- Municipal wastewater treatment
- Industrial wastewater treatment
- Sludge treatment

WABAG is one of the world's most innovative water treatment companies with know-how in specific technologies and in-house developed processes such as:

Biofiltration	BIOPUR®
Moving bed biology	FLUOPUR®
Activated sludge processes	Hybrid™, SBR, MICROPUR-CAS®
Membrane bioreactor	MARAPUR®, MICROPUR-MBR®
Membrane filtration	RO, MF, UF, NF CERAMOPUR®, CERAMOZONE®
Denitrification	BIODEN®, ENR®
Oxidation processes	ADOX®, BIOZONE®
Adsorption processes	CARBOPUR®, PACOPUR®
Thermal desalination	MED, TVC, MVC, MSF MED XXL™
Fine sieving	MICROPUR®
Deep bed filtration in various designs	
Anaerobic sludge digestion including advanced energy recovery	

The WABAG Group represents a leading multinational player with companies and offices in 20 countries and a focus on emerging markets in Europe, Africa, Middle East, South East Asia, China and India.

sustainable solutions. for a better life.

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