# Solve Your Nitrogen Problems

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Nitrogen pollution is a major issue causing eutrophication of fresh water systems. The member states of the EU, as well as most of the developed non-EU countries have, over the past few decades, introduced various programmes to reduce the amount of nitrogen entering their systems, mostly in terms of gradually tightening of wastewater discharge limits. Municipal as well as industrial wastewater treatment plants have found themselves facing the challenge to meet these strict limits using traditionally available technologies. Lentikats Biotechnology is a new tool to help meet the challenges of removing those last few milligrams as well dealing with the high nitrogen-loads of industrial effluents.

Lentikats Biotechnology presents a modern solution for the removal of inorganic forms of nitrogen from industrial as well as municipal wastewater. This patented technology is based on the immobilisation (encapsulation) of nitrification and denitrification bacteria, commonly found in activated sludge, in a porous hydrogel matrix made of polyvinyl alcohol (PVA). Apart from its high immobilisation capacity, the matrix possesses excellent physical and mechanical characteristics (elasticity, low abrasion), which provides a lasting durability of the "Biocatalyst". The unique lentil-like shape (see Fig. 1) ensures unlimited substrate diffusion to the immobilised cells, while still retaining a convenient size for easy separation of the Biocatalyst from the reaction media. Moreover, the PVA is biologically non-degradable and has zero toxicity. It is an inexpensive immobilisation material with no side effects on the biochemical process.

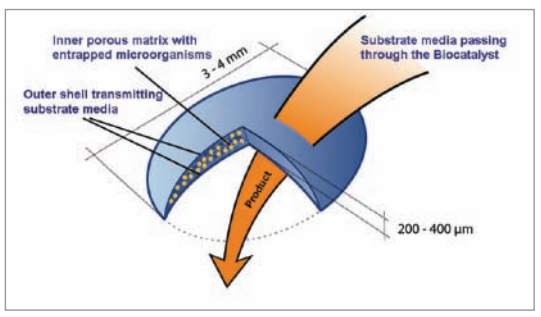


Figure 1: Lentikats Biocatalyst

In comparison to other immobilisation techniques applied to current wastewater treatments that are usually based on the growth and development of a mixed microbial community on the surface of a solid carrier, Lentikats Biocatalyst contains a high concentration of pre-defined biomass encapsulated within the carrier. Consequently, the Biocatalyst retains its high activity regardless of the varying composition of the treated media. The outer shell of the porous matrix protects the encapsulated biomass, thus increasing its robustness against negative environmental effects, such as chemical shocks or the presence of any potentially toxic compounds (Schlieker and Vorlop, 2006).

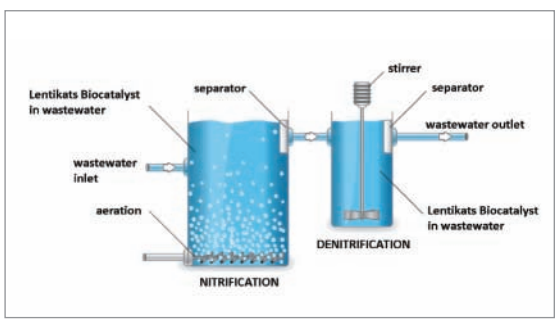


Figure 2: Lentikats Biotechnology – a technical layout.

Nitrogen removal is carried out in two separate stages, nitrification and denitrification, using two different types of Lentikats Biocatalyst. The nitrification Biocatalyst contains a mixture of *Nitrosomonas europaea* and *Nitrobacter winogradskyi*, while *Paracoccus denitrificans* or *Pseudomonas fluorescens* are used for the production of the denitrification Biocatalyst. Due to the nature of the immobilised microorganisms, it is necessary to provide oxygen and organic substrate for nitrification and denitrification, respectively. A common plant lay-out for the technology is presented in Figure 2. However it is important to note that each of the two reactors/stages can work independently of one another.

## The Applications

The use and applicability of Lentikats Biotechnology is endless, dealing with standard municipal wastewater and sewage to industrial effluents and highly nitrogen-loaded streams, such as biogas plants effluents. Lentikats successfully caters to the individual demands of the many different applications in which the technology is viable alternative to current solutions

In municipal wastewater treatment, it is the ability to specifically target nitrogen pollution in the wastewater that makes Lentikats Biotechnology superior to other conventional biological nitrogen removing processes. With no need for the construction of additional large activated sludge basins, existing wastewater treatment plants (WWTPs) can increase their nitrogen removal capacity or efficiently meet their nitrogen discharge limits. The experts at LentiKat's have developed two designs for the retrofit of existing municipal treatment plants. One solution is based on the removal of residual nitrogen in effluent and is suitable for any treatment plant, regardless of its size or current treatment process. The second solution targets nitrogen-loaded streams within the treatment line, which, in case of large municipal WWTPs with extensive sludge management, is the centrate originating from the dewatering of anaerobically stabilised sludge. The centrate is commonly brought back to the biological treatment stage, where it can contribute up to 10 – 25% of the total nitrogen load. The selective removal of nitrogen from this stream reduces nitrogen loads in the main treatment stage, which then reflects in the lower concentration of nitrogen in the effluent.

Both of theses solutions usually require limited construction of one or two small tanks or can be easily retrofitted into existing abandoned tanks. Moreover, traditional activated sludge technology requires a high concentration of organic matter in treated wastewater for the development of new sludge, of which the nitrogen-removing bacteria present only a small fraction. At the same time, large amounts of waste sludge is continually produced and must be both treated and disposed of, adding further costs to existing systems. Lentikats Biotechnology, on the other hand, eliminates both of these issues, requiring only an amount of organic matter corresponding to the denitrification stoichiometric value for the biochemical conversion and produces up to 170 times less sludge in comparison to the activated sludge process (industrial wastewater with low content of organic matter).

Figure 3: Full-scale application (WWTP Ostrov u Macochy, Czech Republic) – removal of residual nitrates.

The high and stable concentration of nitrogen removing bacteria in Lentikats Biocatalyst allows the application to easily deal with the very high nitrogen-concentrated effluents mostly produced in food, chemical or pharmaceutical industries or from biogas plants. The high concentration of immobilised bacteria provides for high reaction rates and results in very compact and space efficient treatment units. Concentrations of nitrogen as high as 800 mg/l $N\text{-}NH_4^+$ or 1000 mg/l $N\text{-}NO_3^-$ can be treated without prior dilution and with an efficiency at more than 98%. Immobilisation, on the other hand, ensures a stable treatment performance even in effluents with a semi-continuous production or fluctuating composition. The system's capacity is determined by the amount of Lentikats Biocatalyst in the reactor. Actual performance is controlled by the amount of oxygen/organic substrate dosed into the system.

The increased robustness of the immobilised bacteria towards negative environmental effects (high salinity, presence of toxic compounds, etc.) enables the application of Lentikats technology in even the most extreme conditions (brines or wastewater from the production of cyanides).

Lentikats Biotechnology can be applied as a main treatment or as an add-on process to other technologies.

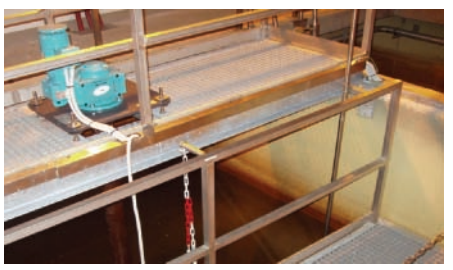

Figure 4: Full-scale application (Industrial WWTP, Czech Republic) – elimination of fluctuating effluent concentration of nitrates; the system has been adopted into an existing empty tank.

## The Benefits

To summarise the above, the main advantages of Lentikats Biotechnology in removing nitrogen from wastewater are:

- high nitrification and denitrification reaction rates,
- shorter hydraulic retention time in nitrification (12 – 50 hr) and denitrification (3 – 6 hr),
- reduction of reaction volume – overall reduction of investment costs by 40 – 90%,
- possibility to work at high concentrations of 1000 mg $N{\cdot}NH_4^+$, $N{\cdot}NO_3^-$ ,
- lower consumption of energy and operational material by as much as 30%,
- significantly lower sludge production and consequent reductions in related costs (regeneration and disposal)
- enhanced robustness against negative external factors,
- nitrification-denitrification set-up,
- a stable process with easy control,
- process continualisation.

## Full-Scale Experience

Within the wastewater treatment field, Lentikats Biotechnology has a proven laboratory and pilot-scale track record as well as full industrial scale use, ranging from drinking water to municipal and industrial wastewater of many types and origins. The first full-scale installation has been designed to remove residual nitrate effluent from a municipal WWTP (1000 PE, Fig. 3), the second removes nitrogen from centrate at a medium size municipal WWTP (40 000 PE) and the last one eliminates fluctuating effluent nitrate concentrations at an industrial WWTP treating effluent from pharmaceutical industry (Fig. 4). In all three cases, the technology is providing superb efficiency and has demonstrated extremely short start-up periods, a matter of only a few days rather than the weeks of set up required by other solution. Several new projects are starting in 2010 in the Czech Republic (biogas plant effluent), UK (agricultural effluent), Poland (power plant effluent) and New Zealand (geothermal streams). Lentikats Biotechnology has been patented in over 80 countries world wide.

## The Costs

Due to the large diversity in the characteristics of every individual wastewater Lentikats Biocatalyst responds differently in each case. Lentikats Biocatalyst activity, and consequently the amount of the Biocatalyst that has to be applied, is strongly influenced by the composition and temperature of the wastewater. It is therefore very difficult to compare or generalise the costs related to Lentikats Biotechnology. One parameter that transfers well across all cases is the price for removing of 1 kg of nitrogen. In case of centrate treatment, which provides quite optimal conditions for the immobilised bacteria, the cost for removal of 1 kg of nitrogen can be below 1 €. When applied to the removal of residual nitrogen from a WWTP effluent, the price increases up to an average 4 – 5 €/kg N removed as a result of usually low temperature and very low concentrations of nitrogen. In terms of investment costs, a reduction of 40 – 90% can be expected in comparison to traditional technologies, due to the small construction footprint of the proposed solutions and the absence of sludge treatment and disposal demand.

Figure 5: A pilot-scale test unit (nitrification – denitrification – retention).

Figure 6: Lentikats Biocatalyst inside a reactor.

## Conclusion

Lentikats Biotechnology presents an interesting and novel alternative to other currently available nitrogen removing technologies. The system is characterised by superb removal efficiency, high stability and easy control and operation. The cost-effectiveness of the process lies in the reduced investment as well as greatly reduced operational costs.

## References

Schlieker M., Vorlop K.D. (2006). A novel immobilization method for entrapment LentiKats®. In: Immobilization of enzymes and cells, J. M. Guisan (ed), 2nd edn, Humana Press Inc., Totowa, New Jersey, pp 333-343.

# Market Report on Factors Influencing the Brazilian Industrial Water and Wastewater Market

This market snapshot research service looked at the Brazilian Industrial Water & Wastewater Treatment Market. A market profile was provided, which included a review of the overall Brazilian industrial market in each segment of water & wastewater treatment, analysing the key market forces of drivers and restraints, market measurements of market size for base year, corresponding annual growth rate including the compound annual growth rate for the forecast period and the revenue share trends by technology types. Frost & Sullivan believes there is a strong need for stakeholders to understand the key dynamics and factors influencing the Brazilian industrial water and wastewater market. Recent developments in incentives and legislation combined with our ongoing client councils, industry knowledge, and internal discussions have made us believe in the potential of the Brazilian market, hence produce the following market evaluation:

Rapid industrial growth spurring an increased demand for water and wastewater treatment systems , industry standards for process water treatment and legislative requirements of wastewater treatment, relatively higher water tariffs for the industrial sector, increasing presence of multi-national industrial companies and their internal procedures in favour of global standards of environment management, (which includes water conservation and management), increasing trend in favour of sustainable treatment technologies, such as membrane bioreactor systems (MBRs) for water reuse and recycling and upflowanaerobic sludge blanket (UASB) biogas generation from industrial wastewater treatment

The focus of this research service is to analyse the industrial water and wastewater market in Brazil:

- The sales and forecasts of the industrial water and wastewater treatment systems market
- The present industry challenges, market drivers, and market restraints in the industrial sector in Brazil
- Policies and incentive mechanisms promoting the growth of sustainable treatment solutions
- Trends by treatment segment of water and wastewater
- Trends by technologies segments within the market segments of water and wastewater treatment
- Influence of water tariffs on water reuse and recycling technologies, such as membrane bioreactors systems
- Trends of industrial wastewater treatment by employing systems, such as the UASB reactors
- Competitive analysis highlighting best practise strategies

The Brazilian industrial water and wastewater treatment market is defined as the combined market revenues comprising The plant and equipment used in the treatment of industrial water and wastewater, including all component parts, tanks, plates and distributors, but excluding pumps, valves, chemicals, microbes, monitoring equipment and civil structure.

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# New Large Air-Blower for Wastewater Treatment Introduced

Based on their patented "linear shuttle" technology, **Nitto Kohki** (Germany) have introduced the larger LAM-200 blower to their market leading range of LA series blowers. The eagerly anticipated big brother is born! Air-blowers are commonly used in wastewater treatment systems, aquatic & pond applications as well as sulphur scrubbing on biogas applications. The "linear shuttle" technology removes the need for troublesome diaphragms and so offers the benefit of much longer lifetimes. Their existing product range offered air flow of 7,2 $m^3/h$ at 180mbar (normally 1.8 meter water depth ), whilst their new big brother gives a superior $12m^3/h$ airflow at 200mbar (normally 2 meters water depth).

Therefore the new LAM-200 can be used in larger plants that historically were unable to take advantage of Nitto Kohki's superior "linear shuttle" technology. The LAM is also an interesting alternative to rotary disc and by-pass channel pumps. With a power consumption of only 220W and whisper-quiet 48dB(A) noise, the new model is an ecological and quiet solution. Besides their Air blowers, Nitto Kohki offers a wide range of "Linear Shuttle" air-pumps, liquid–pumps and diaphragm-pumps all with AC and DC options. Additionally they manufacture ranges of quick release couplers and Pneumatic Tools.

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