FILTRALITE® AND BIOBOX®, A SOLID ALTERNATIVE FOR THE TREATMENT OF NITRATES IN THE MAR MENOR.

In a demanding pilot project treating water from a drainage channel that flows into the Mar Menor, the BIOBOX® Nitrates technology with Filtralite® as a carrier, has demonstrated its high efficiency, achieving a nitrate removal of over 95% and an operating cost per m3 treated of less than 0.10 €.

The Mar Menor lagoon, located in Murcia (Spain), is the largest permanent body of salt water in Europe. It is a unique natural enclave of great ecological and scenic value. The ecosystem of the Mar Menor has remained unchanged for thousands of years, being originally isolated from the Mediterranean.

Unfortunately, throughout the last third of the 20th century it has suffered increasing anthropic pressure with a consequent degradation of the quality of its waters and its biodiversity.

The first milestone of change in this ecosystem occurred in the 1960s with the opening of the Estacio channel in La Manga del Mar Menor. This channel linked the waters of the Mar Menor with those of the Mediterranean, which led to a transformation of the typical species of the Mar Menor and a colonisation by Mediterranean species.

The 1970s, with their massive urban development, altered the salinity of the lagoon, affecting biodiversity and deteriorating iconic natural spaces.

Biological denitrification has proven to be one of the most advanced, selective and cost-effective processes for removing nitrates from water.

This was compounded by discharges of different kinds: mining, intensive livestock farming and those from the recently established irrigated agriculture, which came with the Tajo-Segura water transfer.

The lagoon was giving previous warnings about its state of depletion and the year 2016 can be dated as the point of rupture of the precarious ecological balance of this ecosystem. In this year, nitrates, mainly from agricultural activity, were the main but not the only cause of the massive growth of phytoplankton, generating such a concentration on the surface that it prevented sunlight from entering the seabed for a prolonged period of time. The lack of light made the process of photosynthesis unviable, which resulted in the death of 98% of the seabed meadows and the death of tons of fish due to anoxia. This was reported in the media. .

Before this event, the authorities and administrations with jurisdiction over the area had put improving and restoring the situation of the Mar Menor at the top of their agendas.

This can be seen in such innovative actions as the bill passed on 13 July, which makes the Mar Menor a subject of rights.

The problem has led the Directorate of the Mar Menor, belonging to the Government of Murcia, to emphasise the importance of eliminating nitrates from the percolation of irrigation percolate from the extensive cultivation of crops in the area. The Regional Government's search for the best available technologies resulted in a call for proposals for a pilot project based on anoxic heterotrophic biofiltration with the aim of validating the technology, already applied to drinking water and urban wastewater, with a view to eliminating nitrates from the watercourses of the wadis and drainage channels that flow into the Mar Menor.

The General Directorate of the Mar Menor tendered and contracted a pilot project to the company Ingeobras with the BIOBOX® Nitrates (Puremust-sn®) technology, which was carried out between April and June 2022. Filtralite® HC 2.5-5 was used as a filter bed in the pilot project, which is one of the secrets of the BIOBOX® Nitratos technology, both in terms of optimising the space required and in comparison with current biological treatments (biological treatments).

Image of the pilot plant taking water from the reception chamber from the from the D-7 canal with a high nitrate content and eutrophicated.

versus current biological treatments (treatment with wood chips, activated sludge...) and also in reducing the cost per cubic metre treated.

Biological denitrification has proven to be one of the most advanced, selective and cost-effective processes for removing nitrates from all types of wastewater and drinking water.

his process achieves, thanks to the formation of a biofilm with denitrifying bacteria on Filtralite®, a very high rate of nitrogen removal per unit volume of reactor. This technology transforms nitrates into nitrogen gas, which is harmless to the environment.

In descriptive terms, biological denitrification involves the oxidation of organic substrates using nitrate or nitrite as an electron acceptor, with the addition of organic matter to promote the heterotrophic process. Denitrification occurs in a single step within an anoxic biofilter containing Filtralite®, the optimum carrier for the bacteria. The process has to be fed with some highly biodegradable organic reagent: methanol, ethanol or acetic acid. The type of organic matter is chosen according to the water to be treated, the applicable regulations and the process cost objective.

BIOBOX® Nitrates pilot plant with a capacity of 0.25 m3/h.

BIOBOX® Nitrates automatically regulates the amount of reagents to be added depending on the incoming nitrate concentration. The design volume of the biofilter depends on the concentration and peak flow rates and is optimised through the use of Filtralite®. Furthermore, BIOBOX® Nitrates

BIOBOX® Nitrates is presented as a solid alternative to tackle the challenge of nitrates flowing into the Mar Menor.

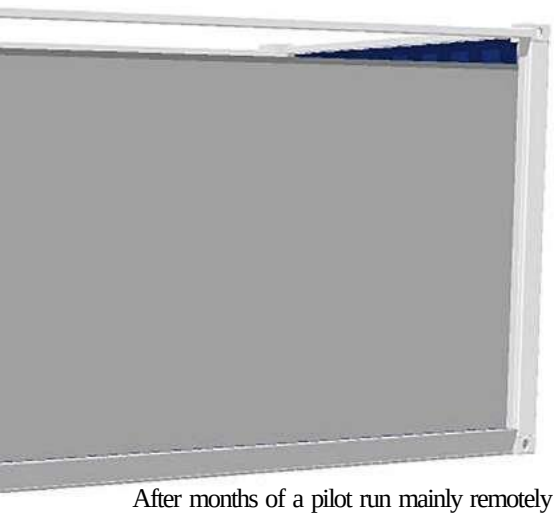
Render of a BIOBOX® Nitrates compact plant.

automatically regulates its operation thanks to a high level of sensorisation, controlling parameters such as water temperature, pH, ORP, among others. In short, it is a very robust technology, based on the well-known biochemical process of biological denitrification and in which safe denitrifying bacteria are used and inoculated.

A BIOBOX® Nitrates pilot plant with a capacity to treat 0.25 m3/hour, which is large enough to obtain scalable results, was used for the three-month pilot test. The plant was installed at the Los Alcázares WWTP (Murcia) with the support of the Directorate General for Water of the Government of Murcia and ESAMUR, and was fed by water from the D-7 drainage channel with nitrate concentrations during the test of between 90-120 mg/l.

The BIOBOX® Nitrates pilot plant integrates advanced technology in both automation and sensorisation, allowing it to be operated autonomously and controlled remotely without the need for on-site personnel, similar to a real plant. Operating data and key parameters are monitored in real time, being recorded both locally and in the cloud. .

At the BIOBOX® Nitrates treatment train level, in order to adapt to the influent coming from the drainage channel, a pre-filter with Filtralite® Pure NC 1.5-2.5 was installed to laminate the entry of solids into the biofilter. The second treatment step is the downflow anoxic biofilter in which methanol dosing is carried out beforehand, adjusted according to the nitrate inlet concentration. This configuration is suitable for treating wastewater or water from a watercourse with medium to high levels of turbidity and suspended solids.



After months of a pilot run mainly remotely and with occasional visits by the BIOBOX® team for maintenance and reagent reloading, a series of important conclusions were reached, which are presented below:

- The start-up of the biofilter was relatively fast despite the high conductivity levels of the inlet water, between 7,000 and 10,000 µS/cm. The selected bacteria set was very adaptive to the type of treated water. Full start-up of the biofilter was achieved 10 days after bacterial inoculation.
- The average nitrate value at the outflow during the pilot months has more than met the parameters for discharge into the public watercourse for 100% of the time. The plant has had an influent with an average value of 98.19 mg/l of NO3-, also achieving an average value of 7.21 mg/l of NO3-. This means an average nitrate removal efficiency of 93%.
- The only by-product of the plant is the nitrogen gas released into the atmosphere - completely harmless - and the treated water is clear, free of solids and odour. Furthermore, there is only a 2% loss of treated water due to backwashing.
- The process was highly stable throughout the pilot, adapting to frequent changes in pH, nitrate concentrations and conductivity without loss of performance.
- The pH remained constant at the inlet and outlet throughout the experiment.
- Almost total elimination of total nitrogen and Kjeldahl nitrogen was achieved. In addition, suspended solids were reduced by half.
- All the monitoring parameters of the inlet and outlet pilot test, sulphates, TOC, COD, COD, COD, BOD, phosphorus, nitrates and total nitrogen, complied with the limits for discharge into public watercourses for 100% of the samples. With regard to the most critical - nutrients - due to their impact on eutrophication, phosphorous, nitrates and including TOC, the values discharged from the plant were even below the limits or recommended values for drinking water.
- The pilot project focused on measuring the consumption of reagents (mainly methanol) and electrical energy in order to estimate the cost of the process per m3. The result of this measurement process gives the more than competitive figure of a price of less than 0.10 €/m3 for inlet nitrate concentration values of 98.19 mg/l NO3- and removals above 90%.
- Based on the pilot data, projections were made for the scalability of the technology to a plant that could treat the peak flow of a wadi. It was concluded that a 450 m3/h plant treating water with concentrations of 100 mg/l of NO3- , occupies a surface area of just 1,200 m2 and represents an investment cost of less than 1.3 M€.

In conclusion, BIOBOX® Nitrates is a mature technology, with a long track record in the world of wastewater and drinking water and which is presented as a solid alternative in terms of performance, guarantees and costs to tackle the challenge of nitrates in the wadis and drainage channels that flow into the Mar Menor.

Perspecti ve image of the Mar Menor