



TECHNICAL MANUAL

"MBR MEMBRANE MODULES"



MBR MEMBRANE MODULES

Introduction

The membrane bio reactor (MBR)

EVERBLUE's MBR membrane modules

EVERBLUE's MBR membranes

Applications



Introduction

The membrane bioreactor (MBR)

Membrane Bioreactors derive from the union of the traditional biological activated sludge process with the tangential flow filtration processes on the membrane.

Unlike a traditional activated sludge purification system, the separation of sludge from water does not occur through sedimentation but through filtration with membrane modules. The modules can be inserted in the oxidation / nitrification compartment of the biological tank or in a special tank downstream of the biological one (recommended solution).

The use of the membrane bioreactor allows to obtain numerous advantages compared to traditional processes:

Better quality of the effluent: filtration through membranes with very small pore diameters (0.08 Micron) guarantees the production of a very high-quality effluent with practically zero bacterial load, potentially reusable in agriculture. This allows to avoid the use of tertiary processes such as disinfection with significant economic and environmental benefits.

Smaller footprint: in the membrane bioreactor the biological treatment takes place with a higher concentration of activated sludge, between 5 and 18 g / l. This leads to a greater efficiency of the biological process compared to the conventional treatment allowing to reduce the size of the activated sludge tank. Furthermore, the sedimentation tank is not required in the MBR system, therefore the footprint is significantly reduced as well as the investment costs.

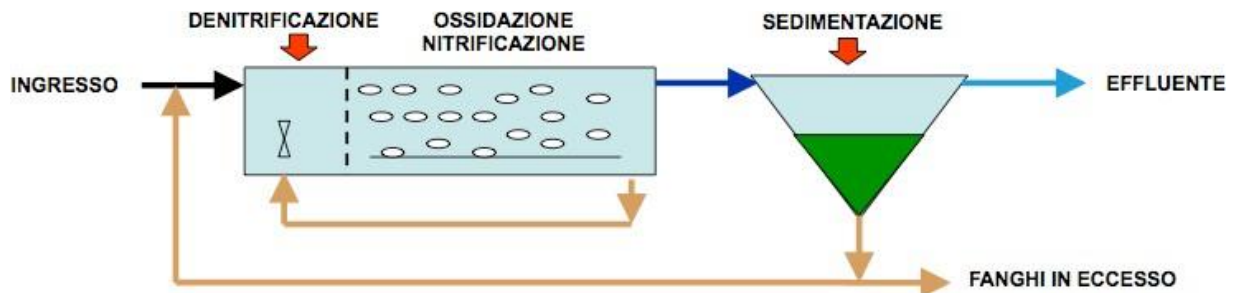
Lower excess sludge production: the liquid solid separation is not based on the sedimentation characteristics of the sludge which in traditional processes place a practical limit in the choice of high SRT (sludge age). Therefore, the MBR reactor can operate with very high mud ages (15-25 g) which guarantee biologically stabilized bacterial colonies which, thanks to endogenous respiration, grow more slowly producing lower quantities of sludge.

Upgrading of pre-existing plants: thanks to the reduced size and flexibility of the membrane modules, the MBR system is particularly suitable for the adaptation and enhancement of pre-existing plants especially where there is little surface availability for the installation of conventional activated sludge processes.



The drawings and tables shown below schematically highlight the advantages of MBR systems compared to classic biological systems.

CONVENTIONAL BIOLOGICAL PLANT

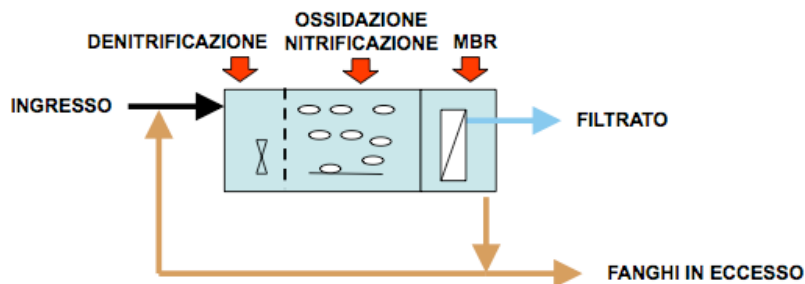


Bioreactor with one ventilated and one non-aerated part
Separation of sludge with sedimentation tank
Typical concentration of sludge: 2 - 4 g / l

Objectives of the treatment:

denitrification, nitrification, carbon removal, phosphorus removal

MBR PLANT

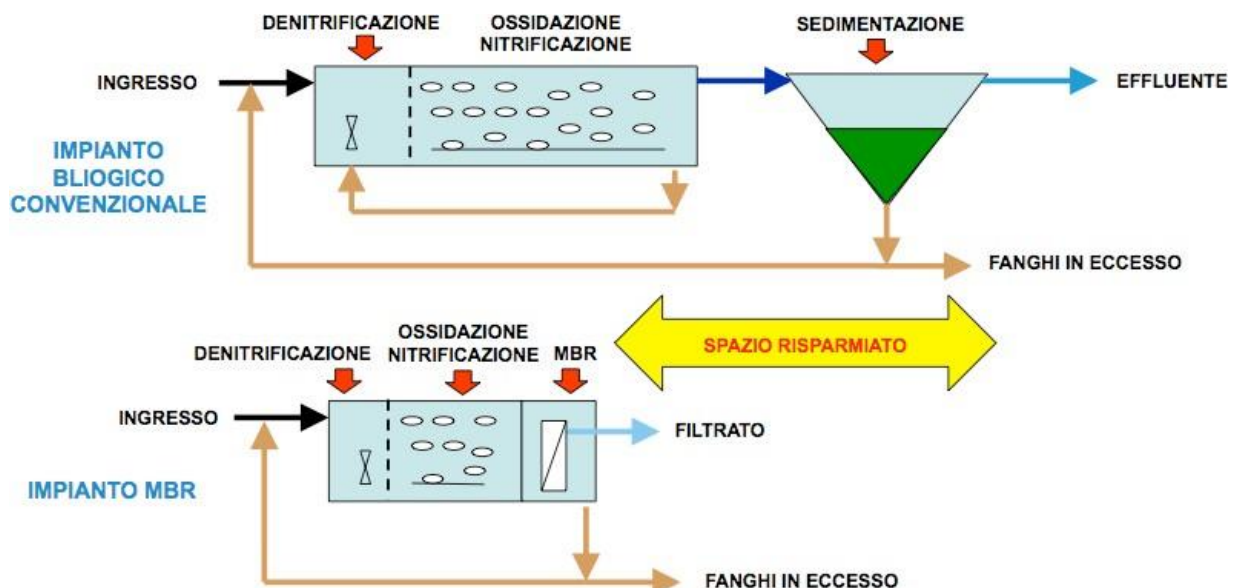


Bioreactor with one aerated and one non-aerated part
Sludge separation by membrane filtration
Typical sludge concentration: 5 - 18 g / l

Objectives of the treatment:

denitrification, nitrification, carbon removal, phosphorus removal, bacteria-free effluent production

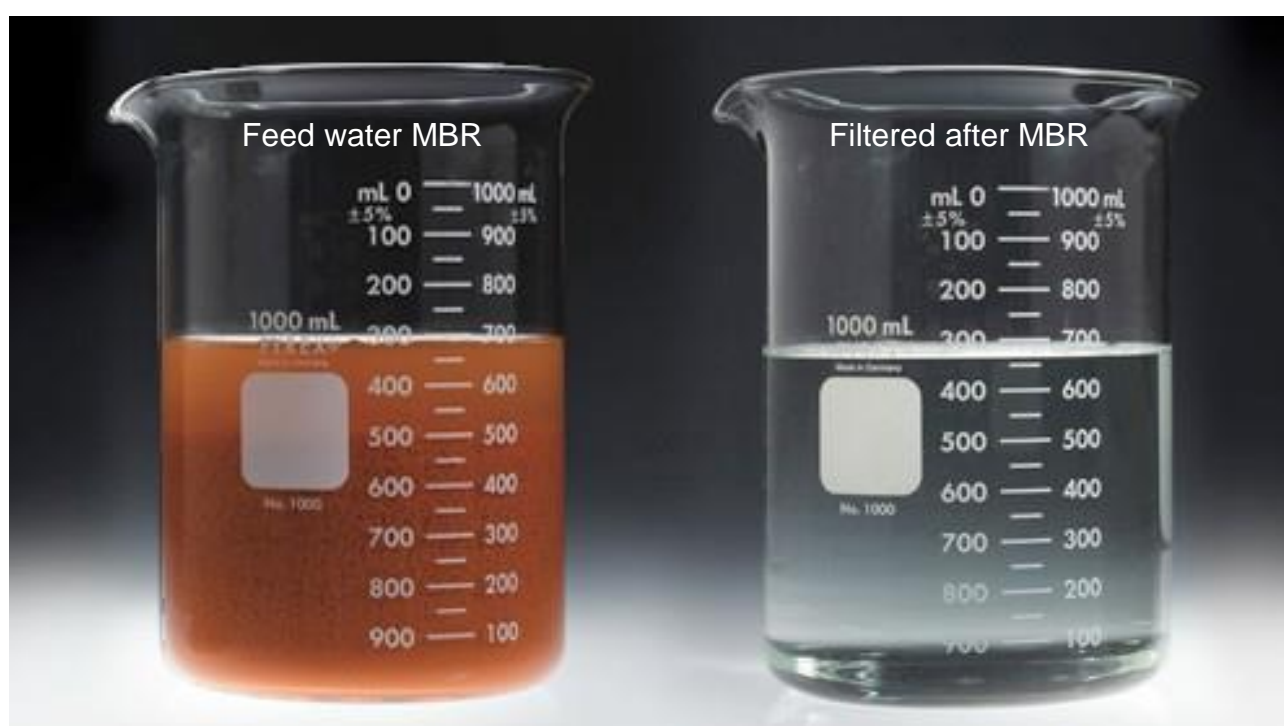
MBR PLANT = SMALLER FOOTPRINT



The table below indicates the quality differences of the water produced by an MBR system and a conventional biological system.

PARAMETER	UNIT	CONVENTIONAL BIOLOGICAL PLANT	MBR PLANT
TSS	mg/l	10 - 15	3,0
COD	mg/l	40 - 50	< 30
TOTAL NITRATES N	mg/l	< 13	< 13
TOTAL PHOSPHORUS P	mg/l	0,8 – 1,0	< 0,3
MICROBIOLOGICAL QUALITY		Water with critical hygiene	Bathing water

It is indisputable that the MBR system produces better quality water than a traditional biological system. The quality of the filtered water is so high that it can be used for industrial use, for agricultural use, for showers, toilets and laundries.



The most used MBR membrane modules on the market are:

- modules with flat membranes
- modules with hollow fiber membranes.

The modules with flat membranes are ideal for medium and small plants (maximum flow rate less than 5,000 m³ / day - 20,000 inhabitants) because they guarantee lower energy consumption, better quality of the water produced and a simpler system to manage.

The modules with hollow fiber membranes are ideal for large systems (minimum flow rate greater than 5,000 m³ / day) because, thanks to the large filtering surface, they allow the construction of systems of smaller dimensions than systems with flat membrane modules and therefore with lower construction costs.

EVERBLUE'S MBR membrane modules

To meet different needs of flow rate and space, EVERBLUE has created two models of MBR modules with flat membranes:

- E-BOX modules suitable for small and containerized systems (see dedicated catalog)
- E-MBR modules suitable for medium-sized systems (see dedicated catalog)

The flat membrane modules produced by EVERBLUE consist of 4 basic elements:

1 - STEEL SUPPORT FRAME - The AISI 304 steel support frame contains the boxes of the E-BOX modules or the elements of the E-MBR modules and supports the air diffusers and the filtrate collector.

- **E-BOX** modules suitable for small and containerized systems (see dedicated catalog)
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2 – MEMBRANES – The cassettes of the E-BOX modules consist of 50 membrane elements of 0.7 m². The membrane elements are made of polyvinylidene fluoride (PVDF). The elements of the E-MBR modules are made of ABS. Two polyvinylidene fluoride (PVDF) membranes adhere to each element (panel).

3 – DIFFUSERS - The diffusers of the E-BOX and E-MBR modules are positioned in the lower part of the frame and are used to introduce air that creates the flow of water from the bottom upwards through the panels. The air is also useful to keep the membranes clean from deposits

4 - FILTERED COLLECTOR - The filtered manifold, positioned in the upper part of the modules, through a suction pump, collects the water produced by the modules.

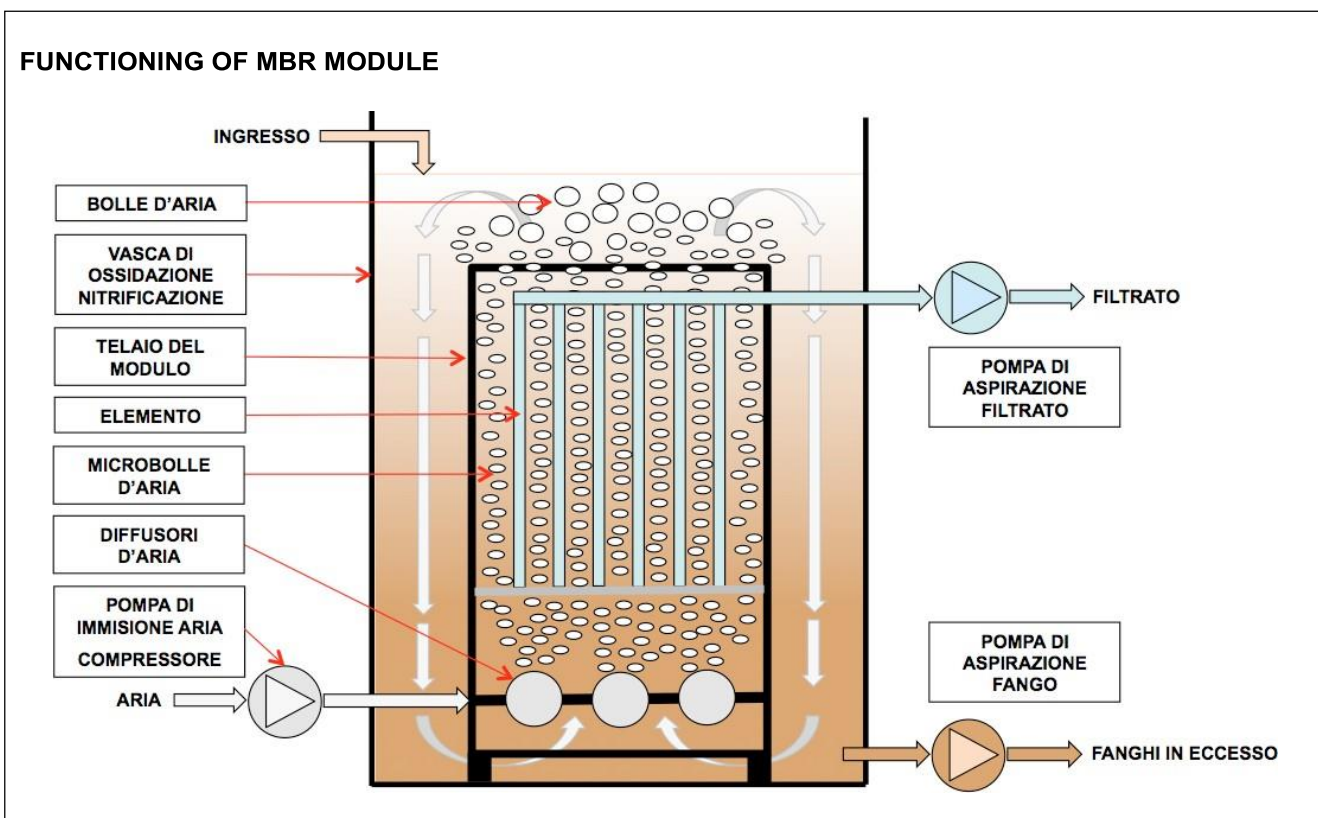
The chart below shows the materials used for the production of EVERBLUE modules.

	E-BOX	E-MBR
MEMBRANE	PVDF	PVDF
MEMBRANE SUPPORT		ABS
FRAME	AISI 304	AISI 304
FILTERED COLECTOR	PVC	AISI 304
DIFFUSERS	PVC	PVC

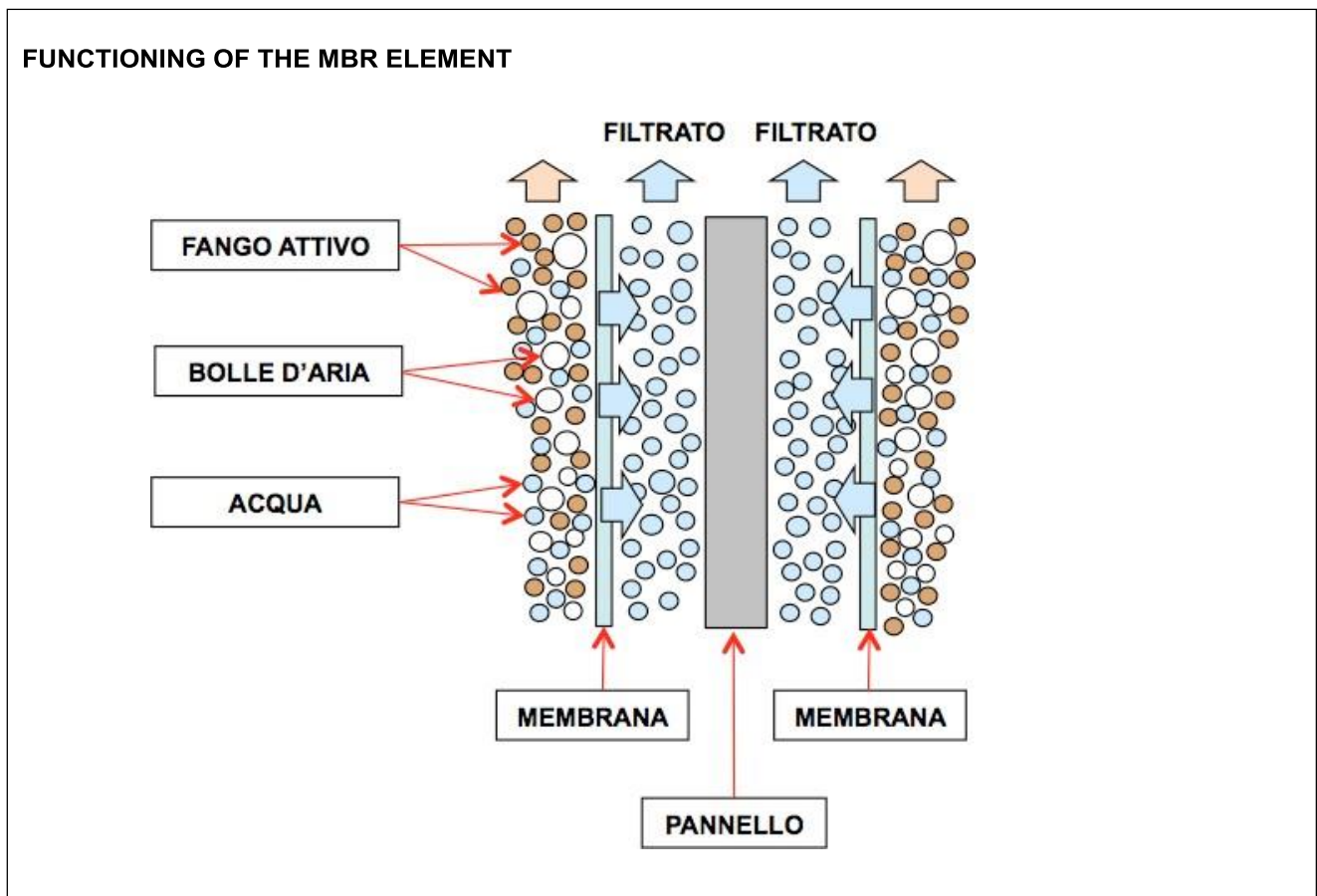
The flat membrane modules produced by EVERBLUE have a very simple operation:

- the water from the oxidation / nitrification tank feeds the tank containing the MBR modules.
- The diffusers of the modules, positioned in the lower part of the frame, introduce air which creates the flow of water from the bottom upwards through the panels.
- The suction pump, connected to the collector of the filtrate, creates the flow of water through the membranes supported by the panels.
- The flow of water created by the air, which moves from the bottom to the top, directs the water that has become enriched with mud as it passes through the panels. Any excessive accumulation of sludge inside the tank is periodically removed thanks to a dedicated pump.

The following drawing clearly illustrates the operation of the MBR module just described.



The following drawing illustrates the flow of water, activated sludge and air bubbles that flow over the membrane surface and the passage of filtered water through the membrane.



The following photo shows the movement of the water on the surface of the MBR tank due to the introduction of air by the diffusers located on the bottom of the modules.



EVERBLUE modules guarantee three great advantages:

1 - MODULARITY

The EVERBLUE flat membrane modules, being modular, can satisfy all flow requirements. This feature allows the modules to be combined with each other to create larger module models, and to house the modules in an extremely compact way inside the tank of the MBR system.



2 - BETTER ENERGY EFFICIENCY

EVERBLUE flat membrane modules allow you to consume less energy than modules with hollow fiber membranes thanks to a more efficient ventilation system and the lower pressure needed to suck water through the membranes.

3 - IMPROVED OPERATION AND LOWER COSTS OF THE MBR PLANT

The plastic support (panel) of the membranes guarantees greater mechanical resistance of the flat membranes compared to the hollow fiber membranes with a consequent longer duration of the same and therefore a considerable reduction in maintenance costs.

Furthermore, the greater mechanical resistance of flat membranes compared to hollow fiber membranes, together with the high efficiency of the ventilation system, give

EVERBLUE MBR modules provide better resistance to clogging which allows the creation of a coarser and therefore less expensive pretreatment system.

This greater resistance to soiling leads to a less frequent request for chemical cleaning resulting in better system operation and reduced operating costs.

The cleaning of the flat membranes takes place by placing the washing solution by gravity inside the panels on which the membranes adhere to two sides, therefore it is not necessary to install a backwash pump as required for systems that use hollow fiber membranes.

The recognized reliability of EVERBLUE's flat membrane modules is the result of the quality of the materials of all the components used, the construction technologies used to produce each single piece, and the careful design of the product.

All EVERBLUE modules are produced exclusively in Italy at our production site in Borgo Val di Taro (Parma).

In order to better understand the qualities of our membranes and our modules, our customers are invited to visit our factory and the MBR plant in operation at a dairy located just one kilometer from our office.



Impianto pilota
Pilot plant

MBR pilot plant always open to visits installed at the dairy factory CASEIFICIO SOCIALE DI BORGOTARO

EVERBLUE'S MBR membranes

The quality of the water produced by the EVERBLUE modules is instead solely linked to the particular type of flat membranes that EVERBLUE uses.

The E-BOX modules have boxes containing 50 0.7 m² membrane elements made up of PVDF with 0.08 micron pores.

The E-MBR modules have elements (panels) inside each of which adhere two polyvinylidene fluoride (PVDF) membranes with 0.08 micron pores.

Flat PVDF membranes guarantee:

1 - HIGH PERMEABILITY AND HIGH QUALITY OF FILTERED WATER

PVDF membranes with 0.08 micron pores allow to eliminate particles larger than 0.1 micron, thus providing high quality water.

The uniform size of the pores and their regular distribution ensures high permeability and reduces the risk of clogging.

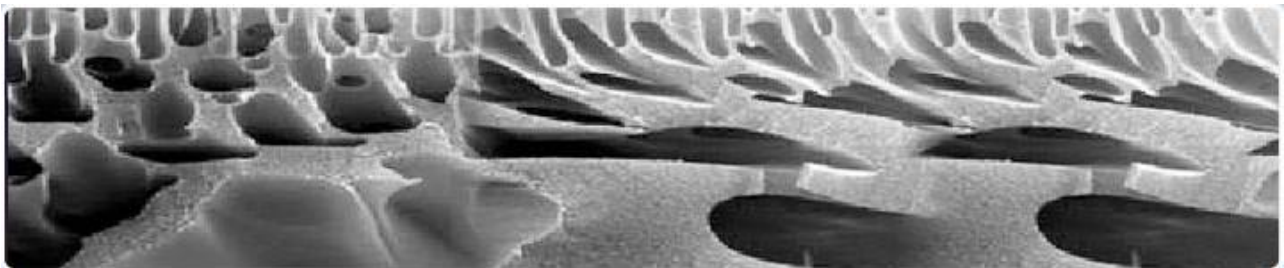
2 - HIGH CHEMICAL RESISTANCE

The PVDF membrane ensures chemical stability and high physical resistance.

3 - HIGH RESISTANCE TO DIRTING

The flat configuration and the structure with regular-sized pores and uniform distribution of the PVDF membranes allows the membranes to remain adequately clean thanks to the constant flow of water generated by the upward flow of the air introduced by the diffusers. This mechanism does not allow the activated sludge to adhere to the membrane surface, thus allowing a constant flow of filtered (permeated) water.

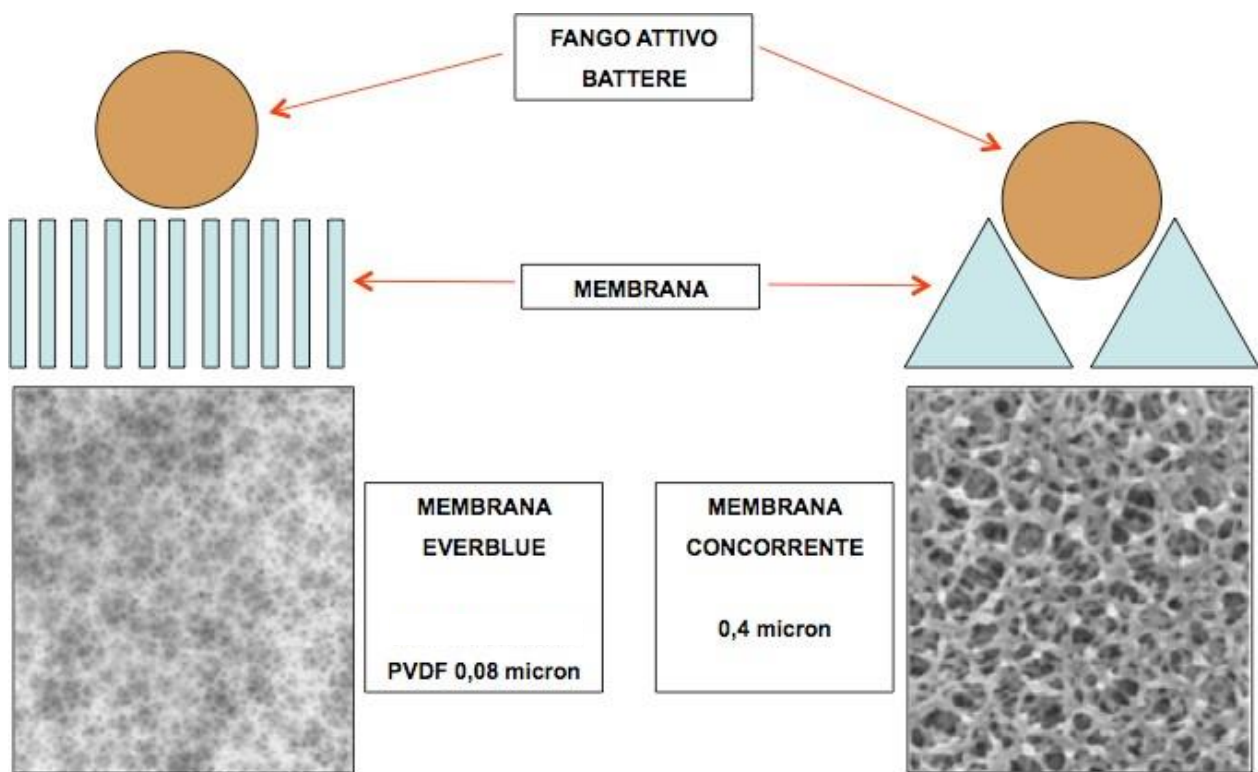
The following photo, taken under a microscope, shows the section of a PVDF membrane used by EVERBLUE for the production of the elements that make up the E-BOX35 boxes of the E-BOX modules.



The following drawing schematically illustrates the difference between MBR EVERBLUE membranes and the membranes of competitors.

The photo attached below illustrates how, even in extreme cases following a malfunction of the system (air intake pump / blower failure) or human error, the extreme resistance to fouling of the membranes, their flat structure and their rigidity given by the plastic panel, it allows recovery thanks to manual washing performed after removing the panels / boxes from the module.

EVERBLUE'S MBR MEMBRANES vs COMPETITORS



Applications

MBR systems with EVERBLUE modules are perfect for waste water treatment of:

- SMALL COUNTRIES
- HOTELS AND TOURISTIC VILLAGES
- HOSPITALS
- CRUISE SHIPS
- WINE CELLARS
- DAIRY
- SLAUGHTERHOUSES
- LAUNDRIES
- COSMETIC INDUSTRIES
- PHARMACEUTICAL INDUSTRIES
- LANDFILL

For all the above applications, the construction of container systems is ideal because it allows a significant reduction in construction costs, an optimization of construction and installation times and a huge saving of space.

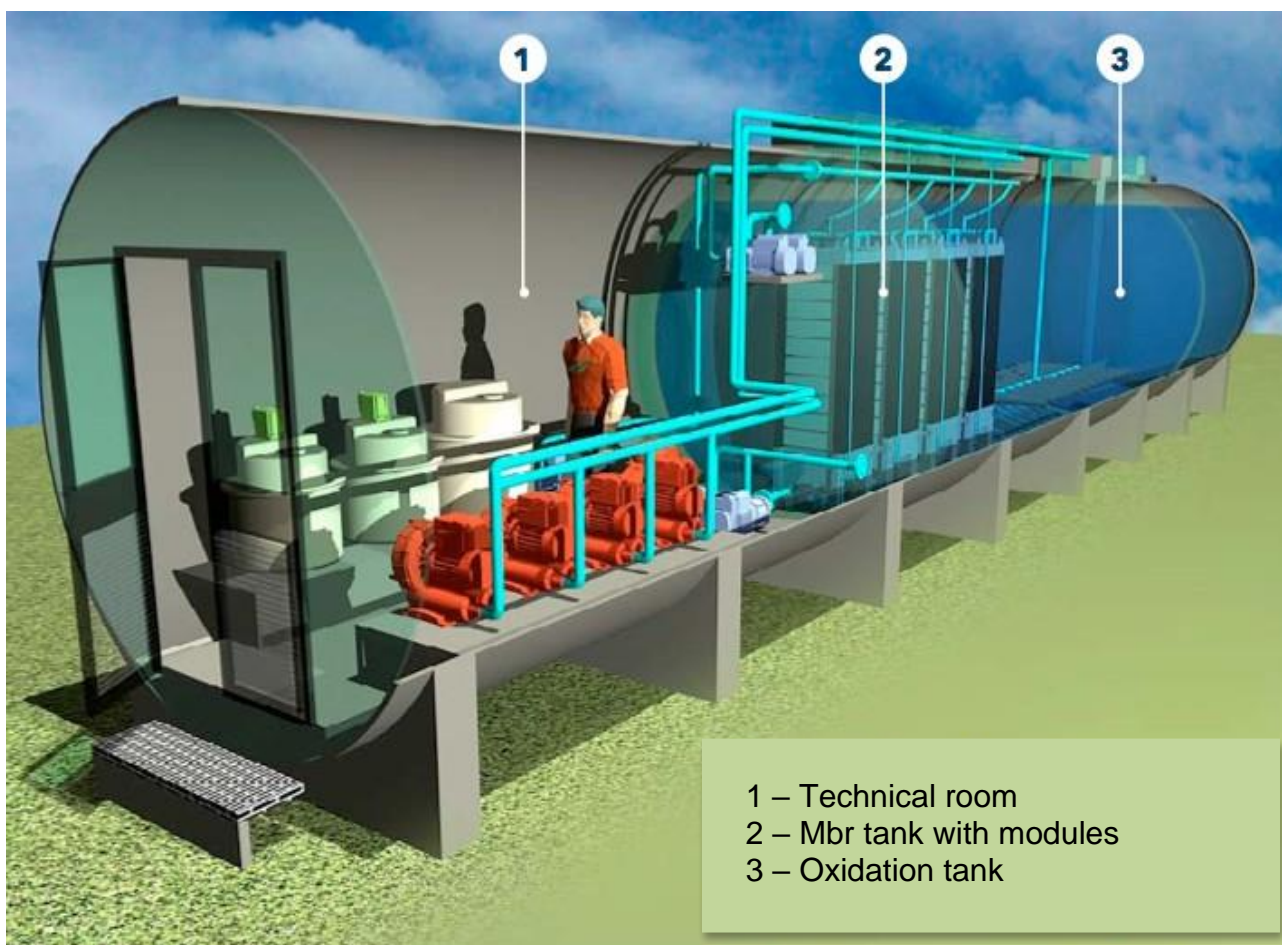
Below are some photos of plants built in containers with EVERBLUE MBR membrane modules.







L'italiana preferita dallo chef.



- 1 – Technical room
- 2 – Mbr tank with modules
- 3 – Oxidation tank



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