TREATMENT OF COMMUNAL WASTEWATER

THE SPECIAL CHARACTERISTICS TO BE TAKEN INTO CONSIDERATION IN A TENDER FOR BIODISKS.

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TECHNOLOGY AND DESIGN COMPARISON

BIODISKS vs ACTIVATED SLUDGE PLANTS

Note: BioDisk stands for **Rotating Biological Contactor** or **RBC**

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Challenges :

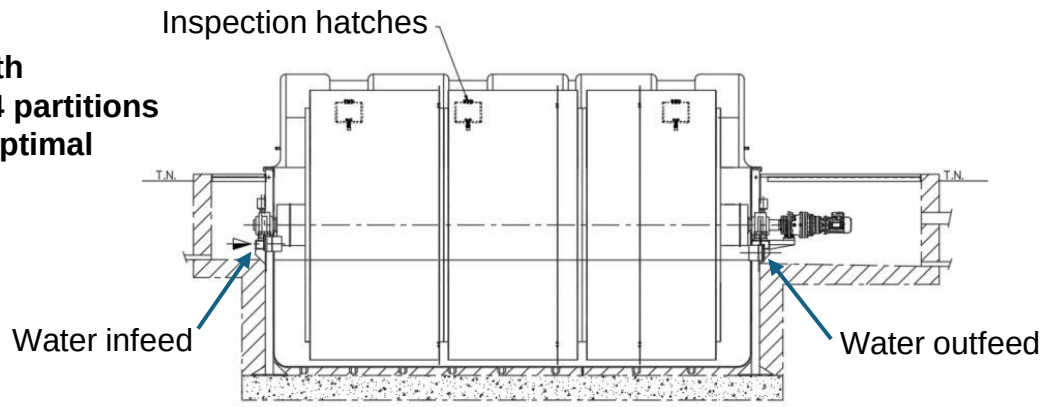
Wastewater treatment in France is generally carried out using 3 technologies :

- **Filters planted with reeds (with the constraint on the maintenance of the beds in order to avoid the presence of weeds, bindweed, nettles, etc.) This treatment is very limited in the elimination of nitrogen.**
- **Activated sludge.**
- **BioDisks (RBCs). This presentation shows you that RBCs with the recent NIFAS® process or with mineralization obtain comparable results, or even better than with activated sludge plants and with only 25% electricity consumption and between 30 or 50% sludge production (or none with mineralization) compared to the activated sludge WWTPs.**

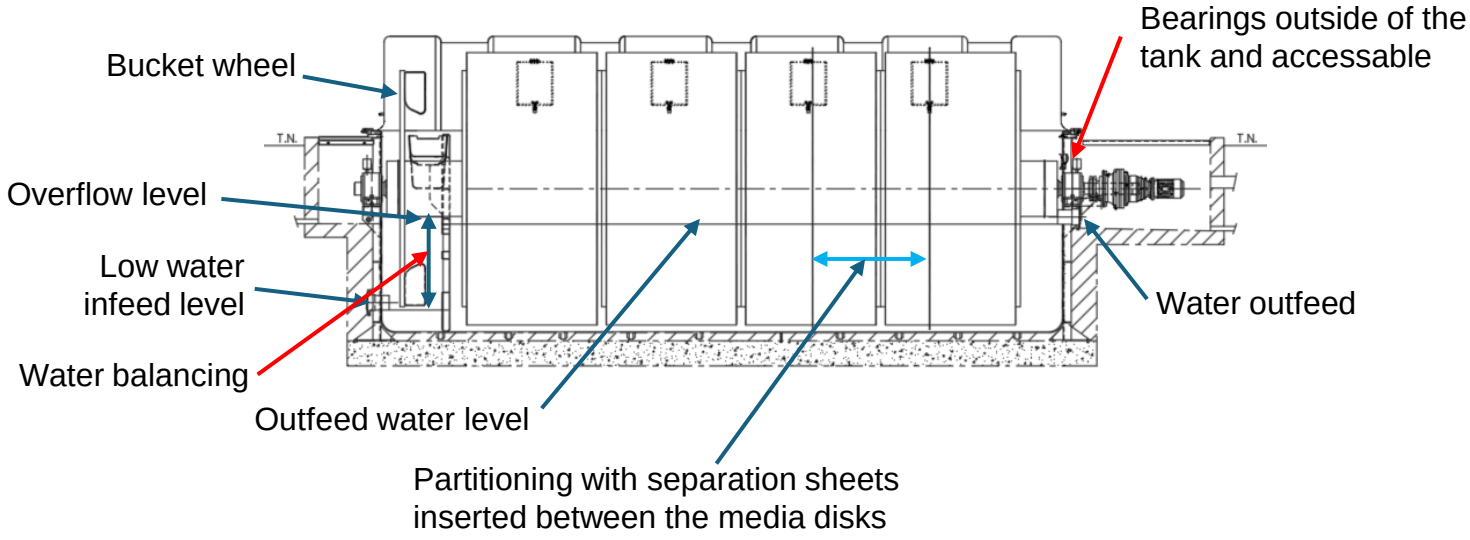
Summary :

Standard RBC construction

Gravity infeed with 3 segments and 4 partitions plates to create optimal bacteria activity



Water transfer with rotating buckets and equalized flow – unit with 4 segments and 5 partitions



NIFAS® technology incorporation in RBCs by EWwS ltd.

The problems caused by global warming and the regulations to combat the release of pollutants from wastewater treatment plants (particularly nitrogen) will tighten rapidly. We can even fear accelerated pressure like that observed for electric cars. You don't have to be Elon Musk to anticipate what will happen to our profession.
EWwS ltd. is directing all its efforts today in this direction to cover the needs of small and medium-sized wastewater treatment plants. (100 to 5000 PE).
EWwS ltd. therefore does its part in the environment to reduce the carbon footprint and to protect it.
Energy needs: 66 Watt-h per PE/day. Carbon footprint = 33 g Carbon per PE/day.
By incorporating sludge recirculation into their process, BioDisks can combine the advantages of activated sludge treatment in order to be able to denitrify nitrogen in a NIFAS® tank upstream of the BioDisks while favoring very low energy consumption.

NIFAS® technology makes it possible to achieve the following rejection thresholds :
BOD_5 < 10 mg/l, TSS < 10 mg/l, COD < 50 mg/l, NH_4-N < 1 mg/l, TNK < 1.5 mg/l, TN < 15 mg/l and TP < 0.5 mg/l.
When these high quality effluents are not required, the discharge rates generally required will allow for a smaller WWTP solution or better effluent quality.

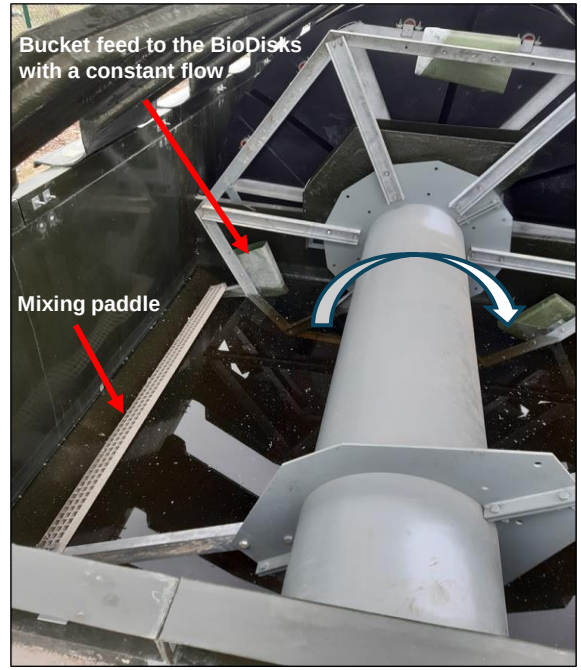
And in all cases with the following advantages:

- ❑ Simple operation with stable process performance.
- ❑ Reduced carbon footprint thanks to reduced energy consumption.
- ❑ Lower plant footprint for a similar discharge quality.

WWTP Les Fontenelles – Le Bignon (44) – 800 PE

NIFAS® technology incorporation in RBCs by EWwS ltd.

NIFAS® reactor with integrated flow attenuation stage, suspended solids mixing and bucket wheel for controlled water supply to the BioDisks.



24h results at the WWTP Les Fontenelles – Le Bignon (44) – 800 PE (loads, flows and efficiency)

Analysis 24h	8 Nov 2023 *)		η in %	22 May 2024		η in %	1 Aug 2024		η in %	16 Sept 2024		η in %
	Infeed	Outfeed		Infeed	Outfeed		Infeed	Outfeed		Infeed	Outfeed	
Flow m^3/d	247	243		235	210		110	100		74		
BOD_5	188	4,97	**97**	700	4,1	**99,4**	645	1,4	**99,8**	350	4,9	**98,6**
COD	465	38,3	**92**	1270	39	**96,9**	1520	33	**97,8**	1100	35	**96,8**
SST	264	13,5	**95**	420	12	**97,1**	500	9,6	**98**	370	3,2	**99,1**
TNK	31,6	9,3	**70,6**	65	2,1	**96,8**	71	2,4	**96,6**	85	3,2	**96,2**
$N\text{-}NH_4$	19,4	7,1	**63**	12,4	0,2	**98,4**	41	0,1	**99,7**	57	1,1	**98,0**
$N\text{-}NO_2$	0,05	0,46		0,28	0,28		0,18	0,44		0,094	0,159	
$N\text{-}NO_3$	0,05	0,93		0,65	1,6		0,2	3,6		0,3	2,52	
TN	31,8	10,7	**66**	65,93	3,98	**94**	71,39	6,44	**91**	83,39	5,88	**92,9**
TP	5,2	0,25	**95**	17,9	0,26	**98,5**	13,7	0,27	**98**	12,6	0,24	**98,1**
Load in PE	**774**			**2741**			**1182**			**432**		

*) Before on-site intervention by EWwS Ltd to reduce the feed volume to the BiolDisks on March 28, 2024, which improved the yields.

BioDisk wastewater treatment with sludge mineralization.

How does sludge treatment by mineralization work?

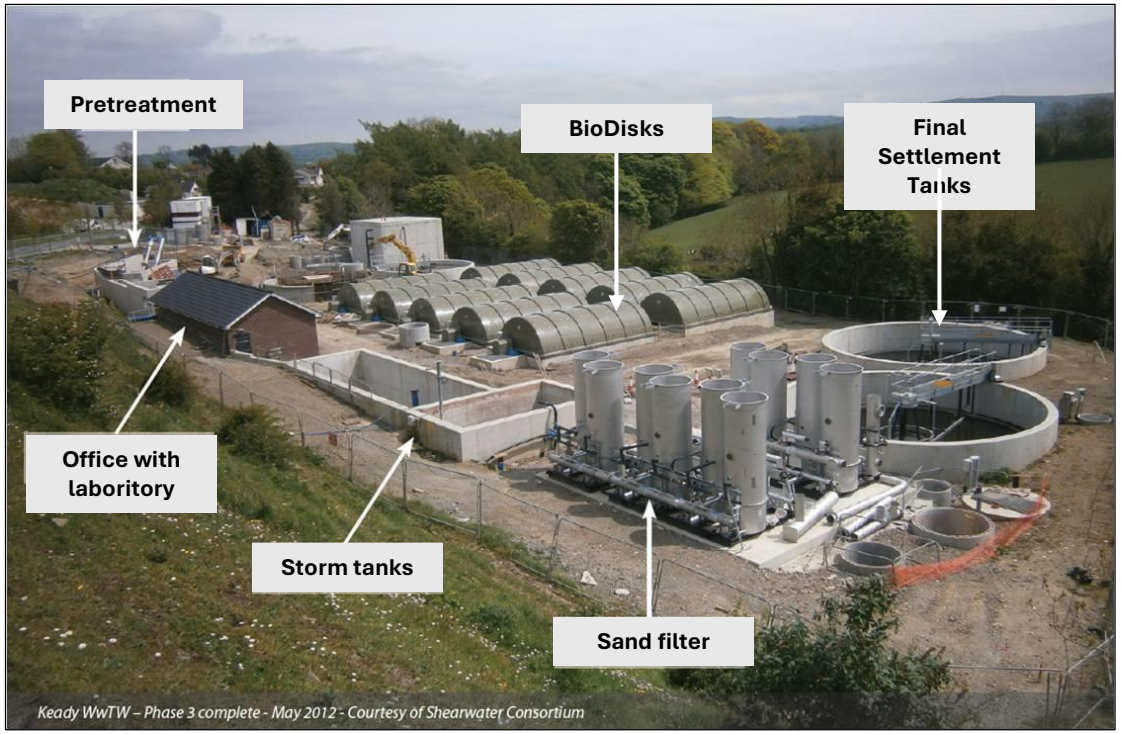
You must first ensure that only organic matter is treated and this requires a screen with a 2 mm opening or a rotating drum with 2 mm perforation. The sand must have been removed during the pretreatment.

In the BioDisk unit for mineralization, the biological treatment is provided in the first 30% of the media. The biomass transformed into sludge is then consumed by bacteria, which are looking for organic food like cannibals. What remains of the sludge is decanted in the clarifier and recycled to the screen in order to return to the BioDisks.

In RBCs and most fixed film reactors, the suspended matter content is between 200 and 300 mg/l. Sludge production per PE = 1.2 L/day. For 250 PE, sludge production = 9000 liters/month. Mineralization makes it possible to reduce this sludge to 30 liters/month. Mineralization is optimal with a surface area of BioDisks being 40 m^2/PE. The treatment yield is 99.66%. Obviously, the investment costs are substantially higher.

Mr Nathwani, the owner of EWwS ltd., designed this mineralization plant in Northern Ireland in the town of Keady for 5000 PE. The BioDisks have a diameter of 4,5 m.

You will find photos and results of this installation which has been in operation since 2013 on the next page.



Conception of BioDisk units

BioDisk wastewater treatment with sludge mineralization.

Flows and loads at the infeed of the 5000 PE plant :

Daily flow	965 m^3/d
BOD_5	300 Kg/d
NH_4	35 kg/d

Rejection thresholds:

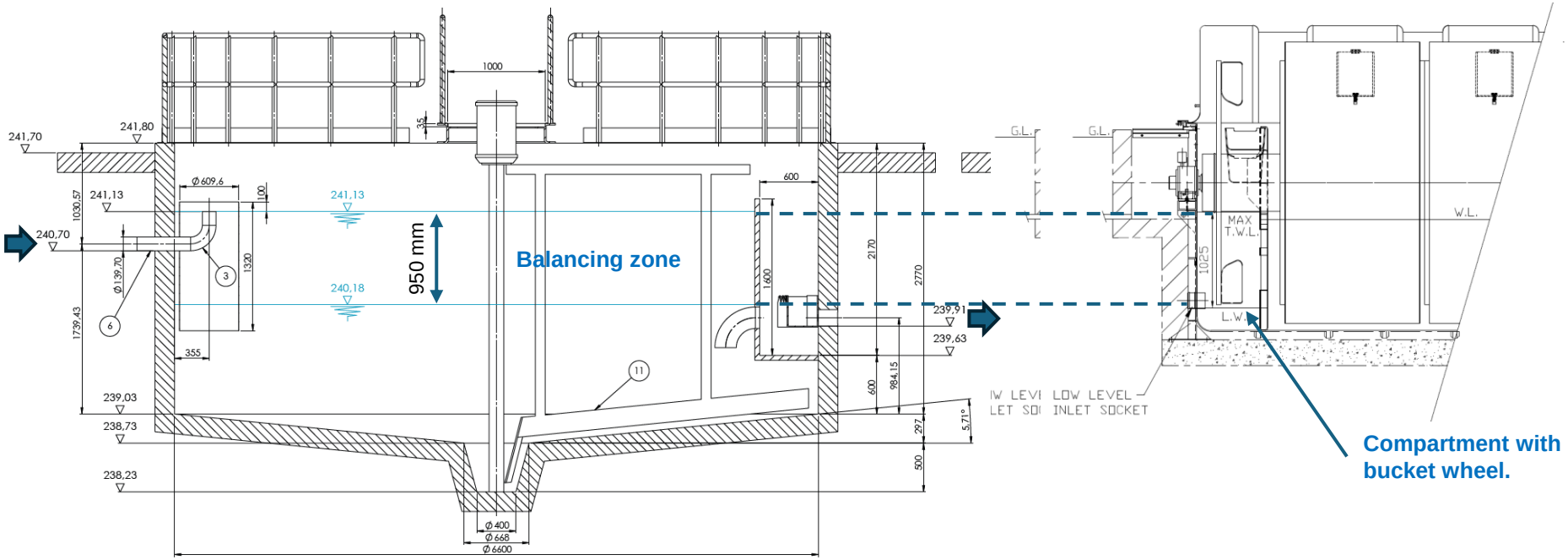
Criteria	Values	Authorized threshold
Daily flow	965 m^3/d	
BOD_5	2,1 mg/l	5 mg/l
COD	27,1 mg/l	
NH3	0,034 mg/l	1,5 mg/l
TSS	3,5 mg/l	10 mg/l

Primary settlement tank.

Primary settlement tank - Decanter / Digester

A primary settlement tank or decanter/digester allows a considerable reduction in the treatment of BOD_5.

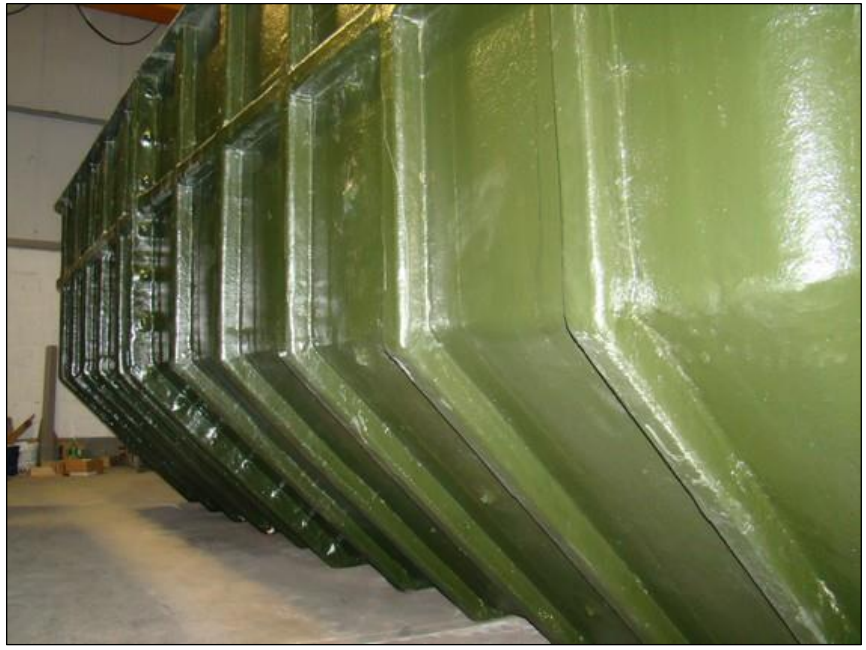
BioDisk treatment is very sensitive to water retention time throughout the unit. A peak flow rate 4 times the average flow rate Q18 and this twice a day can create problems on the discharge threshold. EWwS wishes to be able to adjust the flow rate in the decanter by balancing and provides a compartment upstream of the BioDisks equipped with a bucket wheel which supplies the disk compartment with a constant flow rate.



RBC design concepts

The tank

EWwS delivers its units in a GRP tank and with lateral reinforcements. (See photo.) These tanks are to be placed on a concrete slab. Please note that the tank will allow concrete to be poured around as a backfill with a thickness of 225 mm in the case of a buried installation. The tank walls must not be subjected to deformation pressure when the backfill concrete is poured around them. The tank and all its compartments must be filled with water, which will be 300 mm above the concrete level of the backfill. Before supplying the customer with a quote, EWwS must be informed of the installation requirements.



The shaft

Choice of steel for the shaft and the construction of the unit.
A number of EWwS's competitors have successfully sold RBCs with stainless steel shafts and media support frames. Supposedly, wastewater is corrosive and stainless steel is required.

Why is there no metal corrosion inside a BioDisk unit, which operates 24/7, 365 days a year?

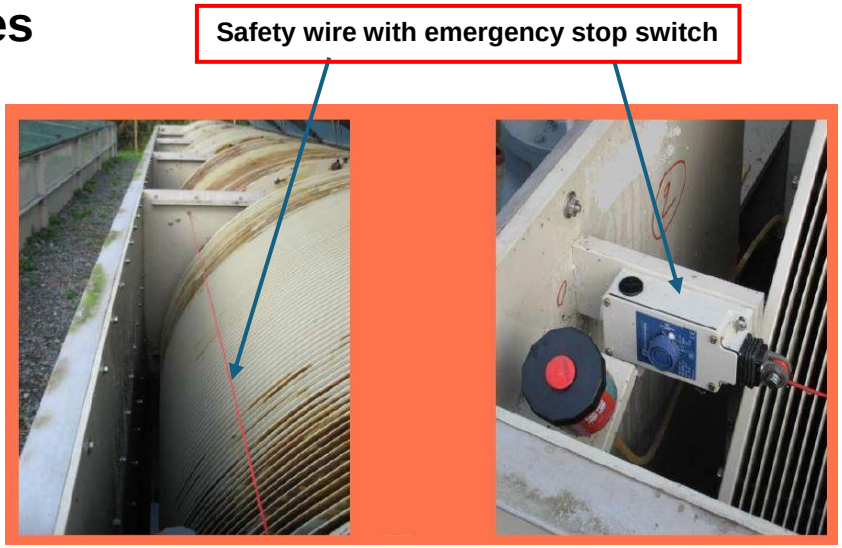
The reason is that the biomass layer, which covers all of the metal surfaces inside the unit, will prevent corrosion. Although the shaft is above the water surface, all surfaces inside the unit are splashed with water. Bacteria are not disciplined and biomass settles on all wet surfaces. Each metal surface is thus covered with biomass. In this layer of biomass, bacteria find their oxygen needs in dissolved oxygen. **Corrosion of metal surfaces inside a biomass layer does not exist.**

Stainless steel has the disadvantage that its resistance against repeated deformation is very low, because the high contents of carbon (1.2%) and chromium (more than 10.5%) make it inflexible. As a consequence the shaft inside the tank must be supported on each side of the media discs with a bearing (each equipped with an automatic lubrication cartridge). This makes the unit very expensive to purchase and to maintain.

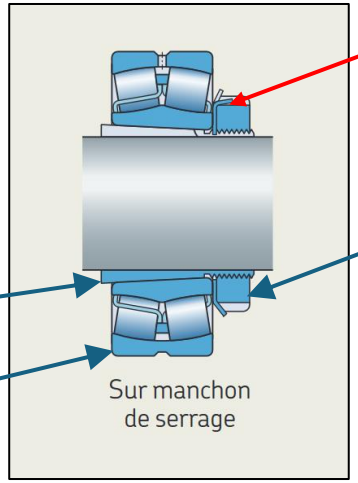
And in order to detect a problem with one of the bearings, the operator must open the covers, which are held open by pneumatic cylinders while the unit is in operation. A safety wire must allow the operator to stop the rotation in the event of an accident. It can be said that this construction is very dangerous for the operator. (See photos)

The EWwS solution: Hollow shafts in galvanized mild steel, highly resistant to deformation due to fatigue under heavy load and a rotation speed of 2 rpm. This solution allows for the use of only one bearing at each end of the tank and outside the covers. Media disks are inspected through protected hatches.

Stailess steel shaft consequences



Bearings



Locking tab engaged in the notch on the clamping ring

Clamping ring

Tightening sleeve

Bearing

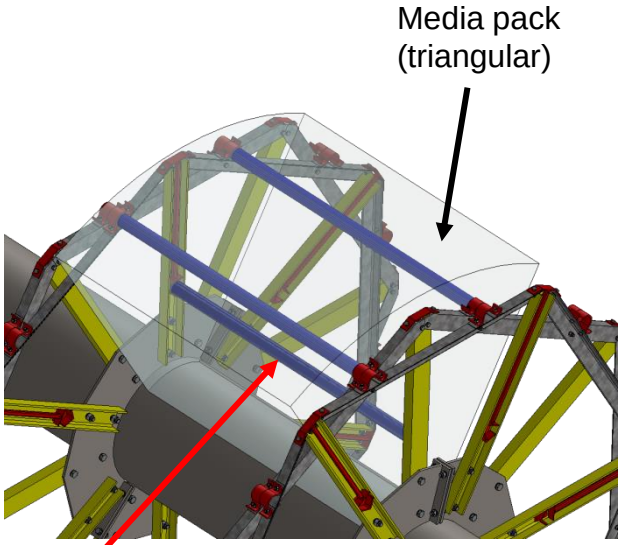
Multiple notches on the clamping ring will allow to insert the tab in the best position

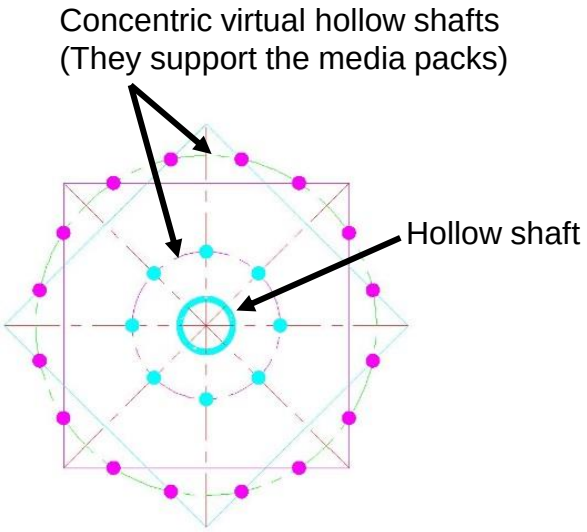
Locking tab.
Only one must be engaged in one of the 4 notches

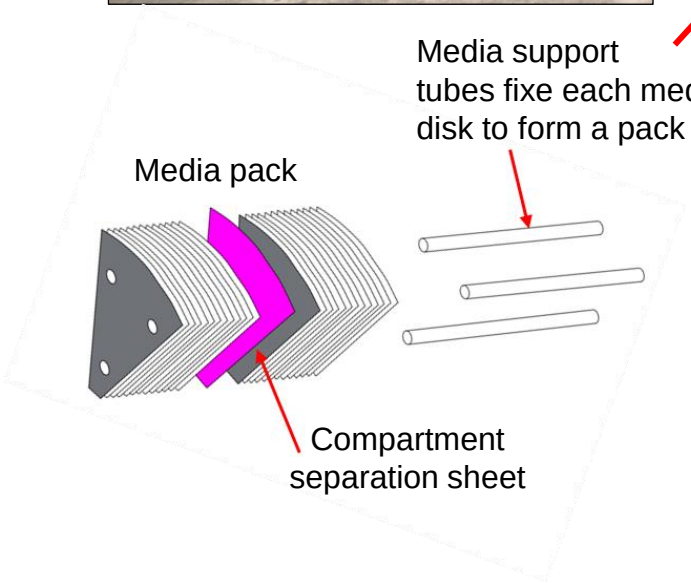
Automatic grease cartridge

Gear drive motor

Media support structure

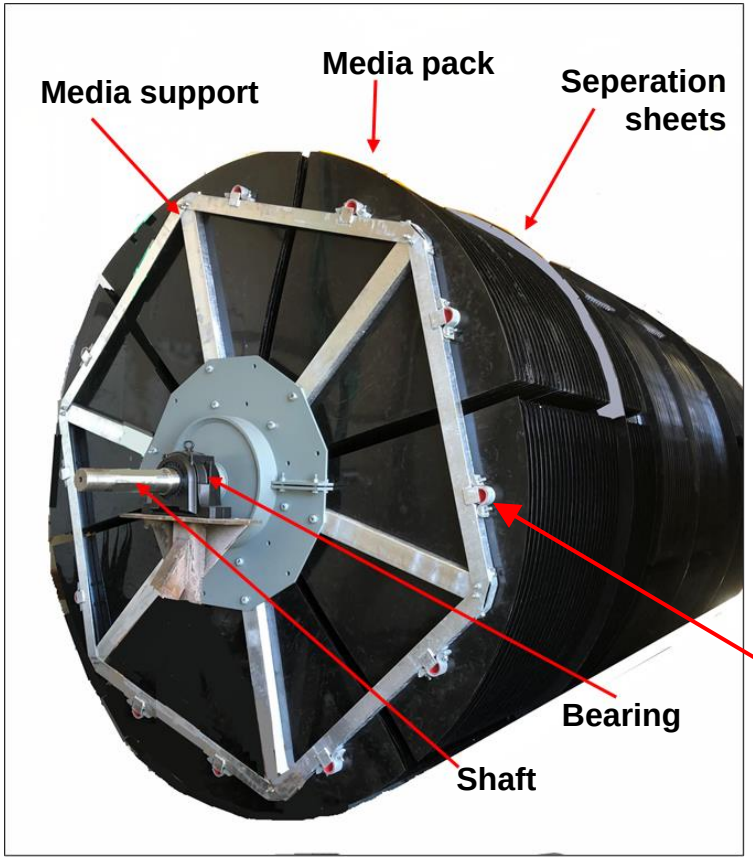


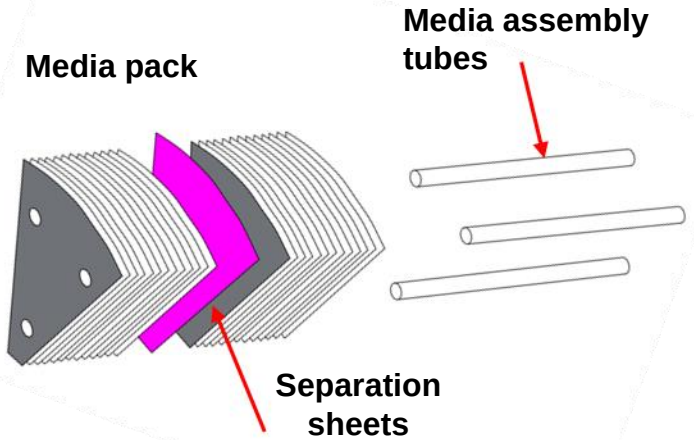




The **resistance** of the shaft against deformation, when it is slowly rotating under a heavy load, is supported by the hollow tube combined with 2 virtual concentric shafts. With an innovative **EWwS Ltd** design**,** the media support tubes (blue wall) are integrated into a solid support structure over the total length of the shaft and they, in terms, provide two more concentric virtual hollow shafts that assist the main shaft to resist the deformation. The deformation of the **EWwS ltd** shaft **is** less than 1 mm maximum, depending on load and shaft length; For that reason, premature shaft failure from fatigue is avoided, as strain combined with energy are the main causes of rotating structure failure from fatigue.

Media and pack extraction with bolts at the outside of the pack.



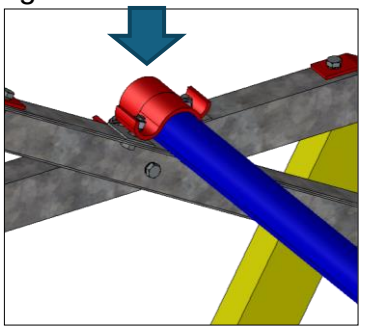


Please note:

The separation sheets serve as tank compartments. They are positioned among the media and their position is determined by the EWwS engineering department. Between the separation sheets, the bacteria culture changes relative to the surrounding areas depending on the treatment objectives.

Nord-Lock washers combine Nord-Lock wedge locking with an innovative spring effect, providing the highest security against spontaneous loosening of bolts. This product is the optimal choice when you have both vibration and applications with the risk of loosening. The Nord-Lock steel washer promises the highest corrosion resistance on the market.

Media pack tubular assembly fixing



Media pack replacement when required

A media bank (Ø 3 m) consists of 6 media packs around the shaft. The packs can be removed from the BioDisk individually from the outside without the need to remove the shaft. To avoid an unbalanced problem, you must also remove the opposite pack on the shaft.

If a pack is damaged and needs to be replaced, both packs are removed within a few hours and the RBC drive is restarted immediately. This construction avoids providing two BioDisk units each with 50% plant capacity to reduce the risk of interrupted treatment.

Media details

- Media material : Polypropylene copolymer with a thickness of 0.6 mm, chosen for its lifespan.
- This media maintains its mechanical properties despite a wide range of temperature variations. Resistance against any biological or mechanical degradation (tearing)
- The molded lips of the media ensure the fixing of the packs by clamping on tubular, which are in turn bolted to the assembly frame.
- This construction is designed to avoid tension and friction on the pack during operation.

- In the design of the BioDisk unit, EWwS uses media with a specific surface/volume ratio of 165 m^2/m^3 (20-40 mm between sheets), 200 m^2/m^3. (20-30 mm between sheets) and 250 m^2/m^3. (15-20 mm between sheets)
- For the 1st segment, we use the media with a specific surface/volume ratio of 165 m^2/m^3. In the case of nitrogen treatment, a specific surface/volume ratio of 200 m^2/m^3 is used.

Beware of your media quality : virgin polypropylene is required!

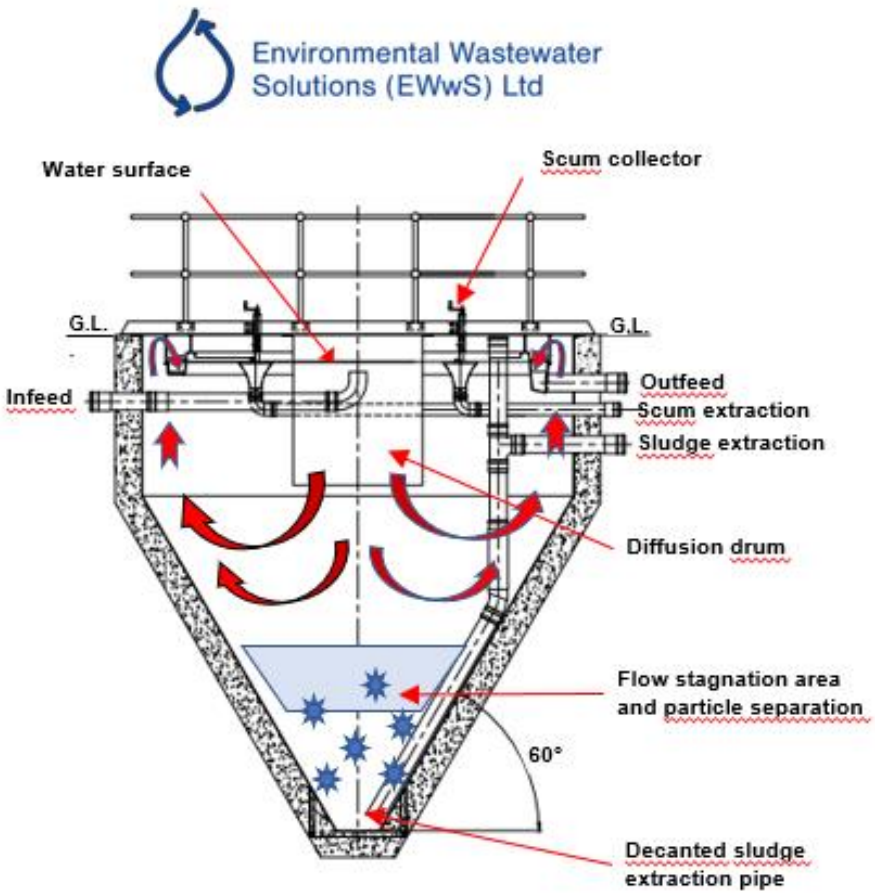
Looking at the photograph, this support is made from recycled materials. This support failed because the material has undergone several heat cycles. The recycled material can be anything, while EWwS Ltd specifies virgin polypropylene and offers a 20-year warranty on the media. Many other problems must be considered, such as stress on plastic.

Covers

The covers on the Ø 3 m units are removable and supplied with a UV resistant gelcoat. Large inspection hatches allow inspection of the biomass on the BioDisks and the transfer of water by the bucket wheels. The inspection hatches are padlockable. Once opened, the staff is protected by a stainless steel grid with large meshes which avoid touching the rotating biological disks. In the case of maintenance with the stopping of the rotation of the biological disks, a simple system allows the upper covers to be unlocked and the covers to be moved for full access. It takes two technicians to move the covers.

Conical final settlement tank

Conical final settlement tank



The sludge produced by fixed film treatment like RBCs as well as in activated sludge plants is biological in nature and fragile with a particle density in the range of 1.05 to 1.1 g/CC or 1.05- 1.1 kg/l (similar to that of water).

The main difference between wastewater treated by RBCs and that by the activated sludge process is the concentration of solids. For RBC wastewater this is 0.2 to 0.3 g/l, while for activated sludge process wastewater it is normally 3 to 4 g/l.

In wastewater from the activated sludge process, the concentration of suspended particles is too high for simple gravity separation, because these particles suffer from "concentration hindered settling" and, therefore, the final sludge clarifier activated must be sized on mass flow theory where the tank solids handling capacity uses critical design parameters based on SSVI 3.5 g/l (stirred sludge volume index at 3.5 g/l of sludge).

Conical decanters use a complex kinetic flow pattern. The water enters through a fairly large Diffusion drum compared to the water surface area. The reason for this is to quickly reduce the speed of the incoming water. Please keep in mind that speed is a vector and therefore has a value and direction. Inside the diffusion drum the water will be forced downward.

Since the water will follow the path of the least resistance, it will quickly reverse its downward flow direction and flow upward toward the perimeter of the decanter wall where the V-notch weir and launder toward the outlet are located.

Reversing flow will create a zero-flow stagnation zone where water velocity (rate of rise) is almost zero, but solids continue to descend at "terminal settling velocity" toward the bottom of the conical section to be consolidated as settled sludge for periodic disposal.

Conical final settlement tank

Two 6m diameter settlement tanks under construction

General remarks

General remarks

Alkalinity of wastewater (expressed in CaCO3)
In order to function properly and process nitrogen, sufficient alkalinity must be ensured for the process.

Phosphorus Treatment
Where it is necessary to dose chemicals for phosphate removal, we recommend the use of PAC (polyaluminum chloride), and this should be dosed immediately after the BioDisk unit. The surplus of aluminum in recirculation has no impact on RBCs. We do not recommend $FeCl_3$ dosing, as it has a detrimental effect on the process and construction materials of the RBC unit. You should know that ferrous iron has an oxygen demand by itself and will generate ferric iron. First, the accumulation of insoluble ferric hydroxide flocs on the media considerably limits the transfer of oxygen to the biomass. These iron deposits are significantly denser than the biomass, thus exerting excessive weight on the system. Additionally, it causes premature rusting of the media support frame, as well as premature failure of the media support through creep deformation. Normally, the iron concentration in a RBC unit should be < 1 ppm. If the customer uses ferric chloride to remove phosphates and decides to recycle the liquid sludge to the plant's indeed, or if the iron concentration in the wastewater entering the BioDisk is > 1 mg/L, EWwS will not be not able to provide the 20-year warranty on the shaft, frame, media and tank. The iron concentration at the entrance to a BioDisk unit will also reduce the alkalinity in the wastewater.

Water recirculation flow from the final settlement tank.
Many design consultants in wastewater have less knowledge of fixed film processes such as RBCs and are more accustomed to activated sludge plants. Recirculation flow rates from the final settlement tank are often excessive for BioDisks and can cause unnecessary problems.

Surface loading of the BioDisks is often based on the desired consent values in the treated water.
The values published by various organizations are today exceeded by new techniques such as NIFAS®. WWTP equipment suppliers are much more familiar with the results that can be obtained based on certain surface loads.
In addition, a supplier like EWwS Ltd guarantees the result of his treatment selection.

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Rotation speed
Our standard biological discs operate with a rotation speed of 1.9 rpm; this speed allows better mass transfer in the biomass layer and based on the process kinetics, mass balance and other parameters, the oxygen transfer will be optimized.

Warranty
For standard shaft units we also include a 20 year warranty for the shaft, GRP tank, media frame and media assuming the unit is operated and maintained in accordance with our operating instructions. operation and maintenance and flow rates, loads and all other parameters are within the values indicated in our proposal. Please note that the gear motor and bearings are excluded from this warranty (wear parts) and only carry original manufacturer (OEM) warranties. Bearing selection is based on a life of L10 >100,000 hours.
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Activated sludge plants compared to RBCs:

WWTPs at low load compared to nominal. When the WWTP operates in conditions close to its nominal load, this does not pose too many problems, because the sludge concentrations are sufficiently high in the tank (approximately 4 g/L and around 6 to 8 g/L in recirculation) , input values which are already limits for correct dehydration. Unfortunately, charging rates are typically below 50%, so WWTPs are often underloaded.
Consequently, the manufacturer's instructions given for the nominal capacity of the sludge concentration in the aeration tanks must be lowered to maintain a target mass load (Cm) of 0.1 kg BOD_5/kg MVS.d, under penalty of see operating parameters altered and operating costs soar (electrical energy in particular: poorer oxygen transfer for high sludge concentrations, higher respiration requirements). Thickening the sludge with short residence times is an essential step. It is imperative to require dynamic or other equipment for sludge thickening in the specifications.

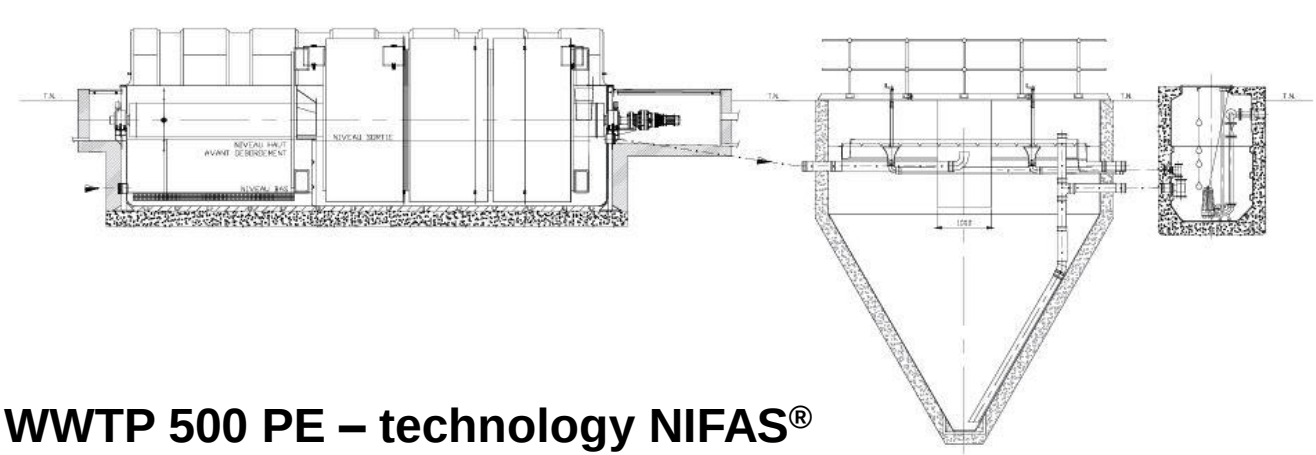
WWTPs with RBCs automatically adapt to the load received

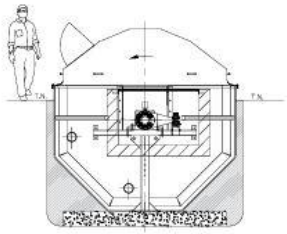
The process of treatment with biodisks being very stable while avoiding many problematic criteria requires little monitoring and without the need for particular knowledge of the biological process. It avoids tanks, pumps, DO or REDOX probes and consequently maintenance.

Treatment by BioDisk units consumes only 25% of the electricity compared to the needs of an Activated Sludge plant for the aeration of the reactor tank.

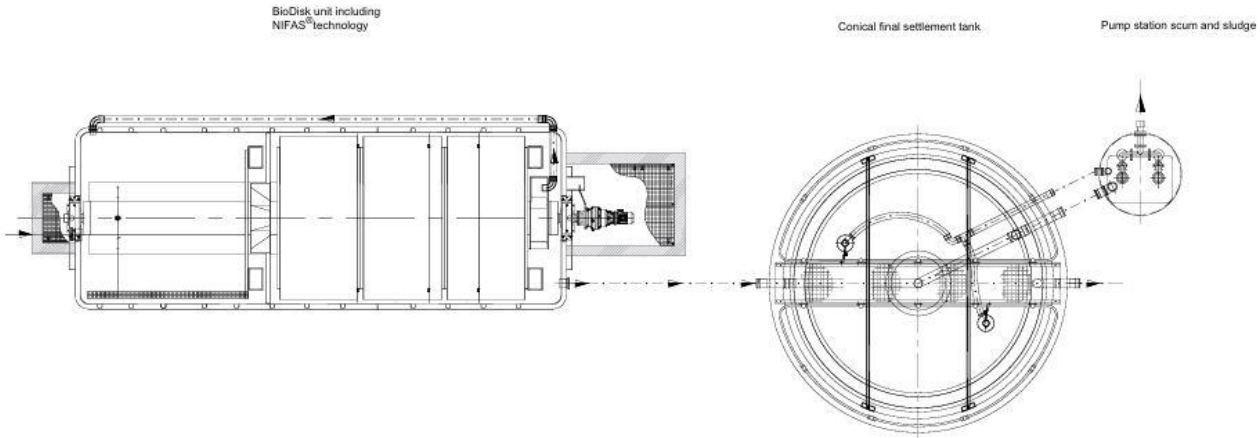
Treatment with BioDisks only produces 30 to 50% of the sludge compared to the sludge from an Activated Sludge WWTP.

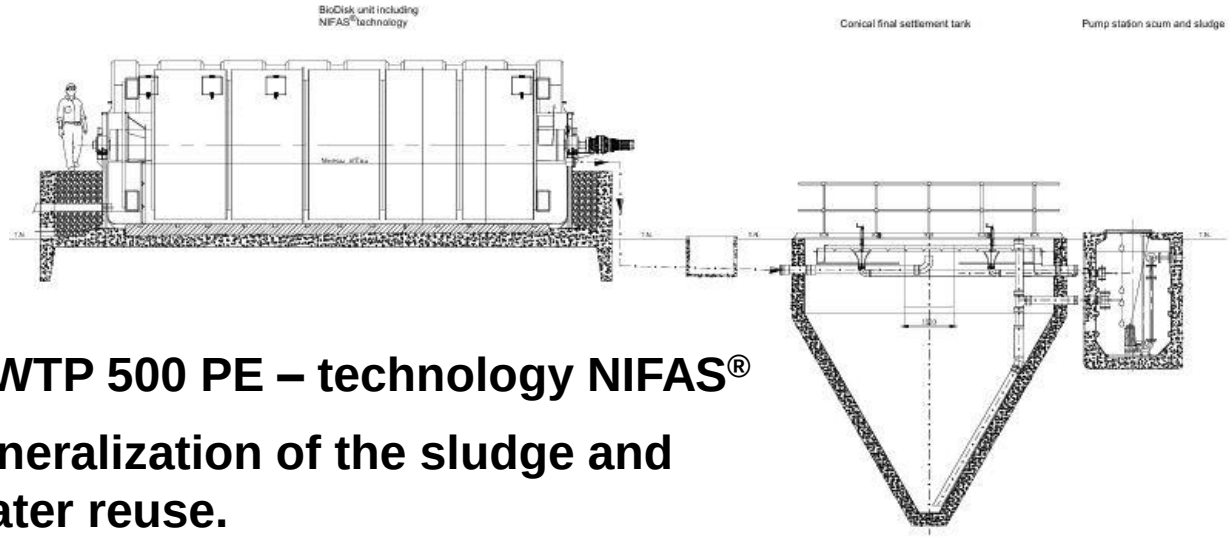
Treatment by Biological Discs with mineralization of the sludge allows the treated water to be reused without filtration but requires tertiary UV treatment.

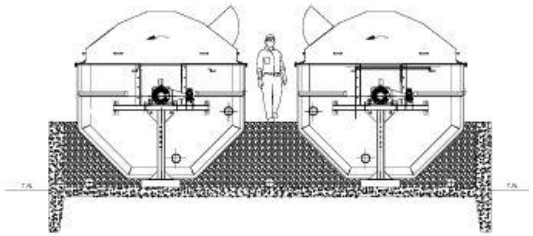




WWTP 500 PE – technology NIFAS®

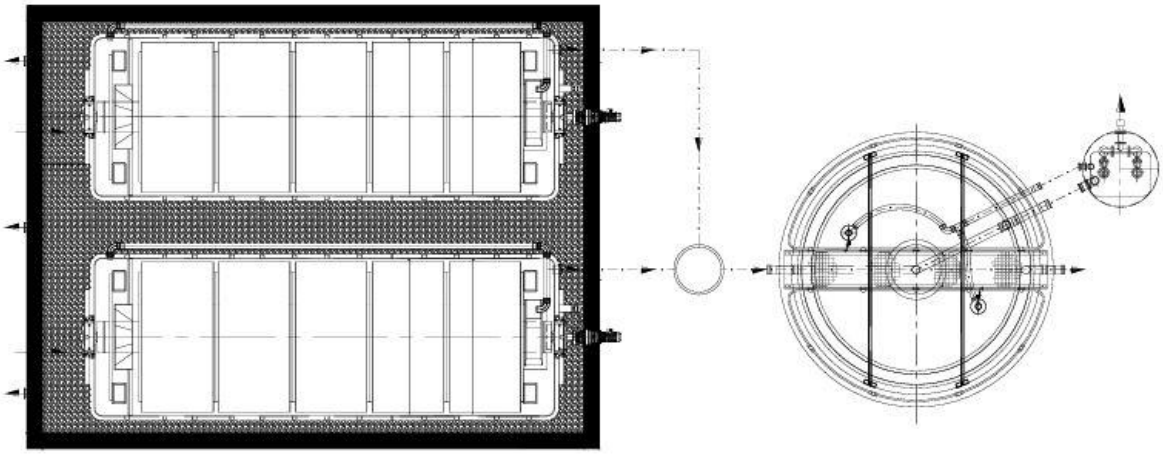






WWTP 500 PE – technology NIFAS®

Mineralization of the sludge and Water reuse.



The solution of two RBCs with mineralization for a WWTP of 500 PE requires a surface area of the BioDisks of 20,400 m^2 compared to the solution with NIFAS®, which requires a surface area of 5,230 m^2. For this increase in disk area, the cost of the supply is increased by 2.5 times.

Thank you for your interest

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