WASTEWATER TECHNOLOGIES

Reclaiming Clean Water

" This plant is going to be a pleasure to run, it has all the bells and whistles that make my job easier. It is the best designed small plant I have ever seen."

Garvis Reynolds
EcoOptions, LLC
Manager/Operator
Cedar Rock WWTP

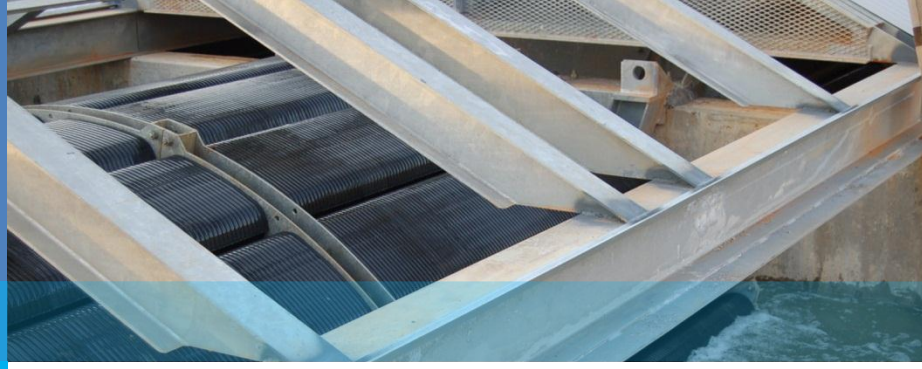
Wastewater treatment is a vital link in the recycling of water resources. The demands on performance and effluent quality of wastewater treatment facilities have increased substantially in order to comply with higher standards to protect human health, to clean up rivers and lakes, and to provide needed resources for drinking water and industrial uses. In addition to the removal of oxygen consuming compounds of carbon and nitrogen, it has become increasingly important to remove inorganic nutrients such as nitrates and phosphorous.

Most biological wastewater treatment plants use either a fixed film process or an activated sludge process, each of which have distinctive characteristics. The fixed film process is simpler, and provides more stable treatment with lower power costs, while activated sludge is more flexible and will meet higher quality effluent standards.

The **Biorotor™** biological treatment system has been developed to combine the compactness and flexibility of the activated sludge process with the stability and simplicity of the fixed film process. The Biorotor™ system integrates the two processes in a single tank by using a simple mechanical drive system. The rotation of the **Biorotor™** provides alternating air and water cycles for the fixed film process, and aeration and mixing for the activated sludge process.

With the **Biorotor™** system, advanced water treatment with high quality effluent is possible by biodegradation of the organic compounds, nitrification, and denitrification and uptake of excess P without using chemicals.

The combination of the two processes provides high stability, with low capital and operating costs.



DESCRIPTION OF THE PROCESS

In general the following process steps are involved:

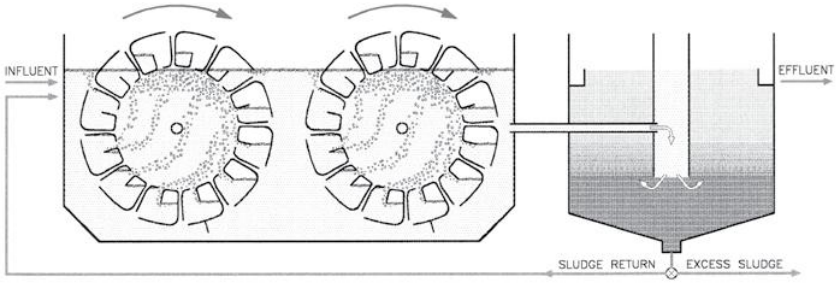
- Mechanical pretreatment with a bar screen, comminutor or pre-clarification
- Aeration and mixing in the bio-tank with the rotating **Biorotor™**
- Clarification, with sludge recycling to the biotank and withdrawal of excess sludge

The heart of the wastewater treatment process is the **Biorotor™** which consists of a rotating structure with patented cell plates arranged in a series of rows.

The cell plates are 3/4” apart and provide a roughened surface as media for fixed film growth, and also provide a source of aeration for the activated sludge. By adjusting the speed of rotation for varying oxygen requirements, treatment of the wastewater occurs both in the activated sludge and the fixed film.

During rotation of the **Biorotor™**, trapped air is gradually released into the mixed liquor as medium to fine bubble aeration. Some of the air is transferred from one pocket to another inside the cells providing additional buoyancy reducing energy requirements. Before the cells are rotated to the surface, a majority of the air is expended as medium/fine bubble diffusion. By this method, the time of retention of air-water contact is extended so that oxygen transfer is optimized.

The rotational speed of the **Biorotor™** is adjustable, which regulates the amount of aeration and mixing in the bio-tank. The deep submergence of the wheel in the mixed liquor increases the efficiency of oxygen transfer.



OPERATION OF THE **BIOROTOR™**

In general the following process steps are involved:

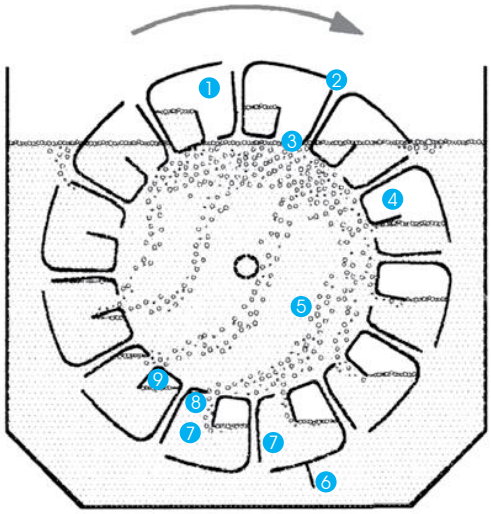
The **Biorotor™** consists of a number of cells, which are arranged in a circular fashion around a horizontal shaft as shown in the schematic drawing. Each cell contains a number of specially profiled polyvinylchloride plates which form a self supporting segment to provide aeration and mixing as well as a surface area for the biologically active fixed film. The wheel is submersed to 80% of its diameter in the mixed liquor and is driven by an easily accessible gear motor and chain drive located above the liquid level on the upper wall of the bio-tank.

Aeration and mixing are provided by the rotation of the **Biorotor™**. As a cell emerges above the mixed liquor, the liquid drains out, and the cell is filled with air under normal atmospheric pressure. Because the large surface of the plate is directly exposed to pressure of the air, immediate saturation of oxygen is obtained.

As the **Biorotor™** rotates and the cell segments are sub-merged into the mixed liquor, the entrapped air is com-pressed and forced toward the bottom of the bio-tank. During downward rotation, a portion of the air escapes to the surface as fine bubbles. The resulting turbulence, combined with the rotation of the wheel, provides homogeneous mixing in the bio-tank. During upward rotation of the wheel, the partially air filled cell provides buoyancy and reduces the power required for rotation.

The fixed film on the surface area within the cells is supplied with oxygen while above the surface, and air is taken in to be compressed and distributed during rotation. This process results in the coincident supply of oxygen for the fixed film and the activated sludge.

The intake of air is adjusted by the speed of rotation of the **Biorotor™**. Even with very high loading and corresponding high oxygen consumption rates, a sufficient supply of oxygen can be transferred. The fixed film component provides an ideal environment for slow growing nitrifiers to provide stable nitrification. By creating a separate anoxic zone, complete nitrification and denitrification can be provided with minimal power consumption by the **Biorotor™** system.



1. OXYGEN SUPPLY TO FIXED FILM
2. AIR INTAKE
3. OXYGEN TRANSFER
4. COMPRESSION OF ENTRAPPED AIR
5. FINE BUBBLE AERATION FROM RELEASE OF ENTRAPPED AIR
6. SLUDGE SCRAPER
7. OXYGEN TRANSFER AT TRANSITION ZONES
8. TRANSFER OF ENTRAPPED AIR
9. BUOYANCY FROM ENTRAPPED AIR

DESIGN FEATURES

The properties of the **Biorotor™** system are the high de-gradation efficiency, quality effluent and degree of flexibility.

New plants can be constructed in concrete tanks, or steel packaged systems can be furnished. There are a large number of standard sizes of wheels available, and special sizes can be constructed. Existing plants can be retrofitted with the **Biorotor™** system to upgrade capacity and effluent water quality, while lowering operating cost.

The materials used in construction guarantee a long service life with low maintenance. The **Biorotor™** assemblies feature galvanized and epoxy coated components and UV resistant polyvinylchloride plates. Stainless steel fastenings are used, along with UHMW nylon and stainless steel bearings. Patented inverted "A-frames" are used to suspend the **Biorotor™** from the top of the concrete so that the entire wheel may be easily removed for maintenance or inspection without dewatering the bio-tank. This A-Frame assembly can be installed in steel tanks as an option.

1. MEN WORKING IN CONCRETE **BIOROTOR™** TANK TO ASSEMBLE 400,000 GPD WASTEWATER TREATMENT PLANT AT FREDERICK COUNTY, MIDDLETOWN, VIRGINIA
2. OPERATOR FRIENDLY DRIVE GEAR AND CHAIN AT A 150,000 GPD WASTEWATER TREATMENT PLANT FOR KERN COUNTY IN BUTTONWILLOW, CALIFORNIA
3. GALVANIZED STEEL **BIOROTOR™** FRAME
4. ONE OF THE SIX BR 24 x 5.0 **BIOROTORS™** BEING MOVED BY CRANE AT THE BEDFORD COUNTY PUBLIC SERVICE AUTHORITY, MONETA, VIRGINIA
5. 25,000 GPD CONCRETE TANK WASTEWATER TREATMENT PLANT, PRODUCING REUSE WATER FOR GOLF COURSE IRRIGATION AT THE RESERVES SUBDIVISION IN LEWES, DELAWARE
6. 25,000 GPD POST-LAGOON TREATMENT TO REDUCE AMMONIA TO LESS THAN 1 MG/L

INSTALLATIONS AND APPLICATIONS

The **Biorotor™** is used for the following:

- New wastewater treatment facilities as self contained and preassembled package plants
- New wastewater treatment facilities using cast-in-place or pre-cast concrete tanks
- Retrofit of existing plants to provide nitrification, denitrification and biological phosphorus removal
- Modernization of existing plants for increased flow and loading capacity and reduced power consumption

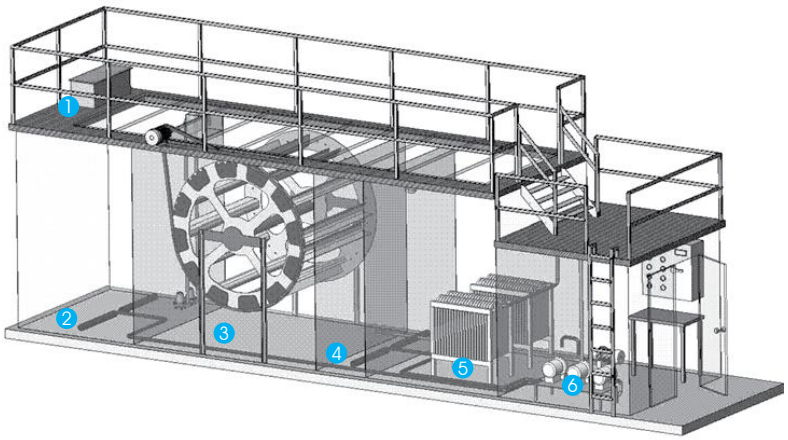
Applications include the following:

- Treatment of domestic and municipal wastewater from 2,000 GPD to 5.0 MGD
- Treatment of domestic wastewater containing industrial Wastewater
- Treatment and pre-treatment of high strength organic industrial wastewater
- Treatment of landfill leachate
- Combined with septic tanks and lagoons for improved nitrification, denitrification and biological phosphorus removal
- Food processing operations
- Aerobic sludge stabilization

1. A 400,000 GPD WASTEWATER TREATMENT PLANT DISCHARGING INTO THE GALLATIN RIVER FOR THE TOWN OF MANHATTAN, MONTANA, THUS PROTECTING THE EXCEPTIONAL QUALITY TROUT STREAM.
2. 45,000 GPD WASTEWATER TREATMENT PLANT LOCATED IN BALTIMORE HARBOR THAT DISCHARGES DIRECTLY INTO THE CHESAPEAKE BAY. CONSISTENTLY MEETS THE EFFLUENT REQUIREMENTS OF 10 MG/L FOR BOD5 AND TSS.
3. 500,000 GPD WASTEWATER TREATMENT PLANT PRODUCING LESS THAN 10 MG/L BOD5, TSS AND TOTAL N TO MEET THE CHESAPEAKE BAY REQUIREMENTS.

INTRODUCING THE **BiorotorMBR™**

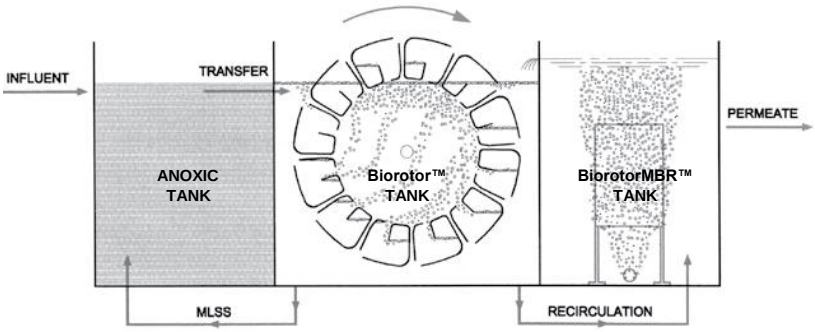
BiorotorMBR™ membrane bioreactor (MBR) combines the low power consumption of the **Biorotor™** technology with a highly efficient submerged membrane process. This wastewater treatment exceeds the most stringent standards for effluent discharge or reuse, and eliminates the requirement for a clarifier or a filter. With the **BiorotorMBR™**, it is possible to achieve effluent BOD and TSS almost to non-detectable limits.



1. BARSCREEN
2. EQ TANK (WATER LEVEL VARIES)
3. **BIOROTOR™** AND AEROBIC TANK
4. SLUDGE DIGESTER (WATER LEVEL VARIES)
5. MEMBRANE MODULES AND TANK
6. CONTROL ROOM (BLOWERS & PUMPS)
7. TYPICAL MEMBRANE CASSETTE
8. MEMBRANE AERATION DURING CLEANING

DESCRIPTION OF THE PROCESS

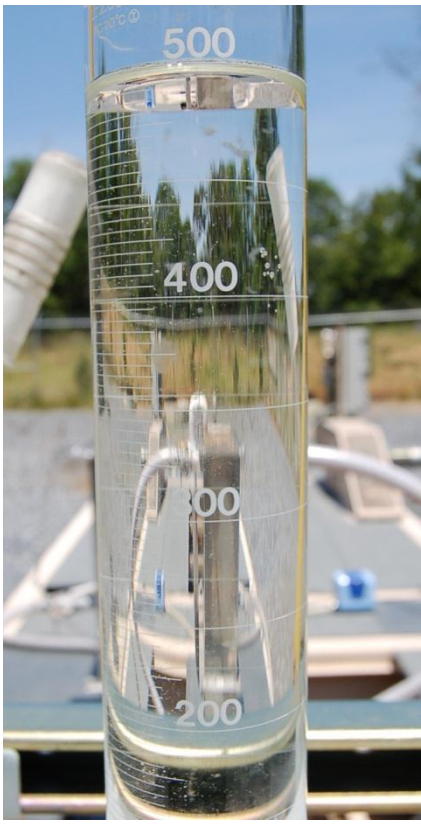
There are just a few simple steps in the **BiorotorMBR™** process. The first step consists of an appropriate mechanical screen for initial solids removal. The wastewater then flows to an aerated EQ tank to provide a uniform flow through the biological treatment section. For denitrification, an anoxic tank may be placed between the equalization tank and the bio-tank. The wastewater proceeds by gravity through the **Biorotor™** tank where the BOD is digested. Then it is pumped to the membrane tank. The liquid in the membrane tank is recycled to the bio-tank which contributes to the aeration, thereby significantly reducing power costs. As the mixed liquor suspended solids increase, they are periodically removed to the sludge digester.



The membrane filtration takes place in a aerobic environment where one or more membrane modules are installed inside the membrane tank. Air diffusers located below the membrane module scour the membrane surface so that minimum periodic chemical cleaning is required. In addition, the diffusers create a vertically upward flow on the surface of the membrane to continuously provide mixed liquor to be filtered.

While the “outside-in” filtration mode is applied to all of our systems, either the “flat sheet” or “”hollow fiber” membrane configuration can be implemented The permeate flow rate can be by either gravity or suction with flow rate controlled by an automated ball valve or VFD controlled pump.

When necessary, pilot units are available to perform testing which can help determining the optimal final design.



RESULTS HAVE BEEN EXCELLENT, WITH TSS NONDETECTABLE IN EVERY CASE. BOD5 IS GENERALLY 2-3 MG/L AND TN BELOW 10 MG/L.

ADVANTAGES OF THE **BIOROTOR™** SYSTEM

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Advanced Wastewater Treatment
With the Biorotor™ process, it is possible to achieve nitri-fication and denitrification, bringing BOD5 and TSS below 10 mg/L and N Total substantially below 5.0 mg/L, and reducing P to 0.8 mg/L.

High Process Efficiency
By combining activated sludge and fixed film processes into a single system, a much higher treatment efficiency is obtained.

Control Systems
Controls range from the simple comprised of position switches and indicating lights to latest generation microprocessors and touch-screen HMIs.

Sturdy and Simple Construction
Biorotor™ wheels are assembled at the construction site from sub-assemblies prepared at the factory. Through modular construction, it is possible to provide wheels of many different sizes to suit any given application.

Reliability of Operation
A high degree of flexibility and stability in the treatment process is possible due to the wide spectrum of fixed and suspended microorganisms combined with the ability to regulate oxygen intake. Temporary overloads can be buffered without problem.

Optimum Consistency of the Sludge
The sludge settles well and has excellent dewatering characteristics due to the fixed film component of the system. The clarifier and sludge treatment facilities can be designed with less volume and be more compact. Waste sludge is greatly reduced in volume.

Reduced Need for Space, and Lower Cost to Build
High operating efficiency and compact design reduce space requirements as much as 40% over comparable systems. Yard piping and electrical are significantly reduced and buildings are at Owner's discretion. Cost of construction is reduced due to the small size and simplicity of the system.

No Annoying Odors and Low Noise Level
Through efficient oxygen transfer, air intake requirement is minimized. Most of the turbulence and mixing take place within the submerged aerator, minimizing the production of aerosols and emission of odors. There are no blowers requiring dust control, silencers, or protective covers.

Reduced Power Consumption and Operating Cost
Power consumption of the **Biorotor™** is typically less than 30% of other aerobic processes using blowers.

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