AquaTech Systems
DECENTRALIZED WASTEWATER SYSTEMS

SELF CONTAINED

WASTEWATER TREATMENT SYSTEMS

10,000 TO 1,000,000 GPD

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Introduction

The Aqua Tech Systems BioTank Technology is a fixed film reactor, which was developed in Eastern Europe and is used extensively throughout Europe and Mexico for secondary treatment of wastewater, for the conversion and reduction of nitrogen and phosphorus removal. A full range of mechanical pretreatment and tertiary components are available for addition to the process chain.

STEP COLLECTION SYSTEM TREATING 100,000 GPD DISCHARGING
WITH A DRIP IRRIGATION SYSTEM
DESIGNED TO MEET EFFLUENT STANDARDS OF 15BOD/15TSS

Installations to 1,000,000 gpd and more. The BioTank is constructed of carbon steel or stainless steel, with plastic and zinc coated steel (railings and fencing only). The system is modular in nature and may be installed in parallel to accommodate larger flows. Each filter is partitioned into several treatment compartments that can be operated under anaerobic, anoxic or aerobic conditions. It is this design feature that provides for highly efficient and specialized microbiological communities of select trophic levels to accomplish stringent treatment goals. The BioTank maximizes treatment efficiency in a very small footprint and minimizes excess sludge generation. In fact, under optimum conditions a majority of the excess sludge is mineralized resulting in a minimum of sludge yield. The stability of the process, which is characterized as fixed film heritage, and the simplicity of the design, minimizes the life cycle operating and maintenance costs generally associated with the treatment of wastewater. Typical installations include residential clusters, malls nursing homes, schools, supermarkets, restaurants, gas stations, golf courses, hotels and small communities.

The BioTank is a fixed film process in which microorganisms attach themselves to a highly permeable media that is submerged in the wastewater. This allows for the absorption of organic and inorganic matter into the slime layer where treatment is realized. Designed properly this filter is self-purging.

Hydraulic dosing and secondary sludge airlift pump systems are set at pre-determined rates to minimize maintenance and enhance treatment. The self-purging biological filter is designed by Aqua Tech Systems to accommodate influent characteristics and achieve effluent requirements. Oxygen is introduced to the system via an oil-less compressor and membrane aeration equipment.

The BioTank is a designed treatment system. Hydraulic and organic influent characteristics must be determined in designing the BioTank to meet effluent requirements. A design criteria sheet is included for this purpose on page 8.

The BioTank is a "pump to" treatment system. The unit can stand alone or be installed in line between primary tank and final effluent station. The BioTank neither intrudes on nor adversely affects the flow of a conventional onsite system.

BIOTANK PROCESS

Wastewater is pumped from the influent pump chamber to mechanical equipment or directly into the first baffled compartment of the BioTank. Alternatively, primarily settled or prescreened wastewater is pumped from an equalization basin to the BioTank. Wastewater flows by gravity through each treatment compartment of the BioTank and effluent is discharges over a weir in the final section that may contain a lamella clarifier.

As flow enters each aerobic compartment dissolved oxygen is transferred to the wastewater via compressor and membrane aeration module. Each compartment has an independent and fully adjustable air regulation valve. In the aerobic modules the compressor acts as a mixer to enhance treatment and prevent the short-circuiting of wastewater through the plant.

In the BioTank the organic material in the wastewater is reduced by a population of microorganisms that attach to the filter media and form a biological slime layer. In the outer portion of the slime layer treatment is accomplished by aerobic microorganisms. As the microorganisms multiply the biological film thickens and diffused oxygen is consumed before penetrating the full depth of the slime layer. Consequently the film develops aerobic, anoxic and anaerobic zones.

Absent oxygen and a sufficient external organic source for all cell carbon the microorganisms near the media surface lose their ability to cling to the media. The wastewater flowing over the media washes the slime layer off the media and a new slime layer begins to form. The process of losing the slime layer is called "sloughing" and it is primarily a function of organic and hydraulic loading on the filter. This natural process allows a properly designed media bed to be self-purging and maintenance free.

Any excess sloughed biomass is transferred with the wastewater flow to the final clarifier as sludge. These secondary sludges are periodically pumped back to the primary tank or sludge holding tank for eventual removal or further treatment.

This physical process is essentially the same for the reduction of BOD_5 and nitrification. (the conversion of ammonia nitrogen to nitrate nitrogen)

NITRIFICATION/DENITRIFICATION

Removing ammonia nitrogen from wastewater is a well-established and quantifiable biological process. Nitrogen exists in the influent primarily in the form of organic nitrogen and ammonia nitrogen. (Total Kejldahl Nitrogen + TKN). The principal part of the organic nitrogen is mineralized to ammonia nitrogen through bacterial activity. Therefore, ammonia-N is commonly regarded as the starting point in the nitrogen reduction process. Nitrification: the conversion of ammonia nitrogen (NH_3-N) to nitrate nitrogen (NO_3-N) is a biological process accomplished in the presence of dissolved oxygen. Typical requirements for effluent ammonia-N are from 1 to 3 mg/l, which is reliably accomplished.

Successful nitrification is accomplished with a healthy microorganism population and an environment where PH, temperature, alkalinity, organic loading and dissolved oxygen are stable. In the BioTank system the pH is generally buffered by the carbonate system associated with the wastewater; the temperature remains consistent due to the biological activity in the plant; the organic loading is relatively constant because the wastewater has been treated in the first compartment(s) of the plant; and the compressor provides an adequate supply of dissolved oxygen.

NITROGEN TRANSFORMATIONS REMOVAL

Form of Nitrogen	Responsible Microorganism	Representative Equations	Control and Removal Process
Organic-N (Protein) To Ammonia-N NH_3	Facultative Heterotrophs		Mineralization
Nitrate-N NO_2 Nitrate-N NO_3	Aerobic Autotrophs, Nitrosomonas and Nitrobacter	$2NH_4 + 3O_2 => 2NO_2 + 2H + 2H_2O$ $2NO_2 + O2 => 2NO_3$	Biological Nitrification "aerobic"
Nitrate-N NO_2 Nitrogen gas N_2	Facultative Heterotrophs	$3NO_3 + CH_3OH => 3NO_2 + 2H_2O + CO_2$ $2NO_2 + CH_3OH => N_2 + H_2O + 2OH + CO_2$	Biological Denitrification "anoxic"

Facultative heterotrophic organisms under anoxic conditions accomplish biological denitrification. In this process bacteria convert the nitrate-N to nitrate-N to nitrogen gas that is released into the atmosphere.

Denitrification occurs by several different means and though process control adjustments. As the microorganisms multiply the biological film thickens on the submerged media and the diffused oxygen is consumed before penetrating the full depth of the slime layer. Consequently the film develops aerobic, anoxic and anaerobic zones. It is this fact, which accounts for significant nitrogen removal via simultaneous nitrification and denitrification. Denitrification utilizing septic tank carbon is widely considered to be the most economical and efficient method for nitrogen removal. Utilizing prescribed recirculation rates this method of returning BioTank nitrified wastewater to the carbon source in the anoxic zone of the primary tank has achieved reductions of nitrogen of approximately 80 percent. Nitrogen removal may be enhanced further in a tertiary anoxic zone located after the aerobic treatment.

PHOSPHORUS PRECIPITATION

P-removal with metal salts, typically aluminum or iron is by far the most popular method used in the United States. Controls for this type of P removal are considered to be simple and straightforward. (Phosphorus Removal 1997). It consists of adding metal salts as coagulants that react with phosphates in the wastewater to form insoluble precipitates. Dosing of coagulant is based on the stoichiometric metal salt to phosphorus ratio dictated by the concentration of phosphorus in the daily Wasteflow. The efficiency of P-removal is simply related to the coagulant dose provided that the alkalinity is present in sufficient quantities. The sludge produced may be processed in the same manner as non P-removal systems. Systems utilizing metal salt addition can effectively achieve 80-95 percent total phosphorus removal and effluent-P concentrations less than 1.0 mg/l (Phosphorus removal 1987).

The BioTank onsite system incorporates a separate stage chemical precipitation compartment prior to settling in the lamella clarifier. Coagulants are automatically dosed to the compartment using the chemical feed pump. The compressed air provides sufficient mixing to form stable flocs, which are settled and removed from the final settling compartment via an airlift pump. The BioTank reduce effluent phosphorus concentrations to >1 mg/l.

BIOTANK COMPONENTS

Major components of the BioTank system are constructed of carbon steel or stainless steel, with plastic or zinc coated steel for railings and fences.

The unit provides ready access to each treatment compartment facilitating operation and maintenance procedures. The media blocks are easily removed from each treatment compartment for inspection or plant maintenance. Random packed media that is biologically inert and mechanically durable enhances oxygen transfer. An efficient oil-less compressor with few moving parts supplies dissolved oxygen to the treatment process. Low noise and vibration is a positive design characteristic associated with these compressors.

A 304 stainless steel exterior or NEMA 4X mountable control cabinet is provided with each BioTank. Each cabinet contains the control logic to automate the function of the compressor, sludge airlift, coagulant dosing pump and pump and cabinet heater if necessary.

The BioTank treatment plants can be supplied with separate or attached offices, laboratories and mechanical equipment rooms.

The BioTank treatment plants may also be supplied with bar racks or screens, grit chambers, flow meters, chemical dosing equipment, UV disinfection modules and sludge dewatering systems.

GENERAL INFORMATION

Existing septic tanks may be adapted to form the primary treatment stage of the BioTank process.

The BioTank units are delivered to the site completely assembled. Interconnecting piping is the responsibility of the general contractor. Units are to be anchored to a concrete mounting slab that must offset any buoyant forces due to installations in groundwater. Units may be lifted with an excavator or crane depending on the size of the treatment plant.

The BioTank should be pre-tested by filling the unit with fresh water. Once the system is commissioned by an Aqua tech Systems representative, six to twelve weeks are required to establish a functioning biomass and accomplish treatment goals. The use of commercially available bacteria is recommended to suppress foaming that may occur upon start up and to reduce the biological development period.