

LOTUS – ActiveCell TREATMENT PROCESS

Primary settled or screened wastewater can flow directly to the Lotus-ActiveCell reactor(s) by gravity or can be pumped in from an equalization basin. Once the wastewater enters the plant, it flows by gravity through each treatment compartment contacting the submerged, free-moving *ActiveCell450 Biofilm Carriers*. Stainless steel media retention screens are installed to ensure that the media is held within each basin.

As flow enters each aerobic treatment compartment, dissolved oxygen is transferred into the wastewater by an air compressor and stainless steel coarse bubble aeration grids. The aeration grids are designed to provide complete coverage of the bottom of the basin and distribute air downward against the bottom of the treatment basin to prevent settling of solids. The diffused air provides the oxygen needed for aerobic treatment and prevents short-circuiting by completely mixing the media and the wastewater.

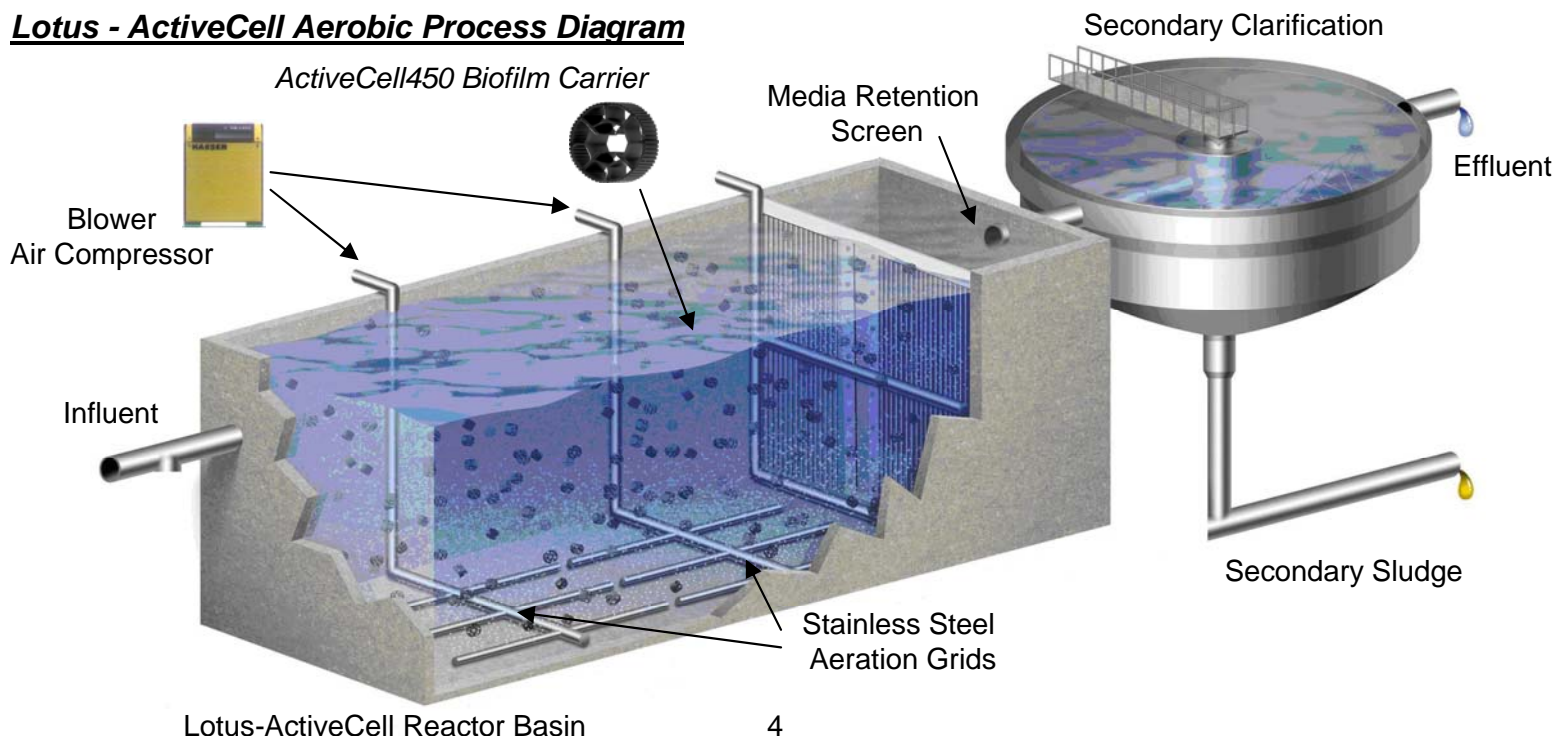
In the aerobic chambers of the Lotus-ActiveCell, treatment is accomplished by a population of aerobic microorganisms that attach themselves to the media and consume the organic material in the wastewater. These microorganisms form a biological film known as biomass. As the microorganisms multiply and the biomass thickens, diffused oxygen is consumed before it can penetrate the full depth of the film. Consequently the biomass develops aerobic, anoxic and anaerobic layers.

As the microorganisms near the media surface become starved for oxygen and organic carbon that is consumed by the surface layer, they lose their ability to cling to the media. The mixing of the wastewater washes the biomass off the media and a new biological film begins to form. This process of losing the biomass is called “sloughing” and is primarily a function of organic and hydraulic loading on the system. Sloughing does not compromise treatment and allows the media beds to be self-purging, self-regulating and maintenance free. These characteristics eliminate the need to manage mixed liquor suspended solids (MLSS), food to mass ratios (F/M) and return activated sludge (RAS).

Sloughed biomass flows with treated wastewater to secondary clarification where it settles as secondary sludge. The sludge is periodically pumped back to a primary tank, sludge holding basin or digester for eventual removal and treated effluent flows out of the clarifier by gravity to the next stage of treatment or disposal.

This physical process is essentially the same for the reduction of BOD₅ and nitrification (conversion of ammonia nitrogen to nitrate nitrogen).

Lotus - ActiveCell Aerobic Process Diagram



NITROGEN REDUCTION (NITRIFICATION/DENITRIFICATION)

Removing ammonia from wastewater is a well-established and quantifiable biological process. Nitrogen exists in the influent waste stream primarily in the form of organic nitrogen and ammonia nitrogen (Total Kjeldahl Nitrogen or TKN). The principle part of the organic nitrogen is mineralized to ammonia nitrogen by bacterial activity. Therefore, ammonia nitrogen is commonly regarded as the starting point in the nitrogen reduction process.

Nitrification is the conversion of ammonia (NH_3) nitrogen to nitrate (NO_3) nitrogen. This biological process is accomplished aerobically by Autotrophs, Nitrosomonas and Nitrobacter bacteria in the presence of dissolved oxygen. Lotus-ActiveCell can reliably achieve effluent ammonia concentrations to less than 1mg/l.

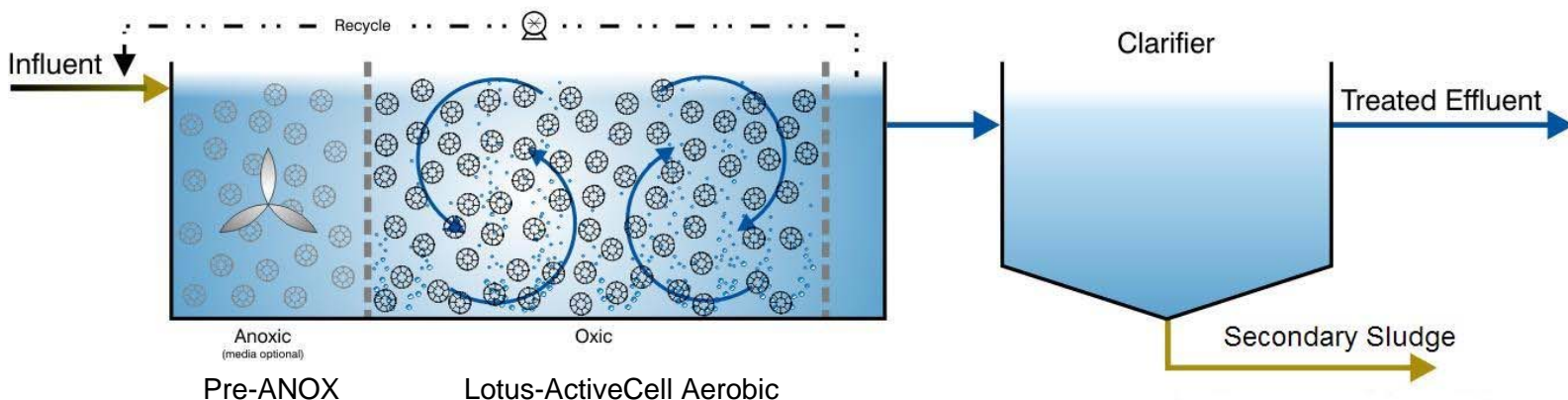
Successful nitrification is accomplished with a healthy microorganism population and an environment where pH, alkalinity, temperature, organic loading and oxygen supply are stable. In a Lotus-ActiveCell system; the pH is buffered by the carbonate system associated with wastewater; the temperature remains relatively constant because the biological activity in the plant produces heat; the organic loading is consistent because the wastewater is treated in the compartments prior to nitrification processes; and the air compressors provide an adequate supply of oxygen.

Denitrification is the conversion of nitrate (NO_3) nitrogen to nitrite (NO_2) nitrogen and then to nitrogen gas which is released into the atmosphere. This is a biological process performed by Facultative Heterotrophic bacteria in the presence of a soluble carbon source and anoxic conditions (dissolved oxygen = < 0.3mg/l).

Denitrification occurs by several different means and through process control adjustments. In the Lotus-ActiveCell submerged media beds, diffused oxygen is consumed by the aerobic outer portion of the biomass and anoxic conditions are created within the biological film. This allows for significant nitrogen removal via simultaneous nitrification and denitrification. Further denitrification can be achieved by re-circulating nitrified wastewater from the final aerobic chamber back to the anoxic zone of a primary settling tank or by incorporating an attached growth Aquapoint Pre-ANOX Denitrification Reactor in the Lotus-ActiveCell design.

In the Pre-ANOX Reactor, a mechanical mixer is used to mix the organic carbon in the influent wastewater, the re-circulated nitrified water and the media. This mixing sustains anoxic conditions and ensures contact of denitrifying bacteria, nitrified water and carbon needed to denitrify. Efficient denitrification in the Pre-ANOX Reactor is contingent on the presence of sufficient quantities of organic carbon. Therefore, an external carbon feed system may be implemented depending on the level of nitrogen removal that is required and the quantity of organic carbon in the influent waste stream.

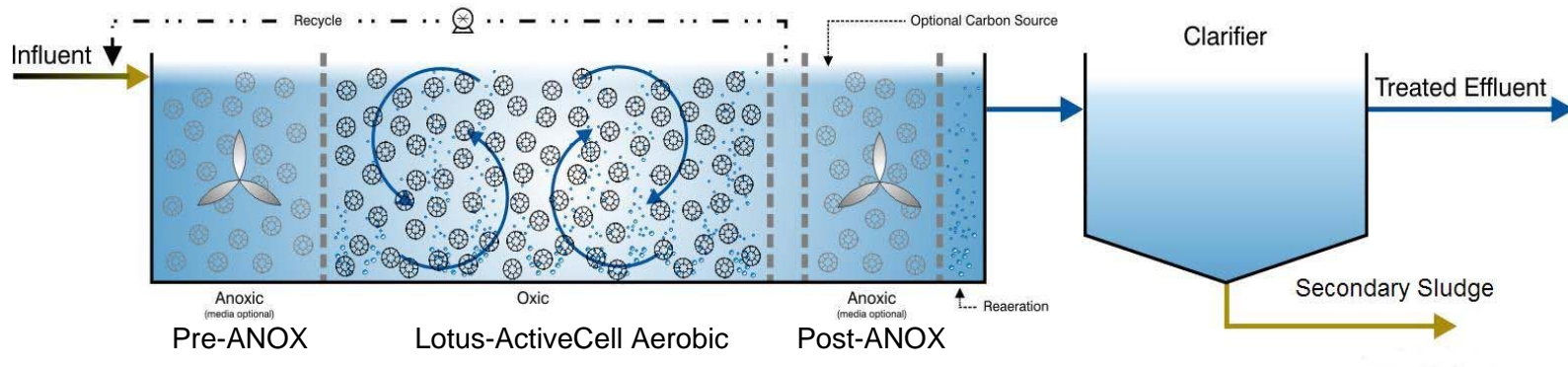
Lotus - ActiveCell Process Diagram Utilizing a Pre-ANOX Denitrification Reactor:



TERTIARY DENITRIFICATION

To achieve low levels of total nitrogen, the system requires Pre and Post-ANOX Denitrification Reactors. The Pre-ANOX Reactor uses nitrified water re-circulated from the final aerobic chamber and the organic carbon present in the influent waste stream to achieve denitrification. The Post-ANOX chamber also uses nitrified water from the final aerobic chamber but incorporates an external chemical feed system to dose organic carbon. The Post-ANOX Reactor needs the external carbon feed system because the organic carbon available in raw wastewater no longer exists in sufficient quantities after the water has undergone aerobic treatment. This proven denitrification method is a process recognized by the EPA.

Lotus - ActiveCell Process Diagram Utilizing Pre and Post-ANOX Denitrification Reactors:



PHOSPHORUS REDUCTION

Lotus-ActiveCell treatment systems achieve phosphorus reduction by incorporating chemical precipitation in the clarification stage. In this process coagulant, typically aluminum or iron salts, are automatically dosed to the clarifier using a chemical feed pump. The metal salts react with phosphates in the wastewater to form insoluble precipitates. The coagulant dosing rates are based on the stoichiometric metal salt to phosphorous ratio dictated by the concentration of phosphorus in the daily wastewater flow. This means that the efficiency of phosphorus removal is simply related to the coagulant dose provided that alkalinity is present in sufficient quantities. The precipitates settle out in the clarifier and are pumped to a sludge holding tank or to a sludge dewatering unit. Lotus-ActiveCell systems are capable of producing effluent total phosphorus concentrations of <math><1\text{ mg/l}</math> without that addition of filtration equipment. Greater reduction in total phosphorus can be achieved by incorporating a physical barrier filter such as a sand filter, disc filter or a membrane.