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TECHNICAL REPORT

FAST®

TOTAL NITROGEN REDUCTION CAPABILITIES

General Background

The BioMicrobics Incorporated Fixed Activated Sludge Treatment (FAST®) System has demonstrated in both independent testing facilities and insitu applications for single family residences and in high strength wastewater conditions that it reduces Total Nitrogen by at least 70% of the influent level.

Measurement of the influent levels of nitrogen is completed by determining the level of Total Kjeldahl Nitrogen (TKN). Organic nitrogen and ammonia (NH_4+) are the constituents that make up TKN.

Historically, in domestic residential sewage wastewater the average TKN is approximately 38 mg/l with approximately 1/3rd in the ammonia (NH_4^+) form and approximately 2/3rds in the form of organic nitrogen. However, in cases where water conservation methods are used in the residence's appliances the TKN concentrations have increased.

The septic tank anaerobic state converts a large percentage of the organic nitrogen to ammonium ions. Septic tank effluent averages about 40 mg/l of nitrogen of which greater than 75% is in the ammonium ion form and the balance is in the organic form. Once the septic effluent enters the soil environment ammonium ion may convert to Nitrate (NO_3^-) due to the aerobic conditions in the soil and drain field. It is this Nitrate that has the potential to contaminate the fresh water resources used for drinking, aquatic life or recreational purposes.

Therefore, it is desired to create a system that removes this potential of Nitrate contamination. The naturally occurring bio-chemical process of Nitrification, followed by the De-Nitrification process, is the most commonly used methods for nitrogen reduction in sewage wastewater.

Nitrification

Nitrification is an aerobic reaction performed by autotrophic organisms and Nitrate (NO_3^-) is the predominate end product. Nitrification requires an aerobic condition to exist and should consist of a Dissolved Oxygen level of not less than 2 mg/l.

Nitrification can be expressed as: $NH_4^+ \rightarrow NO_2^- \rightarrow NO_3^-$

Ammonia $\rightarrow$ Nitrite $\rightarrow$ Nitrate

De-Nitrification

DeNitrification is a biological process performed primarily by ubiquitous facultative bacteria. In the absence of oxygen, NO_3^- acts as an acceptor of electrons generated in the microbial decomposition of an energy (carbon) source. DeNitrification converts nitrates back to nitrites then to nitrogen gas that are vented out of the treatment system.

The absence of oxygen is defined as existing when the Dissolved Oxygen is between 0.5 and 1 mg/l. This state is also known as an "anoxic" state. The carbon source is accomplished by presence of organic matter.

Summary of Bio-Chemical Process

In sewage wastewater a treatment system must therefore employ in its design the ability for Nitrification to occur first and De-Nitrification to occur second. The effect of these two processes acting contiguously is to have the influent TKN bio-chemically treated to reduce the components to the Total Nitrogen down to more acceptable levels for the natural environment to further attenuate.

Total Nitrogen is the sum of the values or levels of Ammonia (NH_4^+) plus Nitrite (NO_2^-) plus Nitrate (NO_3^-) plus organic nitrogen. In assessing the success rate of a treatment system in the reduction of nitrogen it is important to consider the levels of Total Nitrogen (TN) reduction. Some treatment system provide values of Nitrate but ignore the residual values of ammonia and Nitrite that convert in the environment into Nitrate.

Total Nitrogen reduction is considered the most suitable method of assessing the effectiveness of a sewage treatment system as it reflects all of the constituents of nitrogen.

Treatment Process in the FAST® BioFilter

Nitrification

In the FAST® sewage wastewater treatment system, nitrification occurs first in the attached growth chamber area where air is blended with the wastewater and splashed over the exposed attached growth media (aeration) allowing the obligate autotrophic organisms to attached, stabilize and oxidize the TKN to Nitrate.

De-Nitrification

The anoxic zone in the FAST® is created outside of the attached growth media chamber. Small amounts of aerated water are sent into the anoxic area of the tank. The carbon source is supplied by the introduction of incoming sewage and by the activated sludge being returned from the attached media. The combination of these organic laden liquid materials entering the anoxic chamber creates the low DO levels and high carbon source for De-Nitrification to occur. The nitrogen gas that is produced from this natural biological process exits the system through the vent.

Technical Report Summary

The FAST® Sewage wastewater treatment system design allows for the Nitrification and De-Nitrification process to occur in proper sequence and contiguously. This design sets the conditions for a consistent reduction of influent TKN.

As verified by the following test results , the independent testing facilities and the independent testing of insitu facilities confirm the reduction of TKN by at least 70% that in turn substantiates our claim of Total Nitrogen reduction as natural function of the FAST® system's design and performance.

INDEPENDENT TESTING RESULTS

During the NSF International's 1997 testing November through to June of the FAST®, NSF sampled, tested and reported the following to confirm Total Nitrogen reduction. The results are:

	Average	Maximum	Minimum	Median
Ammonia-Nitrogen (mg/l)				
Influent	26.0	34.0	21.0	26.0
Effluent	4.0	6.0	2.2	3.6
Nitrate-Nitrogen (mg/l)				
Influent	3.5	<0.5	0.8	4.0
Effluent	2.6	4.6	0.7	1.6
Total Kjeldahl (mg/l)				
Influent	34.0	39.0	31.0	34.0
Effluent	6.6	8.0	4.7	6.1

Other independent testing agencies and groups, working on behalf of either governments or onsite sewage treatment system owners, have conducted testing of systems in service as required by their regulation or a government lead study.

When and where these test results are submitted back to BioMicrobics Incorporated in Kansas, USA, they are additional confirmation of the capabilities and performance capabilities of the FAST® unit.

The following is a summary of a collection of these submitted results.

Multiple Single Family Homes

Date	BOD_5		CBOD		TSS		TKN		Total Phosphorus	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
11/20/96	137.00	3.26	176.00	2.48	60.00	no data	19.20	1.23	4.32	3.22
12/18/96	148.00	7.75	136.00	8.85	86.00	no data	46.90	1.77	7.09	4.21
1/29/97	299.00	10.00	215.00	9.01	345.00	4.00	62.50	1.82	11.00	4.52
2/26/97	139.00	10.00	183.00	6.00	70.00	4.00	37.40	0.64	7.07	5.22
4/2/97	170.00	2.20	150.00	1.00	17.00	1.00	32.00	1.60	6.60	5.60
4/23/97	210.00	1.40	200.00	1.00	203.00	1.00	46.00	1.10	7.80	5.60
5/8/97 (1)	230.00	1.70	220.00	1.00	170.00	2.50	39.00	1.10	7.10	5.40
5/21/97	62.00	2.70	59.00	1.00	162.00	1.00	33.00	1.60	5.80	5.30
5/29/97 (2)	240.00	1.00	130.00	1.00	80.00	1.00	44.00	1.60	26.00	5.80
6/11/97	100.00	1.40	67.00	1.00	123.00	1.00	36.00	0.83	5.80	7.10
7/17/97	150.00	1.00	130.00	1.00	74.00	3.00	33.00	1.10	7.10	4.50
8/28/97	100.00	1.00	71.00	1.00	20.00	1.00	32.00	0.81	5.00	4.20
Average	165.42	3.62	144.75	2.86	117.50	1.95	38.42	1.27	8.39	5.06
Reduction	97.8%		98%		98.3%		96.7%		39.7%	

(1) sample collected after vacation stress test simulation
(2) sample collected after wash day stress test simulation

Single Family Residence

EFFLUENT ONLY RESULTS REPORTED

Date	BOD	TSS	TKN	Total Phosphorus
04/06/99	<3.0	2.0		
04/18/99	<3.0	2.0	<1.6	2.80
04/23/99	3.0	2.0		
04/28/99	3.0	2.0	1.8	2.60
05/13/99	<3.0	2.0	1.5	2.78
05/20/99	<3.0	3.0		
06/03/99	<3.0	3.0	1.8	2.26