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TECHNICAL BRIEF

FAST®

Wastewater Sewage Treatment Plant's

Operation and Effluent Quality

We wish to outline for you the technical aspects of the FAST®'s sewage package treatment plant's effluent quality and how it is achieved on a consistent basis over time.

We should mention that prime manufacturer and patent holder of the FAST® technology, Bio-Microbics Incorporated and its parent company Smith & Loveless Inc., have been supplying wastewater treatment plants since 1946 and the FAST® system since 1971. Each of these tens of thousands of units, when maintained in accordance to the manufacturers recommendations, will achieve the required effluent quality over the life of the system on a consistent basis. Therefore, a major concern is the element of maintenance. This we also intend to discuss as it has a significant bearing on the effluent quality.

The FAST® plant has been designed using the domestic sewage influent strength described as having a

Biochemical Oxygen Demand 5 day average (BOD_5) of	250 mg/l (or ppm),
Suspended Solids (SS) of	250 mg/l (or ppm), and
Fats, Oils, and Greases (FOGs) of	35 mg/l (or ppm).
Total Kjeldahl Nitrogen	30 mg/l (or ppm).

The independent, internationally recognized, sanitary equipment testing agency, National Sanitation Foundation, International (NSF) confirms the performance data collected by the manufacturer, Bio-Microbics Incorporated in Kansas, USA that the FAST® produces a treated effluent described as:

Biochemical Oxygen Demand 5 day average (BOD_5) of	less than 10 mg/l (or ppm),
Suspended Solids (SS) of	less than 10 mg/l (or ppm),
Total Kjeldahl Nitrogen	less than 10 mg/l (or ppm).
Nitrate	less than 5 mg/l (or ppm),

This level of effluent treatment is accomplished by accepted and known simple methods of sewage treatment, and, the specific arrangement of the FAST® sewage treatment plant.

PROCESS METHOD

The FAST® wastewater sewage treatment plant is a hybrid unit created from the best of the process features that are inherent in technologies known as: (1) activated sludge return, (2) extended aeration (3) attached growth and (4) trickling filters. The FAST® is taking advantage of the inherent sewage treatment benefits gained in each of these natural biological processes.

Extended Aeration is the process inwhich atmospheric air is introduced, through an external air pump, into the sewage wastewater. In the FAST® unit the air mixes with the wastewater in the "attached growth" chamber. The arrangement of the airline inside the attached growth chamber causes the wastewater to be constantly blended together with the oxygen from the atmospheric air. The oxygen activates naturally occurring aerobic micro-organisms that digest and breakdown organic material in the sewage. This constant blending through the recirculating airlift arrangement of the air delivery system does not permit solids to settle in the aeration zone.

The product of the aerobic organisms' digestion process is CO_2 and water. The three (3) main benefits of this extended aeration process are: (1) that there are no hydrogen sulfide or methane gases produced, (2) that the efficiency of the aerobes' absorbtion process is accelerated and enhanced which results in lower BOD_5 and SS levels, and, (3) that the aeration process is the correct condition for Nitrification to occur. (Nitrification is explained latter)

Activated Sludge Return is the process inwhich the 99% live, healthy and hungry bacterial mass (a.k.a. activated sludge) that has accumulated is allowed to be re-used within the overall treatment process. Within the FAST® unit, the naturally created bacteria that has attached to the plastic growth media and accumulated to the point where a layer of bacteria falls off of the plastic media, is returned back into the treatment cycle.

The two (2) main benefits from this process are (1) that the new incoming sewage is immediately attacked by the activated sludge micro-organisms that begin to absorb (digest) the sewage. The quick action speeds along the absorbtion (digestion) process creating an accelerated and enhanced sewage treatment resulting in a lower BOD and SS, and (2) that the right conditions are created for De-nitrification and Total Nitrogen reduction to occur in the anoxic zone.

Attached Growth is the technology of allowing the micro-organisms in the biomass, that perform the main task of digesting and breaking down sewage to inert gases and to water, to attached to a material (a.k.a. media). The main benefits of this process are (1) that the bacteria are attached to a media and therefore do not float around in a suspended state, (2) low likelihood of suspended solids leaving the plant, (3) the media being submerged in liquid and partly exposed to the air creates the conditions for a better mix of the various types and colony size of bacteria needed to perform particular sewage digestion tasks.

Trickling Filter is the process of having the wastewater pass through a filter to hold back and digest any residual paper or suspended solids materials. The main benefit to this process is the protection for drain fields and dispersal sites from an accumulation of particulate and paper that may plug-up drain lines and clog soils.

INDEPENDENT TESTING RESULTS

NSF, International tested daily the FAST® treatment plant at their facility in Michigan for the six (6) months from November to June. During this testing period, NSF put the FAST® under several stress tests such as extended power outages, vacation, and laundry loading days.

The results of the NSF, International testing are reported in a booklet available on request. The following is a summary of the testing:

SUMMARY OF NSF TEST RESULTS OF THE MicroFAST SEWAGE TREATMENT PLANT

	Average	Std. Dev.	Minimum	Maximum	Median	Interquartile Range
BOD_5 (mg/l)						
Influent	144	34	89	280	140	120 - 160
Effluent	9	4	<5	24	8	6 – 11
Suspended Solids (mg/l)						
Influent	197	85	85	740	180	150 - 220
Effluent	7	3	<5	27	5	5 – 8
Volatile Suspended Solids						
Influent (mg/l)	159	54	68	430	150	130 - 180
Effluent	6	3	<5	29	<5	<5 – 7
pH						
Influent	-	-	7.3	7.7	7.5	7.5 - 7.5
Effluent	-	-	7.5	8.2	7.8	7.8 - 7.9
Temperature (^0C)						
Influent	12	2	10	17	12	11 - 13
Effluent	11	4	6	21	10	8 - 13
Dissolved Oxygen (mg/l)						
Effluent	6.8	1.4	2.8	9.9	6.9	6.2 - 7.8

Notes: The median is the point where half of the values are greater and half are less.

The interquartile range is the range of values about the median between the upper and lower 25 percent of all values.

This information found in TABLE 1 Summary of Analytical Results, Page 10 of the NSF Test Results of the MicroFAST MODEL .5, dated July 1997.

DISSOLVED OXYGEN CONTENT

There has been much discussion about certain items that should be low or non-existent in the treated wastewater's' effluent. These are typically BOD, SS, Nitrate and fecal coliform. While these are to be eliminated as best as possible, it is also important that the effluent have as high as possible a Dissolved Oxygen (DO) content.

The FAST® plant has inherent in the treated effluent a DO content of 6 to 8 mg/l. DO is important for maintaining a healthy condition in the dispersal site. Drain fields are designed to be aerobic systems that permit the further attenuation (polishing) of the treated waste water. Surface water dispersal (as permitted in particular jurisdictions under certain permit conditions) are enhanced by DO in that the aquatic life is aided by DO in the water.

A constant feeding of DO into the dispersal site ensures a longer life to the disposal system, better polishing of the wastewater prior to entering groundwater and/or aquifer, and, maintains a healthier condition to the soil's natural occurring life systems and organisms.

One other advantage of the DO level in the wastewater is that in the event of a catastrophic event such as solids entering the dispersal site, the DO will attack these solids and digest them on the spot. Therefore, the DO is providing a form of insurance to the life of the disposal system and the groundwater.

SERVICING & MAINTENANCE

Service is simplicity itself. There are no submersible sewage pumps, no filters, and no moving parts inside the plant to be removed, replaced, or cleaned. The simplicity of servicing also yields lower maintenance costs.

The FAST® plant's only mechanical device is the air pump that is outside the plant. Inside the FAST® there are no moving parts, and, all parts are plastic and are therefore long-lasting, non-corrosive, and not subject to deterioration.

The air pump does not require lubrication or oil changes. Just clean the re-usable air intake filter once very six months. (TIP: when changing the household's furnace filter also clean the air pump's filter)

A two (2) year inspection only service is included in the purchase price to the owner as required by NSF, International to maintain certification of the FAST®. This inspection service is performed by a local authorized Service Agent. After the initial two years, subsequent service contracts are available directly from the local service agent.

Typically, the liquid content of the FAST® will need to be removed once every three (3) years.

Nitrification / DeNitrification - FAST® Plants

Total Kjeldahl Nitrogen (TKN) is organic nitrogen (NH_3) and ammonia (NH_4^+), and, in wastewater leaving a domestic residence averages about 38 mg/l with 32% (or 12 mg/l) in the ammonium (NH_4^+) form. Nitrification is an aerobic reaction performed primarily by obligate autotrophic organisms and nitrate (NO_3^-) is the predominate end product. Nitrification can therefore be expressed as: $NH_4^+ \rightarrow NO_2^- \rightarrow NO_3^-$

DeNitrification is a biological process performed primarily by ubiquitous facultative heterotrophs. 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.

For denitrification to occur, nitrogen must usually be in NO_3^- form and an energy (carbon) source available. Therefore nitrification must occur before denitrification.

In the FAST®, nitrification occurs in the attached growth chamber where air is blended with the wastewater and splashed over the exposed attached growth media (aeration).

The attached growth media is held in a plastic chamber. The anoxic zone in the FAST® is the chamber outside the attached growth media chamber. The attached growth media chamber sends to the anoxic chamber a small amount of aerated water and returns the activated sludge. In addition, the anoxic chamber also received the wastewater from the trash collector tank. The combination of these 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.

With the anoxic chamber having an extended residence time, and, with the FAST® system's design for nitrification and de-nitrification, Total Nitrogen (consisting of ammonia-nitrogen plus nitrite and nitrate) is reduced to less than 10 mg/l.

During the NSF International's 1997 testing of the FAST®, NSF sampled, tested and reported the following to confirm Total Nitrogen reduction (refer to page 70 of the July 1997 report):

	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

SUMMARY

The FAST® wastewater sewage treatment plant may provide an effluent quality of:

Biochemical Oxygen Demand 5 day average (BOD_5) of	less than 10 mg/l (or ppm),
Suspended Solids (SS) of	less than 10 mg/l (or ppm),
Total Nitrogen	less than 10 mg/l (or ppm),

subject to the user's habits and behaviour using commonly known sewage treatment technologies to achieve specific treatment levels in a specific arrangements of components that are not service and maintenance intensive, and, at the same time providing Dissolved Oxygen (DO) to the dispersal site for enhanced attenuation subsequent to the main treatment plant and longer life to the dispersal site.

Definitions

Aerobic Bacteria - are bacteria that require free dissolved oxygen for their growth.

Anaerobic Bacteria - are bacteria that grow only in the absence of free dissolved oxygen.

Biochemical Oxygen Demand - is a characteristic of sewage or sewage effluent, and, is the amount of dissolved oxygen demanded during the decomposition of organic material.

Dissolved Oxygen - is the oxygen in water that is available to support aquatic life.

Suspended Solids - are those solids that are visible and in suspension in water.

Total Kjeldahl Nitrogen - is the sum of organic nitrogen and ammonia.

Total Nitrogen - is the sum of ammonia-nitrogen, nitrite and nitrate in liquid solution.

Pinnacle Environmental Technologies Inc.: Distributor of the FAST® Wastewater Sewage Treatment Plant in Canada.