TREATING SEPTAGE WITH AEROBIC MICRO ORGANISM TECHNOLOGY AND MEETING EPA 503 STANDARDS FOR EXCEPTIONAL QUALITY BIOSOLIDS

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TREATING SEPTAGE WITH AEROBIC MICRO ORGANISM TECHNOLOGY AND MEETING EPA 503 STANDARDS FOR EXCEPTIONAL QUALITY BIOSOLIDS.

by
John Campbell[1] and Steve Young[2]

Big Fish Environmental, the first commercial septage receiving and treatment facility in Michigan, provides a viable, cost effective, and environmentally sound alternative to the land application of septage. With minimal infrastructure inputs and low operational costs, the Big Fish prototype can process 20,000 gallons of residential septage and municipal wastewater treatment plant biosolids per day. The innovative methodology uses aerobic devices which culture proprietary micro-organisms. These devises aerate, mix and continuously inoculate the mixed liquor. Other system components include screen, in-line pH meter, flow control, flow and volume measurement, tanks, pumps and screwpress. Propriatory equipment provides enhancement to the process. The Big Fish process has proven to be effective at BOD, TSS, Phosphorus, total Nitrogen and total solids reduction. As such, it is an important technological public health intervention, as it reduces the dependence on land application of untreated septic sludge and biosolids. The effluent is discharged into a municipal waste water system. Biosolids are processed to meet EPA 503 Exceptional Quality Class 'A' Biosolids standards. The next step is to meet ground water discharge standards for the effluent.

Introduction

Design and construct a septage receiving facility to eliminate the direct placment of untreated septage to the land and/or landfill. Present methods of disposal are unacceptable to the health, safety and welfare of the public.[3] [4]

The process of testing, designing, obtaining public approvals, construction, operation and obtaining information pertaining to influent and effluent values, of septage porta-jon and holding tank material. The facility opened with approvals from the permitting agencies, December 8, 2005. Primary elements of the facility are enclosure, odor control, stable temperature, aerobic conditions, reduction of BOD & TSS, operator simplicity, and energy efficiency. As testing began and approval received the goals of the project have expanded.

Methods

Testing the idea January 2005 ("Why wouldn't that work for septage?", answer "No one has tried it..") A 1500 gallon vessel was filled with 1000 gallons of septage with approximately 1.5% solids. The septage was heated to 24ºC. An aerobic microbial generator[5] placed in the vessel with a supply of microbes. Air entered the generator at 5psi for 5 days. BOD 5 day (EPA 405.1) results indicate a 94% reduction BOD; and TSS residue non-filterable (SM2540D) results

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of 88% reduction. These results provided the initiative to design and construct a full scale 10,000 gallon per day septage receiving facility.

Results of Initial Test
Influent – Effluent February 10, 2005

Septage	**Septage**	**Processed**
BOD 5-day EPA 405.1	2,450 mg/l	>150 mg/l
Nitrogen, Ammonia – EPA 350.1	58.3 mg/l	ND
Nitrogen, Nitrate – EPA 353.2	ND	ND
Nitrogen, Nitrite – EPA 353.2	0.113 mg/l	ND
Residue, Non-filterable(TSS)/SM2540D	7,400	860 mg/l

Phase I - On December 8th, 2005 approvals were received from Michigan Department of Environmental Quality.

January 2006 the structure is complete, insulated, water proofed, heated and ready to began processing. Tanks have been filled with septage, holding tank waste, and porta-jon material.

Air flowed, microbes were introduced, and the process burped, stopped, went to fast, biosolids recycled, oxygen added, microbes added, flow increased, slowed down and waste water treatment plant biosolids were added to the process. Total solids removal less than 90%. Fall of 2006 29,000 gallons of biosolids placed in drying beds for future land application.

Selection of construction elements, screening of inorganics, dergrit, aeration, vessel placement, oxygen supply, solids separation, solids processing, and structure, met the initial needs of the plant.

Receiving: Deliveries are received in a heated, enclosed structure with a partitioned, indoor drive-through lane for septage delivery vehicles. Haulers access the indoor receiving point by use of an access card. A hauler simply inserts the card into the card reader located on the exterior of the building, allowing entrance into the facility. Once entered, the hauler connects the delivery truck to the Septage Receiving Station via cam-lock couplings. The Receiving Station provides ¼-inch screening and dewatering of removed inorganic solids for landfill disposal. As the truck discharges, the Receiving Station automatically tallies the flow.

Material entering the facility is continuously monitored for pH at the Receiving Station. The facility is programmed to close an electrically actuated valve if the pH of any material is outside of established limits.

The facility also automatically monitors available capacity within the receiving tank. If the receiving tank does not have sufficient space, a float switch actuates a valve, preventing further discharges to the plant until space is made available.

The receiving building uses an odor control system consisting of exhaust fans and a biofilter to scrub the exhaust air. Offensive odors are vented directly from the tank and from the building

atmosphere to the biofilter.[6] Material receiving takes place within the drive-through lane when both the entrance and exit doors are closed.

Equalization Tank: After flow measurement, and screening, material is sent directly to a partitioned 15,000-gallon equalization tank. The first section of the tank (4,000 gallons) receives the initial flow from the delivery vehicle and provides a basin for settlement of grit that has passed through the screening process. As more material is delivered to the facility, the first chamber material cascades into the second chamber.

The second chamber (11,000 gallons) provides an aerated mixing area for blending raw material as needed to balance waste strength and initial treatment inoculation. The initial bacterial inoculation occurs using a series of aerobic microorganism generating units. The blended/inoculated material in the second chamber is then pumped into the next 15,000 gallon vessel.

Treatment Vessels: The treatment train of the process is conducted through one, 15,000-gallon and eleven, 2,000-gallon treatment vessels. Each vessel is equipped with microbial aerobic process (MAP). As flow is pumped from the equalization tank, the partially treated material cascades from one treatment vessel to the next. Cascading through the vessels provides the appropriate contact time with the bacteria blend and air to treat the material to a level that can be sent to the municipal wastewater treatment facility for final treatment and discharge to the environment.

Post Equalization Tank: The Big Fish facility incorporates a post-equalization tank prior to discharging treated material to the municipal collection system. The post-equalization tank provides a semi-quiescent zone for settling of solids not consumed in the treatment vessels. Settled solids are pumped to the front of the plant for further treatment. Treated effluent may return to the treatment vessel during periods of no septage processing.

Effluent Discharge: The facility will produce a treated effluent with waste strength characteristics equal to or less than that seen in a typical domestic household waste stream. The treated effluent is discharged to the City of Charlevoix wastewater collection system for final treatment at the Charlevoix Wastewater Treatment Facility, as per "Order of Determination".

The biosolids were stored in an approved drying bed. To be land applied at a later date.

Phase II
Incorporation of a patented Exceptional Quality Class 'A' Biosolids into the process has provided a cleaner effluent and EQ Class 'A' Biosolid. This process is inserted between the equalization tank and treatment vessels.

[6] University of Minnesota Extension publication #BU-3296-GO. 2000 University of Minnesota University Ave. S.E. Minneapolis, MN 55414 USA.

As septage is pumped from the 15,000 gallon vessel, lime is added to the septage to obtain a pH of 12.0, mixed in 1 (one) of 2 (two) 20,000 gallon tanks maintaining a pH of 12.0 for 2 (two) hours and continuing to mix for 22 (twenty two) hours maintaining a pH of not less than 11.5. Following completion of lime mixing, the material is pumped into a dewatering system. Effluent from the dewatering system flows to a pH neutralization treatment vessel. Microbes are injected into the process at this location.

Solids are processed into EQ Class 'A' Biosolids with an screw press[7] and stored undercover. The material is used as soil amendment.

The inclusion of the "FKC process" has increased the processing output by 200% or 20,000 gallons per day.

Phase III
Present testing and evaluation of a patented devise "Biomass Concentrator Reactor" to further reduce pathogens, compounds, and elements to meet local, state, and federal ground water discharge criteria is in process.[8]

Please see the Test Results Exhibit A (page 8).

Discussion
Designing and constructing the facility involved an engineer[9] willing to listen and provide the expertise to meet our goals; receiving in an enclosed building, screen inorganics, aerate, mix, process, recirculate and discharge to municipal sanitary sewer. Initial design, construction and permitting were completed in 10 months.

Materials received during 2006 varied dramatically. January, February, and March consisted primarily of holding tank and porta-jon waste. Low BOD & TSS provided outstanding qualities of effluent but relatively low percentage of BOD and TSS reduction, approximately 85%. As more septage entered the process, BOD & TSS reduction increased to 92% and 98% respectfully. Four issues came to light during this period of testing: Inorganics, microbial generators, biosolids, and phosphorus.

A grinder prior to the screen was cutting the inorganics too small and they were entering the system. The grinder was removed from the process. Our microbial aerobic generators were plugging and were not effective in the process stream. Another device [10] was tested and installed resolving the problem. Biosolids were still an issue. In August of 2006, I was introduced to a screw press system. A portable screw press plant was evaluated on site. Biosolids and septage were tested. A 20,000 gallon per day screw press system was designed, ordered in December 2006; and installed July of 2007. Phosphorus was an issue prior to the screw press system and today our effluent has exhibited days of less than 1mg/l of phosphorus.

[7] FKC Co., LTD 2708 West 18th Street, Port Angeles, WA 98363 USA
[8] National Risk Management Research Laboratory, EPA and University of Cincinnati is patented under U.S. 6,821,425 2600 Clifton Ave., Cincinnati OH 45221 USA.
[9] Rick Prince Prince Engineering, PLC P.O. Box 306, Glen Arbor, MI 49636 USA.
[10] Knight Treatment System 281 Co. Rt. 51A, Oswego, New York 13126 USA.

The Exceptional Quality Class 'A' Biosolids

Pathogens

If the percent solids of the biosolids is 7% or higher, then the temperature of the biosolids shall be 50 degrees Celsius or higher; the time period shall be 20 minutes or longer; and the temperature and time period shall be determined using equation (3).

equation (3) $D = \frac{131{,}700{,}000}{10^{0.1400t}}$

Vector attraction reduction

pH of biosolids is raised to 12, remains at 12 or higher for 2 hours and then at 11.5 or higher for an additional 22 hours.

Exceptional Quality Class 'A' Biosolids	October 2007	December 2007	
Organic	99.9% MDEQ & EPA	99.9%	99.9%
Metals	Limits mg/kg	Actual mg/kg	Actual mg/kg
Arsenic	75	4.8	3.8
Cadmium	85	2.5	1.45
Copper	4300	888.	258
Lead	840	30.	21
Mercury	57	1.020	0.7326
Molybdenum	75	1.34	4.4
Nickel	420	15	10
Selenium	100	3.9	3.9
Zinc	7500	2550.	1120
Total Kjeldhal Nitrogen		684,000mg/kg	60 lbs/ton
Nitrate		22mg/kg	
Nitrite		4.2 mg/kg	
Fecal coliform	<1000 colonies/gm	<100 colonies/gm	<67 colonies/gm
Salmonella	<3 MPN/4 g dry	<3 MPN/4 g dry	<3 MPN/4 g dry
Solids		43.4%	41.2%

Total phosphorus has been dramatically reduced from the effluent. Ammonia has increased from an monthly average of 10 mg/l to 50 mg/l with the addition of the screw press system.

Research and testing of the biomass concentrator reactor (BCR) in cooperation with the US Environmental Protection Agency and University of Cincinnati may allow effluent discharge to ground water. Testing is proceeding.

Protocols to test pharmaceuticals, endocrine disruptors, and hormones are being finalized.[11]
Big Fish significantly reduces solids of septage, municipal biosolids, porta-jon and holding tank waste and providing a relatively clean effluent and Exceptional Quality Class 'A' Biosolid.

[11] Joan Rose, PhD 2007. College of Agriculture and Natural Resources, 13 Natural Resources, Michigan State University, East Lansing, Michigan 48824-1222 USA.