

EHS SMART-Treat™ Onsite Moving Media Treatment System

Sampling & Testing Protocol for SMART-Treat™ Wastewater Treatment System

SAMPLING DURING OPERATION OF THE TREATMENT SYSTEM-IF DESIRED

Sampling and analytical routines may be desired in certain situations. During this time, at minimum, daily system checks are recommended.

- Daily system check of blowers and pumps,
- Daily readings of dissolved oxygen, temperature, flow, pH are recommended,
- Collect necessary samples from the treatment process and perform analytical testing
- Log in computer manual readings and analytical data

The overall goal of the treatment process is to provide aerobic removal of soluble organics and in some cases ammonia reduction (nitrification) or partial TN removal. Heterotrophic and autotrophic microorganisms will preferentially grow on the protected surfaces of the BWT-X biofilm carrier and provide desired pollutant removal. There are a number of factors that influence SMART-Treat™ Onsite design including but not limited to:

- Organic Load
- Dissolved oxygen concentration
- Nutrient Concentration
- Inhibitory or toxic compounds
- pH & Alkalinity
- Temperature

Organic Load

The organic load is the food source for the microorganisms. Without enough organic load the microorganisms will starve and scavenger type microorganisms will proliferate. The microorganisms will not be removing the wastewater pollutants and there will be a reduction in removal efficiencies. At the opposite end of the spectrum too much food will also create problems for the treatment process, as carryover of organic load to the nitrification reactors will promote growth of heterotrophs (oxidizers of organics) rather than autotrophs (nitrifiers).

Dissolved Oxygen

The dissolved oxygen (DO) concentration is very important for the microorganisms. Without the necessary DO, the amount of organic removal and nitrification will be diminished. The aeration system is designed to provide residual DO concentration of 3.0 mg/L in the BOD reduction reactor 2.0 mg/L in the nitrification reactor (if a multi-stage system) at maximum allowable summer water temperature (35C). Heterotrophic biomass requires positive DO concentrations of 2.0 mg/L to optimize substrate removal. Temperature of the wastewater affects the amount of air required to maintain a certain DO concentration, the cooler the wastewater temperature, the more oxygen can be dissolved per unit volume of air diffused into water and vice versa the warmer the wastewater the less oxygen can be dissolved in water per unit volume of air. The amount of air sent to the biofilm reactor

can be varied by 1) the number of blowers operating at a time or 2) by sequencing the blower ON time and OFF time (for example, 2 hrs ON, 2 hrs OFF) with maximum off time of 2 hours. With the exception of dissolved oxygen entering an anoxic zone and residual DO within the anoxic zone, a DO concentration above the design point is not a problem.

Nutrient Concentration

The microorganisms require certain nutrients for health cellular function. The ideal carbon to nitrogen to phosphorus ratio has been found to be 100:4:1 (C: N: P). With reduced nutrient concentrations in the wastewater there will be a reduction in removal efficiencies.

Inhibitory or Toxic Compounds

There are a number of natural and man-made compounds that can be toxic to the microorganisms such as high concentrations of sulfur, chlorine, or ammonia. Additionally cleaning chemicals such as quaternary ammonia has been shown to have negative impacts to municipal wastewater treatment plants. If during a normal plant operating day, there appears to be a major die off or sloughing of biofilm is found it is possible a toxic slug has been sent to the treatment plant and additional analytical testing should be conducted to determine the root cause.

pH & Alkalinity

The best performance will likely be observed when the operating pH within the biofilm reactor is between 6 and 8 s.u. However, numerous systems operate with influent pH between 4 and 6, while the biomass, assimilated to the wastewater, buffers the reactor's pH to neutral.

Temperature

Like all biological creatures, (bacteria to humans), as the temperature decreases the rate at which something is performed also decreases. Below is a graph of the growth rate of mesophilic bacteria with respect to temperature. As can be seen, the growth rate between the temperature of 10 and 20 nearly doubles (0.45 to 0.9). The optimum operating temperature lies between 30 and 35°C.

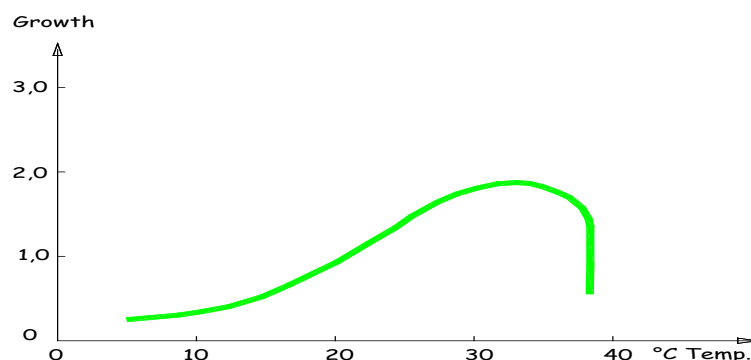


FIGURE 1 - GROWTH RATE CHART OF MESOPHILIC BACTERIA

Alkalinity Dosing

Influent alkalinity is unknown for most applications. In high strength waste reduction applications alkalinity is usually not an issue. Alkalinity may become an issue in ammonia reduction or Total Nitrogen reduction cases. The amount of alkalinity recovered by denitrification is 2.57 kg/d per kg NO_x reduced. A target minimum of 35 mg/L residual alkalinity is the goal. Therefore, in some situations, supplemental alkalinity dosing may be required. If supplemental alkalinity is needed to achieve effluent goals, chemical dosing requirements will be reviewed/determined in final engineering.

Sludge Removal

The biological process will generate solids through cellular growth and solids found in the wastewater. The smart-treat™ treatment system contains an integral clarifier that will allow the solids to settle to the bottom of the clarifier tank and be removed automatically on a timed dose or continuous basis--to storage for ultimate disposal.

Sampling and Analytical Routines

Laboratory analytical methods shall be in accordance with the latest published version of Standard Methods for Water & Wastewater analysis. EHS has the right to substitute onsite field methods for process control purposes. Inlet, outlet, and unit process sampling routines should reflect the minimum schedule required by permit, when permit requires sampling and analysis.

At any time plants assembled by EHS are tested for performance, it is imperative that samples are collected properly and analyzed correctly by appropriate methods so that the results provide accurate representation of the performance of our plants. Anything short of that can result in misleading results and unnecessary or ineffective process changes. All representatives of SMART-Treat™ Onsite Moving Media process will use the following protocol when sampling SMART-Treat™ Wastewater Treatment Systems.

I. Sampling Equipment

- A. It is required that equipment designed for proper sampling be used. All samples should be collected in sample bottles provided by a certified laboratory. A means to collect samples where the sampling point is difficult to reach shall be provided, i.e. a pole with a sampling container attached, a clean tube with bottom valve or plug, etc.
- B. Each sample will require at least 3 labeled sample bottles.
 1. Samples collected for TKN and ammonia concentrations require a preservative and should have the preservative put in the bottles by the laboratory.
 2. Samples collected for NO₃ and NO₂ will have one bottle.
 3. Samples collected for BOD and TSS will have one bottle.
 4. Samples collected for pH may require another bottle.
- C. Dissolved oxygen and pH meters that are calibrated at the site by a trained individual and a thermometer will be provided.
- D. A sludge measurement device, such as a "Sludge Judge".
- E. A logbook to record pH, DO and temperature will be provided. Sample time, flow conditions, sampler's name and a verbal description of the effluent indicating the relative amount of solids, the clarity, and any color or odor, detected will also be

- recorded.
- F. A cooler stocked with wet ice will be provided every day that samples are to be collected.
 - G. A chain of custody sheet to be completed by the sampler.
 - H. A brush will be provided to facilitate cleaning of the effluent discharge pipe in preparation for the collection of effluent samples.
 - I. A garden hose with a back-flow preventer attached to the end hooked to the home. This will be used for inducing hydraulic flow for sampling in situations where there is not a free flowing effluent at the time of collection. The hose should be inserted into the wastewater system far enough upstream of the treatment system to induce the flow through the system, but not affect the sample collected in any way. The preventer is necessary to protect the water supply of the home from possible contamination. An apparatus should be supplied that would help hold the hose up out of the sewage when possible.
 - J. Antibacterial soap and distilled water will also be provided for cleaning of collection equipment.
 - K. Latex gloves and eye protection will be provided.

II. Sampling techniques

Sampling locations—

The purpose of sampling is to determine the influent quality of the aerobic treatment unit, and to determine the quality of treated water going to surface or subsurface discharge. Raw and final samples are important also, however, the protocol below is for unit process sampling.

Sample Location 1: Influent to aerobic treatment unit

For Onsite wastewater treatment systems, primary solids removal is typically a septic or trash tank. For other systems, primary treatment may be a primary clarifier or screening device.

- A. A grab sample must be taken from a free flowing effluent pipe coming from the septic tank or primary solids removal device. The pipe will most likely be located at the outlet end of the septic tank or other solids removal device upstream from the treatment unit. It is very important that the pipe be cleaned (see D).
- B. If flow is not present, connect the garden hose to an outdoor faucet. The hose should be inserted into the wastewater system far enough upstream of the treatment system to induce the flow through the system, but not affect the sample collected in any way. For most commercial or residential units this would be in the inlet to the septic tank. For this location, the hose should be placed in the inlet tee to best simulate influent into the septic tank. The hose should **not** be allowed to run at this location longer than 10 minutes.
- C. Put on protective eye wear and latex gloves.
- D. To the extent possible, use the brush to clean the discharge pipe of attached growth that may dislodge during the process of collecting. Rinse the pipe with the garden hose. (**Note:** If the pipe is not accessible for cleaning in this manner – the sampler must be mindful not to touch the pipe when sampling to avoid knocking loose large solids that could contaminate the sample.)

- E. Place the end of the garden hose in position to add water to the first compartment of the septic tank or other solids removal device (See step B) –**DO not add water to** the moving media aerated reactor chamber. Take care to not touch the sewage with the end of the hose. Turn the faucet on.
- F. After the effluent has been flowing out of the pipe for a minimum of 10 minutes, place the collection container into the stream of effluent at the outlet of the solids removal device (septic tank effluent baffle or tee) and rinse any collection containers (including sample bottles) that will contain effluent. **DO NOT** rinse TKN and ammonia sample bottles that contain a preservative.

Sample Location 2: Highly Pretreated Effluent sample:

The sample location will most likely be located in a distribution box or pump chamber down stream from the biosolids clarifier and treatment unit. It is very important that the pipe be cleaned (see D) if taking a sample in a free-flowing pipe. If there is a pump chamber and water is in the pump chamber, this is a good place to take a sample---if it reflects aeration chamber quality.

- G. If a sample cannot be taken from a pump chamber, then the operator must determine if the contents of the settling chamber directly downstream of the aeration reactor are representative of the effluent. The first evaluation of whether this sample will be representative will be to determine if there are substantial settleable solids in the biosolids clarifier or the pump chamber. A sludge measurement device should be used to determine if there are substantial settled solids in the bottom of the settling chamber—more commonly referred to as the biosolids clarifier. If there are a substantial amount of solids (more than 10-12”), the sample may not be representative of the effluent produced by the aeration device. In that event, the biosolids clarifier or pump chamber should be cleaned out and pump be checked for proper operation.

A test for evaluation of the biosolids clarifier or pump chamber will be to measure the dissolved oxygen in the biosolids clarifier and/or pump chamber. The dissolved oxygen in this chamber must be above 1.0 mg/l for the sample to be representative of an aerobic effluent. If the dissolved oxygen is below 1.0 mg/l, then the biosolids clarifier or pump chamber should not be used for sampling.

Another test for evaluation of the biosolids clarifier or pump chamber will be to collect a sample from the biosolids clarifier or pump chamber and compare it to a sample from the reaction chamber. Samples collected from a biosolids clarifier or pump chamber should be taken from six inches to a foot below the surface. This will help to eliminate any floatable solids from affecting the sample. This sample should be compared to a sample collected at the effluent side of the aeration chamber. This sample should be allowed to settle for 5 minutes and then compared to the sample from the biosolids clarifier or pump chamber. If the clarity of the two samples is similar, then it can be assumed that the samples are similar. If the biosolids clarifier or pump chamber sample is cloudy or obviously darker than the settled aeration sample, then the biosolids clarifier or pump chamber sample should not be used as a representative sample. If the sample can not be collected from the pump chamber --1st choice, or biosolids clarifier---2nd choice, then a sample should be collected from the outlet end of the aeration chamber. This sample should be allowed to settle for 5 minutes, the clear liquid portion decanted to a clean sample bottle and this information should be noted in the log as well as the other observations used to collect this sample.

- H. Take the sample for pH and temperature and test for those parameters immediately. When finished with this sample discard it back into the system and rinse it several times with water.
- I. Take the DO reading inside the reaction chamber and outside the unit in the anoxic zone of the tank.
- J. Record the pH, DO and temperature in the logbook along with the date address and time.
- K. Take the sample bottles and place them into the cooler with the wet ice. The bottles should be well covered by the ice in order to facilitate faster cooling.
- L. Clean the sampling containers with antibacterial soap and water and rinse them with distilled water before collecting another sample.
- M. Fill out the chain of custody sheet with correct sample ID numbers and all other required information and/or pertinent comments. Be sure and sign this sheet and observe the laboratory personnel signing it when you deliver a sample. The samples should be delivered the same day it is collected. If necessary arrangements should be made to deliver the samples after normal business hours.