POTW Operations

Managing Influent Streams with Microtox®

MODERN WATER
A Deepverge Company

POTW Operations

Abstract

This document describes how Publicly Owned Treatment Works (POTWs) can use Microtox® to control incoming toxicity by managing influent streams and setting local toxicity limits. The following areas are covered: planning, establishing baselines for the POTW plant influent and the selected industry waste streams, batched and trucked wastes, collecting flow rate data on the selected waste streams, calculating local toxicity limits for each selected industry, and routine monitoring of the selected industries for acceptable levels of toxicity in their discharges. Data Sheets and Daily Toxicity Charts demonstrating the determination of baselines, the calculation of toxicity limits, and the illustration of toxicity profiles, are included along with examples of actual data presented in tabular and graphic form.

Introduction

The intent of managing influent streams, especially when associated with an industrial pretreatment program, is to monitor and regulate the introduction of pollutants from nondomestic sources into POTWs to maintain smooth operations, minimize upsets and maintain compliance.

One aspect of a pretreatment program is the setting of local toxicity limits by a POTW. Local toxicity limits are established and enforced by POTWs as authorized by the Clean Water Act (1987). They are intended to prevent site-specific plant and environmental problems resulting from the discharge of any industrial pretreatment facility, and to address federal standards as well as state and local regulations. A local toxicity limit set by a POTW using Microtox will allow the POTW to ensure that toxicity of an individual industrial contributor's discharge does not significantly exceed the toxicity levels normally present in the combined influent of the POTW based on the proportional flow from the industrial contributor.

Purpose

The most common goals of controlling and managing influent at a POTW (with or without an industrial pretreatment program) are:

1. Protect the plant from upsets due to influent streams.
2. Operate the plant at optimum efficiency and minimum cost.
3. To track toxicity excursions to their source.
4. Ensure the acceptable quality of the final effluent.
5. Generate revenue

Main Components to Implementing an Influent Control Program

Before implementing such a program, it is necessary to:

1. Identify the industries to be monitored.
2. Determine monitoring frequency for significant industrial users.
3. Identify sampling points for each industry to be monitored.
4. Determine whether grab or composite samples are required for individual industrial users.

Definition of Terms

Continuous discharger

An industrial facility that discharges waste through a sewerage system to a POTW over a 24-hour period.

Batch discharger

(1) An industrial facility that discharges a certain volume of waste over a certain period of time through a sewerage system to a POTW;

(2) A waste hauler company that discharges waste from a tank truck or container into a POTW waste collection system.

EC50

Exposure concentration of a sample which has a defined effect upon 50 percent of the test population. This is the same as LC50. In the case of toxicity, it represents the concentration of the sample that kills or impairs 50% of the test population.

MGD

Million gallons per day.

Sample Collection Guidelines for Testing Industrial Discharge to a POTW

1. When establishing the baseline EC50 for an individual industrial contributor, use 24-hour composite samples.
2. When spot checking any industrial contributor once the program has been implemented, use grab samples.
3. When monitoring a difficult to treat industrial contributor, use a composite sampler to collect samples.
4. For industrial batch dischargers (batch discharge into a waste stream flowing to a POTW or trucked waste), use grab samples.

Microtox Testing Guidelines

1. It is recommended that all samples be tested within 24 - 48 hours after collection.
2. It is recommended that samples be collected in borosilicate glass containers (polycarbonate and polypropylene containers are also acceptable) and filled to minimize the vapor space.
3. Always test reference standards (phenol and zinc sulfate) on a frequent basis to ensure the accuracy and validity of test results.
4. When testing industrial discharges to establish baselines, determine how many samples can be adequately tested per day using the Microtox test.
5. Any industrial discharge that has been treated with chlorine by the discharger must be dechlorinated prior to testing with Microtox.

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Establishing POTW Influent Baseline EC50

Before an industrial pretreatment toxicity limit can be set for an industrial contributor by a POTW, a baseline EC50 of the POTW combined influent must be established to document the normal levels of toxicity typically present in the POTW influent. As sample results are collected, record the EC50 values on the provided data sheet labeled "Baseline EC50 Data for POTW Combined Influent." In addition, plot the recorded EC50 values on the Microtox Daily Toxicity Chart. Plotting the data provides a scan of events as they occur over time. The baseline EC50 is established as follows:

1. POTWs will require the use of the Microtox Basic Test protocol for testing influent samples. Preliminary testing will help determine which Basic Test protocol (either Basic, 2% Basic or 81.9% Basic) is appropriate for testing influent. Once this has been determined, use the same protocol for testing all the influent samples.
2. Over a period of at least 30 to 60 days during normal plant operation, perform Microtox testing daily on a 24-hour combined influent sample.
3. At the same time the combined influent sample is collected (on a daily basis), measure and record the influent plant flow.
4. Calculate the average EC50 from the data collected over 30 to 60 days. This average value represents the influent baseline EC50 of the POTW.

Establishing Baseline EC50 for Individual Industrial Contributors

The purpose of this section is to determine the average EC50 (baseline) of the waste stream that an individual contributor continuously or batch discharges to a POTW. This information will allow the POTW to monitor each individual industrial contributor on a periodic basis to determine whether each contributor is discharging acceptable waste and to track potential toxicity excursions in the future.

As samples are analyzed, record the EC50 values on the provided data sheet labeled "Baseline EC50 Data for Industrial Contributor." In addition, plot the recorded EC50 values on the Microtox Daily Toxicity Chart. Plotting the data provides a scan of events as they occur over time. Determination of the baseline is accomplished as follows and should be established at the same time the influent baseline is being established:

1. Industrial samples will require the use of the Microtox Basic Test protocol.
2. Preliminary testing will help determine which protocol is appropriate for that contributor's discharge. Once this has been determined, use the same protocol for testing all samples from that particular industrial contributor.
3. Over a period of at least 30 to 60 days, perform a Microtox Test daily on a 24-hour composite sample for a continuous discharger. Use grab samples for a batch discharger, and test daily, if possible, for the same period of days. Testing must be performed for each selected industrial contributor.
4. As samples are collected daily, measure and record the discharge flow for each continuous discharger.
5. Calculate the average EC50 from the data collected over 30 to 60 days. This average value represents the baseline EC50 of the individual contributor's waste stream.

Setting Toxicity Limits for Industrial Continuous Dischargers

The POTW combined influent, along with the determination of average flow rates (in million gallons per day, MGD) for the POTW plant influent and the industrial contributors, the limit for that industrial contributor can be determined.

The limit is calculated using the following formula:

$$EC50 = \frac{(\text{Avg POTW Influent EC50})\,(\text{Total Flow in MGD from Contributor})}{(\text{Total POTW Plant Flow in MGD} - \text{Total Flow in MGD from Contributor})}$$

This limit will allow the POTW to ensure that the toxicity of an individual industrial contributor's discharge does not significantly exceed the toxicity present in the combined influent of the POTW based on the proportional flow from the industrial contributor.

Setting Toxicity Limits For Industrial Batch Dischargers

Once the baselines have been established for both the individual industrial contributors and the POTW combined influent, the toxicity limit for a batch industrial discharger (including trucked waste) can be determined.

Calculation of the toxicity limit requires knowledge of the volume of waste to be discharged and the time it takes to discharge the volume. The limit is determined using the following formula:

$$EC50 = \frac{(\text{Avg POTW Influent EC50})(0.00144)(\text{Volume of Batch Discharge in gal})}{(\text{Total POTW Plant Flow in MGD})(\text{Duration of Batch Discharge in minutes})}$$

Note: The constant, 0.00144, in the above equation is derived from the number of minutes in 24 hours (1,440) divided by one million (this converts the number of gallons to millions of gallons).

This toxicity limit will allow the POTW to ensure that the toxicity of an individual industrial contributor's discharge does not significantly exceed the toxicity present in the combined influent of the POTW on the basis of the proportional flow from the industrial contributor during the time allotted for the batch discharge.

Once a toxicity limit is established, a safe discharge time can be calculated for any batch discharge whose measured toxicity exceeds the established toxicity limit. The safe discharge time is determined using the following formula:

$$\text{Minimum Time for Safe Batch Discharge to POTW (in min)} = \frac{(\text{Avg POTW Influent EC50})\,(0.00144)\,(\text{Volume of Discharge in gal})}{(\text{Total POTW Plant Flow in MGD})\,(\text{EC50 of Batch Discharge})}$$

Note: The constant, 0.00144, in the above equation is derived from the number of minutes in 24 hours (1,440) divided by one million (this converts the number of gallons to millions of gallons).

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Pretreatment Program In Operation – Routine Industrial Monitoring

Once the baselines have been established for both the individual industrial contributors and the POTW combined influent, the toxicity limit for a batch industrial discharger (including trucked waste) can be determined. After all toxicity limits have been set, the monitoring program can be put into operation. It will be decided at this point how often to monitor the individual industrial contributors and the kind of monitoring to perform (i.e. spot checking or close and on-going monitoring of a troublesome contributor). Spot checking industrial contributors for compliance with the toxicity limit is most efficiently accomplished by performing a Screening Test. Assuming the contributor is discharging waste of a known volume or at a known flow rate for which a toxicity limit has been set, a grab sample can be tested at a concentration that is equivalent to the toxicity limit without needing to calculate an actual EC50 value for the grab sample. If the test indicates the grab sample toxicity to be within the established limit, then no further testing is required. If the grab sample toxicity is shown to exceed the limit, then a Basic Test may be performed to document the violation or, in the case of a batch discharge, to provide information so that a Safe Discharge Time can be calculated.

A Screening Test is performed by making a single dilution of the grab sample so its concentration approximates the toxicity limit EC50 concentration. A control is also set up. Microtox reagent is added to the two cuvettes containing the grab sample and the control. After 5 and/or 15 minutes, the analyzer is calibrated (set) using the control cuvette, and the light readings are taken on both the control and the grab sample and read from the software. **A sample exceeds the toxicity limit (fails) if the light reading in the sample is less than half of the reading in the control.** Many grab samples can be tested very quickly using a Screening Test, provided there is baseline data available for their particular industrial sources. The baseline EC50s determined for each contributor will also allow the POTW to properly trace any toxicity excursion to its source using a Screening Test to process the many grab samples that such a source detection investigation will generate.

It should be kept in mind that variations may be experienced due to seasons, change in some industries, or other factors (changes in federal, state, local regulations; plant design and operational criteria; environmental protections criteria). As important changes are made or experienced, adjustments should be made to baselines or toxicity limits.

The following section will illustrate example calculations using actual data generated by an industrial pretreatment section at a POTW. This POTW uses an extended air activated sludge treatment facility with 11 pumping stations and a design capacity of 25 MGD (million gallons per day). Several industrial contributors are monitored by the industrial pretreatment section on a routine basis.

Suggested Reading

1. U.S. EPA. 2007. Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program.

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