

Monitoring Influent Toxicity to Mitigate Risk and Optimise Treatment

Problem

Influent toxicity represents a major risk to the treatment efficiency of biological wastewater treatment plants. If a toxic influent inhibits wastewater biology, this can lead to permit violations, fines and extended process upsets. Additionally it will require operator hours and reduce public perception of the plant.

Solution

The EZ7900 Toxicity Analyser, with self-cleaning sample preconditioning panels, provides the ability to continuously monitor toxicity levels at the inlet. It uses real plant sludge, so that dynamic changes in biomass viability are immediately detected; providing sufficient time for effective mitigation measures.

Benefits

Online monitoring of influent toxicity mitigates risk and helps you stay compliant:

- Improves treatment efficiency and avoids sudden drop in performance
- Avoids downtime and plant failure
- Helps avoid discharge compliance failure



Background

Wastewater treatment plant managers are increasingly being required to accommodate greater capacity, whilst at the same time complying with tighter discharge consents. Consequently, they are under pressure to optimise processes, lower process risks and improve the quality of treated effluent.

During optimal conditions, a biological wastewater treatment plant has a fast throughput of wastewater with a high rate of organics and nutrient removal. Sludge settlement is good with a low rate of sludge production; aeration costs are

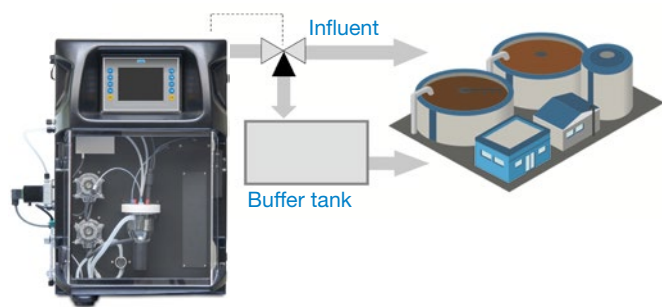
minimised, and the plant produces high quality final effluent. However, influent toxicity can disrupt normal plant performance, which makes it important to track this non-specific parameter.

If the influent remains consistent, providing sufficient nutrients and at the right level of aeration, the correct balance of microbes will be maintained and treatment will proceed with optimal efficiency. However, any sudden or unexpected changes in the influent will have the potential to upset the microbial balance and reduce the efficiency of wastewater treatment. In severe conditions, toxic influent can harm the microorganisms to such an extent that the treatment lane would have to be closed, emptied and regenerated.

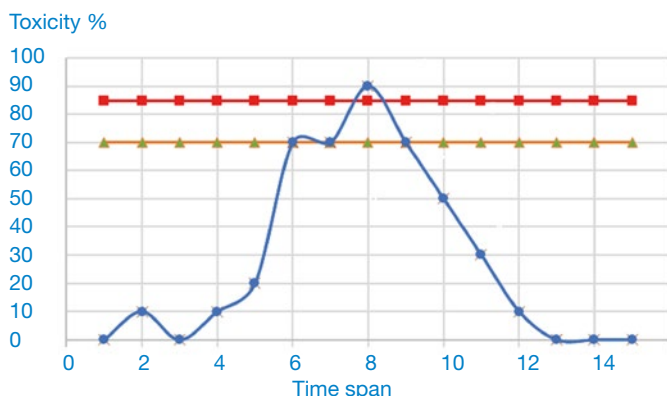
Historically influent TOC (Total Organic Carbon; sometimes combined with Total Nitrogen) has been used to predict influent toxicity. However, it is important to note that not all influent changes harm microorganisms. For example, a significant increase in the sugar content of the influent would increase the organic load but would not necessarily harm the microbes. In contrast, a sudden increase in alcohols coming from a production line, or in cleaning chemicals from a wash-down, would significantly reduce the biological treatment capability of the plant.



Toxicity of Wastewater Influent



Toxicity analysis results help decide whether to divert the influent into an emergency buffer tank.



In this exemplary graph the alarm level is at 70 %, the action level at 85 %. Alarm values can be programmed in the analyser or the SCADA system.

In these examples, TOC monitoring would indicate an increase in influent TOC, but would not provide any insight into the likely effects on the plant biomass. This is why influent TOC monitoring alone would not provide effective protection from toxic influent.

Safeguarding activated sludge microorganisms

An experienced wastewater treatment plant manager can tell from the appearance and odour of an aeration lane when conditions are not optimised. However, by the time such effects are noticed, it is usually too late – performance has been compromised and permit limits may have been violated. It is common practice therefore, for influent samples to be taken to a laboratory to assess the influent toxicity by measuring the respiration rate of those samples.

The drawbacks from this manual sampling and analysis approach are that it is costly and time-consuming, and may miss a toxic influent incident, especially if that incident takes place outside of normal laboratory working hours. However, if toxic influent is detected in a timely manner, the plant manager is able to divert the influent to an emergency buffer tank, or to treat or dilute the level of toxicity.

In 2018, Hach® launched an online monitoring technology which is able to detect Influent Toxicity and provide timely data to the operators of biological wastewater treatment plants; thereby protecting activated sludge, maintaining treatment efficiency, and avoiding plant downtime and discharge consent failure.

The benefits of online toxicity monitoring

Risk reduction

By automating the measurement of influent toxicity, Hach has resolved one of the major risk factors affecting the management of biological wastewater treatment plants. Toxic influent can be derived from a number of different sources. In a municipal wastewater treatment plant, toxicity may arise from the deliberate or accidental release of toxic waste from an industrial discharge. At an industrial wastewater treatment plant it may arise from a change in production, a cleaning process, or from a spill or accidental release of harmful chemicals.

By continuously sampling and measuring influent toxicity, the Hach EZ7900 Toxicity analyser is able to provide timely warnings so that appropriate mitigation measures can be instigated. The cycle time for the instrument is just 10-15 minutes. Many customers typically run at one sample per hour; 24 hours per day; seven days per week. This ensures that all toxicity incidents are detected; night or day.

Process Optimisation

By effectively protecting the plant's biomass from toxicity, online monitoring helps with process optimisation; maximising treatment capacity and helping to optimise the energy and financial costs of aeration. Continuous monitoring also helps to optimise sludge loading, maintain nitrification and prevent sludge wastage with the effluent.

Potential Sources of Influent Toxicity

- Production dependent wastewater
- Clean In Place (CIP) processes
- High salt concentrations
- Toxic waste in the collection system
- Increased heavy metal discharges
- Tank truck cleaning station
- Chemical toilet disposal
- Collections system chemical root clean

Process Insights from Plant-specific Measurements

The Hach EZ7900 automatically collects real sludge, freshly sampled from the treatment plant by means of a self-cleaning sampling-filtration system. This unique approach, with plant specific sludge, means that data from the analyser are specific to that treatment plant's biomass, and dynamic changes in viability are immediately detected.

Importantly, continuous toxicity monitoring helps to improve understanding of the plant's biological processes. For many users, this has provided valuable insights that have been used to refine process control. It is not uncommon for plants to divert influent by rule of thumb when it reaches 50% of the dose that would be lethal to the biomass. However, with the benefit of continuous toxicity monitoring, a number of EZ7900 users have been able to evaluate the effects of higher dose rates, and some have found that it is possible to set the action/divert level as high as 85 % for their specific plant. This saves cost and time, improves productivity, and means that less water needs to be diverted and stored.

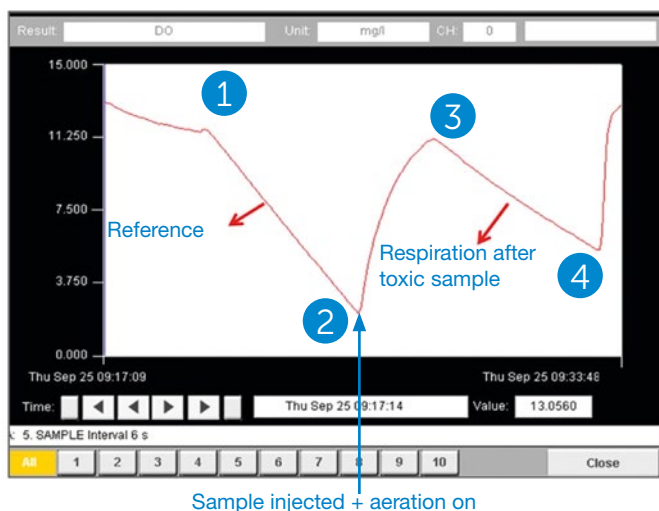
The EZ7900 Toxicity analyser incorporates an industrial panel PC running proprietary controller software, and a 5.7" TFT colour user interface for on-site data visibility. The software allows for modification of visibility and analysis settings and visualisation of data trends. It controls the operation of up to eight influent sample streams in a single analyser, with results for each stream communicated through individual outputs such as mA or Modbus. This multi-channel capability dramatically reduces the cost per sampling point, and a standard 4-20 mA signal output with alarm processing can be established for each channel so that appropriate and timely action can be implemented.

The cleaning of the filters and the analyser is automatic, and both calibration and validation frequency can be set by the user. Smart, automated features contribute to enhanced analytical performance, minimised downtime and negligible operator intervention. Nevertheless, Hach offers a range of Service Agreements to ensure continuous, reliable, hassle-free operation.

Continuous monitoring – how it works

Before analysis, it is first necessary to obtain a representative sample from the influent and a homogeneous sample of sludge from the aeration lanes on the plant. This is achieved with the EZ9110/9120 Series automatic sampling and sample preconditioning systems, which have been developed with many years of field experience. These preconditioning systems use pressurised air and rinse water for self-cleaning and are designed for fully automatic, unsupervised operation.

EZ7900 Analyser: Method Overview



Reference Measurement

- Activated sludge and influent wastewater are auto-filtered
- Analyser aerates sludge and adds nutrient buffer
- Aeration stops and O₂ consumption in sludge is measured
- Respiration rate for "healthy" sludge is calculated

Toxicity Measurement

- Wastewater influent added to vessel and aerated
- Aeration stops, nutrient buffer is added, and second O₂ consumption value is measured
- Respiration rate for wastewater sample is calculated
- Calculation of respiration rate and toxicity index
- Filters, analyser, and O₂ probe are auto flushed and rinsed

Calculation #1 (Reference Value)

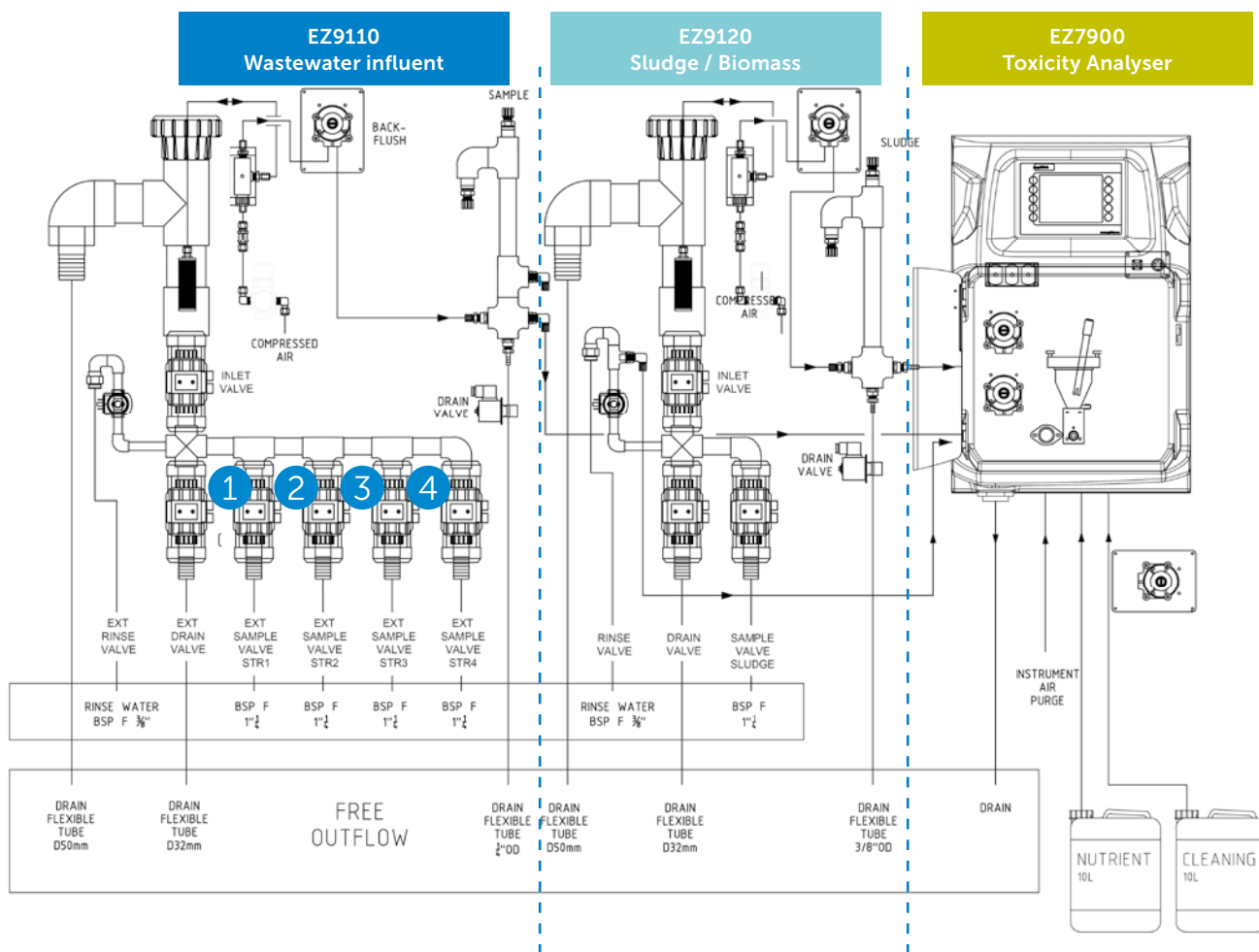
Respiration Rate REF = (Oxygen 1 – Oxygen 2) / Time

Calculation #2 (Toxic Respiration Rate)

Respiration Rate TOX = (Oxygen 3 – Oxygen 4) / Time

Calculation #3 (Final Result)

Toxicity Index (% Inhibition) = R.R. TOX / R.R. REF



Typical setup of an EZ900 analyser with a four stream sample conditioning panel
 Cleaning occurs after each batch filtration and sample measurement by automated filter flush and air scour, plus rinsing of sample vessel and probe.

Summary

The well-being of the biomass in a biological wastewater treatment plant is vital to the ongoing efficiency of the entire plant, so it is vital to be able to detect both chronic and acute influent toxicity with sufficient time to implement effective mitigation measures (divert, dilute or treat).

Manual sampling may mean that some toxicity episodes are missed, or alarms are issued too late. Online methods that do not use the plant's own biomass to measure the oxygen update rate (OUR) of microbial respiration will also be of limited value, as artificial biomass is not representative of the plant conditions.

By utilising the plant's own biomass, and by automating the process to enable 24/7 monitoring, the Hach EZ900 offers the ideal solution for mitigating the risk presented by toxic influent, whilst also providing insights for process control, improving performance and avoiding discharge consent failure.