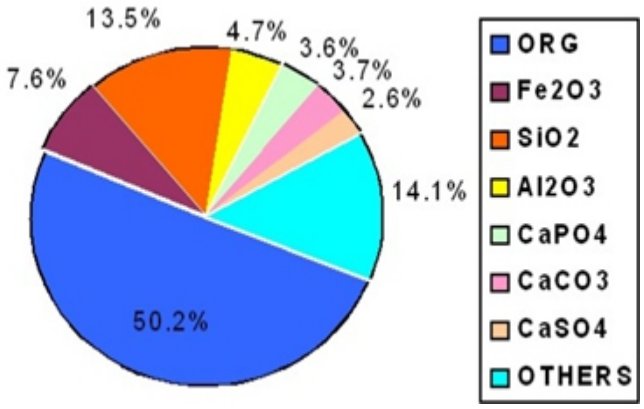
TOC Analysis Application in Water Treatment & Wastewater Treatment Plants

Total Organic Carbon (TOC) and Chemical Oxygen Demand (COD) Analysis in Modern Water Treatment Plant (WTP)

The needs of routine, accurate, and reliable TOC analysis is becoming more important in recent year due to the increasing usage of resin, reverse osmosis, and EDI technology in WTP to produce a better-quality water.

Softened water usually used as boiler feedwater to prevent the scaling problem from happening in the boiler and steam system. With the raising needs of better boiler & steam system protection, lower total operational cost, and energy saving; it is more common nowadays to use demineralized or RO water as boiler feedwater. Switching from softened water to demineralized or RO water will directly reduce the boiler blowdown, indirectly decreasing the fuel and chemical cost. Nowadays, depending on the technology that the plant chooses, both softener/demineralizer and reverse osmosis must operate optimally with minimum downtime. TOC is often one of the major contributors, beside the suspended solid and free chlorine, that could shorten the lifespan of any resin that being used in softener and demineralizer, forcing an early resin replacement, and increasing cost on the long run. Uncontrolled TOC (optimally maintained as low as possible) will also shorten the throughput of the resin system and increase the regeneration cost per m3 water produced. Regeneration chemical cost, especially for demineralizer, is not cheap and throughput optimization is usually giving the biggest saving in resin operation cost. Unscheduled resin regeneration and replacement will increase the system downtime which could give stress to the system reliability.

On the reverse osmosis system, major RO membrane manufacturer strictly limits the maximum TOC allowed in membrane feedwater at 3,0 up to 5,0 ppm of TOC (depending on the membrane brand and type). In membrane application, TOC is the number one contributor of early reverse osmosis membrane failure. Uncontrolled TOC will quickly foul the RO membrane, forcing unscheduled CIP and reducing the membrane replacement time. RO CIP cost usually in the big three of the biggest cost centers in RO operation; besides electric cost and membrane replacement. Optimizing the CIP period will save the operational cost in the long run. Failed to monitor and control the TOC will lead to increase downtime, putting more stress to system reliability, and higher operational cost.



Pic 1. Major Contributors of Reverse Osmosis Membrane Failure

Nowadays, Electro-de-ionization (EDI) starts to replace mixed bed as the final polisher of WTP, since it is considered more eco-friendly (EDI eliminate the needs of storing hazardous chemicals and producing hazardous waste stream) and deliver better quality product. EDI also have a strict TOC limit on its feedwater to prevent the organic fouling. TOC on EDI feedwater must be controlled less than 0,5 ppm of TOC. Failed to do so will lead to equipment breakdown and reliability issue. Due to the limitations of the reliable and tough online TOC analyzer, COD is often being used as replacement of TOC in WTP application. COD analysis can't replace TOC analysis on these cases, since COD doesn't measure how much organic content is contained in the feedwater.

Total Organic Carbon (TOC) and Chemical Oxygen Demand (COD) Analysis in Wastewater Treatment Plant (WWTP)

In optimal WWTP operation, both TOC and COD analysis are needed so the plant could run smoothly.

TOC analysis is perfect for shock load prevention application, since it is faster than COD analysis (TOC analysis is 6-8 minutes per cycle, meanwhile COD is 2 hours per cycle) and the Two-Stage Advance Oxidation (TSAO) method could analyze all kind of sample that might not be able to be analyzed with COD method. Common COD method used to have difficulties in analyzing sample with interferences (such as chloride). TOC analysis also being used for C : N : P ratio calculation.

COD is used on effluent analysis, organic loading rate calculation on the secondary system, F/M ratio, and aeration DO calculation. In many applications, we can use TOC to measure COD with a correlation factor. Unlike another online analyzer, Hach Biotector is specially made for on-site online TOC analysis that could also be used to measure COD with correlation factor. Biotector break the limitation of common online TOC analyzer and made it reliable enough to analyze TOC or COD from tough wastewater condition with high accuracy.

Having a reliable and accurate online TOC or COD analyzer on WWTP will improve system reliability significantly, reducing the risk from microbial collapsing at the secondary system, ease the WWTP complex operation, and put less stress to the operators.

Pic 2. Wastewater Treatment Plant (WWTP)

TOC Analysis in Water Treatment Plant (WTP)

Detecting TOC in Water Treatment Plant (WTP) might be useful for:

- Preventing organic fouling from happening in Reverse Osmosis (RO) unit, and
- Preventing organic fouling from happening in Electro de-Ionization (EDI) unit.

Organic fouling can result in reduced performance of said units, which calls for Cleaning in Place (CIP). Although this maintenance action is expensive, conducting it too often further add up to the total operating costs. If organic fouling has reached a severe level, equipment replacement may become necessary, and it comes with an even higher price tag. Additionally, while CIP and replacing the machinery takes place, RO and EDI must cease operation unless there are other pure water sources to rely on at the plant. In such cases, production halts as well.

A Wastewater Treatment Plant (WWTP) can detect TOC for the following reasons:

- Preventing shock load,
- Easier way to measure organic load,
- Easier way to measure C: N:P ratio in aerobic system, and
- Monitoring system for wastewater treatment plant effluent.

From all above, shock load prevention might be the most interesting impact from online TOC monitoring, since shock load is commonly happened and could be devastating if uncontrolled. Shock load might kill the microbes in WWTP and destroying the COD reduction capability of WWTP. Effluent monitoring system (no.4) might be interesting for an industry that pay so much attention for environment protection.

The Challenges of Manual TOC or COD Analysis

Manual TOC analysis will have many challenges in today application such as:

- **Water Treatment Plant (WTP):** If the raw water is taken from river or lake, the TOC level might change every hour, especially on a river or lake that near settlement or industrial complex. The changes of the TOC level would be hard to be anticipated in manual TOC analysis.
- **Boiler System:** The product leakage in batch or semi-batch process would be hard to detect manually and it is better to do early detection than the late one, this action could only be achieved easily and reliably by automating the analysis.
- **Wastewater Treatment Plant (WWTP):** Depending on the plant, some plant might have huge fluctuation on their WWTP influent, the changes could happen in just hours. If not maintained optimally, this fluctuation will lead to multiple shock loads and could cause the secondary system collapsing. Manual analysis often does not 'catch' the fluctuation and will let loose some of the shock loads and put stress into the secondary system.

The Benefit of Online TOC or COD Analysis

There are many benefits of analyzing TOC or COD online, such as:

- ✓ Analysis is done on-site, with the current sample condition, and no need for sample pre-conditioning or sample storing.
- ✓ Analysis could be done as many as possible, so the fluctuation or changes could be detected as optimal as possible.
- ✓ Minimizing the human error.
- ✓ The data could be transferred online to the DCS or any other control system, the operators don't have to be near the analyzer to see the results.
- ✓ The data could be data logged and exported to other form. These data could be use for further plant optimization or troubleshooting.

Hach Biotector as the Most Potent Online TOC Analyzer on the Market Right Now

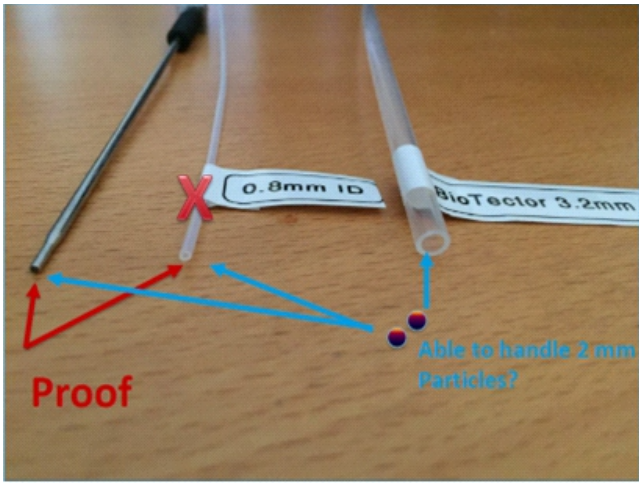
Unlike other TOC analyzer that was built for lab application and modified for online application, Hach Biotector is specially made for online on-site application and does not start from lab application. Because of this, Hach Biotector does not suffer the same limitation as other TOC analyzer and could be used even to analyze the most 'challenging' wastewater condition.

These are some strengths of Hach Biotector that make it more reliable than any other TOC analyzer on market right now:

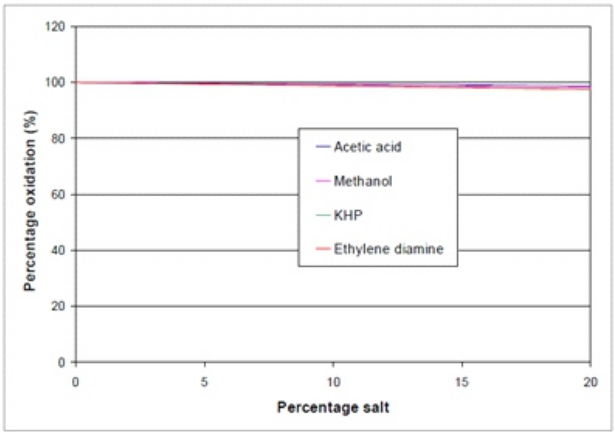
1. Ability to Handle High TSS Sample

Biotector can handle water sample with soft particle size up to 2 mm without the needs of filtering. This is due to the usage of bigger sample pipe than any other technology, the capability of TSAO to completely breakdown the suspended solid, and the sophisticated self-cleaning procedures.

This ability gives Biotector unrivaled strength in detecting TOC (or COD) in wastewater and dirty cooling water system application, since none of other method could handle the condition of those water sample.



Pic 3. Biotector Sampling Tube Compared with Other



Pic 4. Biotector Performance in High Salinity (TDS) Sample

2. Ability to Handle High TDS/Conductivity Sample

Not only high TSS, Biotector also able to handle sample water with high TDS or salinity up to 30% without any noticeable inaccuracy in TOC (or COD) analysis. Biotector TSAO and self-cleaning procedure also ensure that there is no scaling left inside the system, even in high TDS water, making the routine cleaning & maintenance un-needed. With this ability, Biotector is the perfect solution for sea water or high TDS wastewater application.

3. Ability to Handle High Chloride Sample

Biotector can handle water sample with soft particle size up to 2 mm without the needs of filtering. This is due to the usage of bigger sample pipe than any other technology, the capability of TSAO to completely breakdown the suspended solid, and the sophisticated self-cleaning procedures.

This ability gives Biotector unrivaled strength in detecting TOC (or COD) in wastewater and dirty cooling water system application, since none of other method could handle the condition of those water sample.

4. Accurate TOC (or COD) Reading from Advance NDIR Sensor

Biotector is using advance NDIR sensor to determine the amount of CO2 produce from the reaction that will be converted into TOC (or COD). This sensor is calibrated, temperature and pressure compensated CO2 "analyzer" built from Hastelloy, providing the most accurate and stable readings on the market.

6. Automatic Cleaning, Automatic Sampling, Automatic Verification

7. Can be Used for Online COD Analysis with Permanganate or Dichromate Method

Other online COD analyzer might be limited to only one method of COD analysis. Biotector on the other hand provide flexibility with correlation factor, so the COD reading could be matched with either permanganate or dichromate method with ease.

5. Relatively Low Cost of Ownership

For 'replacing' COD analysis, compared to normal COD analysis, Biotector only need 1.8 N Sulfuric Acid (H2SO4) Reagent w 40mg/l Mn and 1.2 N Sodium Hydroxide (NaOH) Reagent for its operation. These Biotector reagents cost are cheaper than COD for one cycle of analysis and can be bought outside Hach. No dependence to Hach for the reagent sourcing. Biotector also only need maintenance once per six months, reducing the maintenance cost significantly.

8. No Toxic Waste Produce

Normal COD analysis will produce toxic waste as byproduct from the reagent. In some regulation, this toxic waste must be treated carefully in certain manner and could cause another issue. Biotector reagent however is non-toxic and could be sent to the WWTP directly without any issue.