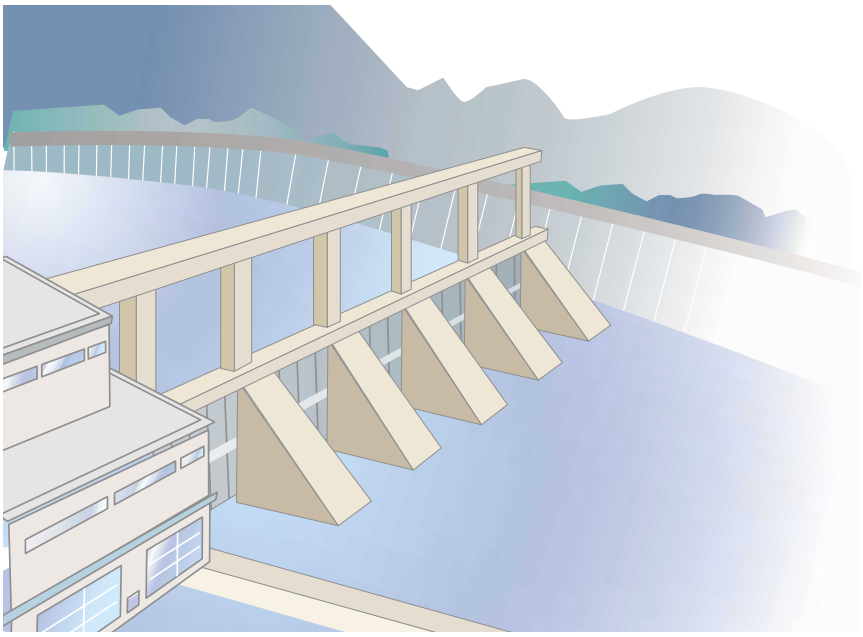
TOC (Total Organic Carbon) Analyzer Applications Broadening Horizons: Beyond Water Pollution Monitoring



TOC Applications

Water (TOC) monitoring can be classified according to its use, described as follows.

1) Environmental monitoring:

TOC is used to monitor organic pollution of water environments, bottom sediments in areas such as rivers, lakes and oceans in conjunction with industrial wastewater monitoring.

2) Industrial water and process management

TOC is used to assist in managing water for industrial processes, cleaning and heat exchangers, etc. It also assists with the management of residual pollution on the surfaces of products and the management of tap water and waste water.

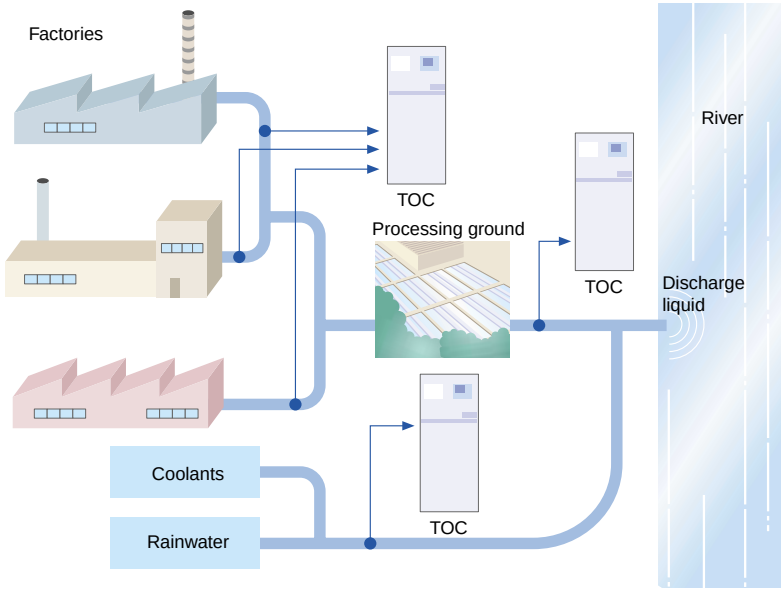
3) Research applications

In this area, the application classification is not separate from items 1) and 2) but rather should be seen as an application in testing, research, and quality control where lab-type TOC analyzers are the preferred mode of monitoring.

TOC is the measuring technique used to monitor the total amount of organic matter in water. It was developed as a form of indexing to replace BOD (biochemical oxygen demand) and COD (chemical oxygen demand) conventionally used in monitoring such situations as in the environmental monitoring. As TOC sensitivity and accuracy has been greatly enhanced, this technique is now regarded more as a carbon content analyzing mode than just a mere form of organic water pollution monitoring. TOC analyzer functions are constantly being improved to the point where this monitoring method is now being increasingly used not only for water but also for solids and gases. Such advances mean that this technology is well on the way to being widely used in industrial processes involving water described previously in item 2). An underlying cause for this advancement is that the use of TOC monitoring almost always enhances product productivity and quality.

TOC Method Advancements: a Comparison with BOD and COD Methods

BOD and COD have long been in use across the globe as organic pollution indexes. However, the following problems have been raised regarding the processes involved.



Time-Consuming BOD & COD Methods

The BOD measurement method involves adding a type of microorganism to the sample water. This sample is then left for five days under environmental conditions suitable for microorganism activity. The concentration of organic matter is indirectly evaluated from the volume of dissolved oxygen lost over the five days. Microorganisms consume oxygen when metabolizing organic matter. For this reason, BOD measurements takes time and an experienced technician is required because the task is manual and diluting is necessary. In addition, testing is a delicate operation due to the fact microorganisms are being used. Moreover, organic matter that is not metabolized by microorganisms cannot be evaluated. The COD measuring method involves adding an oxidation reagent to the sample water. The sample is left for two hours at a set temperature to allow for oxidation decomposition of organic matter. The concentration of organic matter is indirectly evaluated from the concentration of chemically bonded oxygen in oxidation reagent lost during this period. Once again, for this reason, measuring takes time and an experienced technician is required because the task is manual and the technique for chemical analysis is necessary. Furthermore, oxidizing reagents are highly corrosive with some being harmful to humans and the environment. As a result, handling and disposal of reagent is a problem. In addition, coexisting organic matter which cannot be decomposed by oxidizing reagents or oxidizable matter other than organic matter interferes with measurements.

Speedy, Accurate and Precise TOC Method

In comparison to the above two methods, TOC (analyzer working on the principle of combustion oxidation) has the following features.

The detection rate is almost 100% regardless of the type of organic matter. Measuring is relatively speedy (three to four minutes per measurement). Sensitivity and accuracy are superb. The dynamic range is broad ranging from ppb to percent levels. Maintenance is easy. Waste liquid disposal is simple with hardly any waste liquid being created. Most of all, TOC can be regarded as an automatic analyzer because accurate measurements can be obtained without dependence on the skill of a technician.

TOC, BOD and COD are all methods for measuring the level of organic pollution in water. Subsequently, they can be mutually interchanged. At present, major countries use BOD and COD methods as official indexes for waste water management. However, as described above, governments are becoming more aware of TOC features such that the BOD and COD methods are being replaced by TOC. Not all monitoring will be easily replaced in the immediate future by TOC due to issues concerning the carry-over of conventional data, but undoubtedly systems will be gradually switched over to the TOC method in due time. It should be noted that private enterprises have been quick to employ TOC analyzers for monitoring of daily waste water not covered by official regulation. TOC correlates well with BOD & COD and its speed enables prompt action when pollution is detected.

The World Leading TOC Analyzer

Since we at Shimadzu launched the first Japanese online TOC analyzer, we have accumulated some 30 years of experience and success in the manufacture of combustion oxidation TOC analyzers. As a result, we are the leader in this field. All our accumulated know-how has been employed on our products.

Total Organic Carbon Analyzer TOC-4100 in China to monitor wastewater

Online TOC Monitoring

The 4100 Series: the optimum automatic analyzer for environmental monitoring. The series includes the TOC-4100 (a total organic carbon analyzer), the TN-4100 (a total nitrogen analyzer), the TOCN-4100 (a total organic carbon and total nitrogen analyzer) and the TNP-4100 (a total phosphate and total nitrogen analyzer).

This series incorporates Shimadzu's world leading 680°C combustion catalytic oxidation system with outstanding features that enable it to handle samples which even contain mineral salts. In addition, it has a long catalyst life and is easy to maintain. Moreover, dirt in the sample flow line and blockages - major problems with online automatic analyzers - have been resolved at the design stage. A unique water sampling configuration is employed to measure suspended organic matter in samples. These superb features - not seen in competitive TOC analyzers - are praised in the Japanese, US and European markets, including that of the environmentalist "superpower" Germany.

The Shimadzu 4100 Series can continuously monitor carbon, nitrogen and phosphate to help combat the global issue of eutrophication in water catchment areas.

World Best Seller Lab-use TOC

As a follow on to our domestically and internationally popular lab-use TOC analyzers TOC-5000 and TOC-5000A, the TOC-V series was launched in 2000. This includes a combustion oxidation TOC analyzer and a highly sensitive wet oxidation TOC analyzer. It is available as standalone or PC controlled model. There is an added option of auto sampler or manual sample injector model. Shimadzu's combustion oxidation TOC analyzers have greater sensitivity than other manufactures' models. As a result, the TOC series is widely used in various processes where water management is of the utmost importance including management of ultra pure water.

Meeting Organic Pollution Monitoring Standards: Case in China

Finally, an extremely hot topic in China is the enforcement of regulations related to the environmental monitoring area. China is in the midst of its tenth five-year plan. Specially designated industries that discharge wastewater are being obligated to install organic pollution monitoring systems. Hence, Shimadzu has moved to launch the TOC-4100 Series on the Chinese market to meet the need. Already, the series is being put to good use and is being acknowledged with tributes by many industrial fields including dyeing, chemicals, sewage treatment, alcohol production and leather manufacturing.

Contributed by Takeshi Iharada, Process & Environmental Instrumentation Div. of Shimadzu Corporation.

Main Transition of TOC analyzers

TOC-10A

Customized the first laboratory TOC analyzer for a national environmental research institution in 1967.

TOC analyzers for laboratory use

- 1972 TOC-10
- 1983 TOC-500
- 1989 TOC-5000
- 2000 TOC-V

Online TOC analyzers

- 1972 TOC-100
- 1973 TOC-401
- 1978 TOC-402
- 1995 TOC-4000
- 1998 TOC-4100, TN-4100, TOCN-4100

TOC-V

What's the Best Suited Online Environmental Measurement?

Problems with the Online Measurement of Organic Matter using the COD Method

The COD test method indirectly determines the concentration of organic matter in a sample by measuring the amount of oxidant consumed in oxidizing the sample.

COD does not measure a specific component or element. Various measurement methods can be applied if the component and element amounts are determined, but a test method such as COD must conduct measurements strictly in accordance with the conditions and procedures prescribed by the official test method.

COD measurements are affected significantly by factors such as the oxidant type, concentration, and heating temperature, and time. Consequently, the measurement method prescribed by the official test method must be followed faithfully to prevent large discrepancies in the measurement results.

Trend from COD to TOC for the Online Measurement of Organic Matter

Several obstacles exist in conducting feasible online COD measurements in accordance with the official test method. This is typified by the high cost of oxidants and catalysts, and the existence of toxic substances in oxidants and catalysts, in addition to a long 2-hour heating time. Attempts to overcome these problems require a method to be able to make measurements in a relatively short time without requiring organic reagents.

Currently no online COD instrument on the market faithfully complies with the requirements of the official test method in terms of type and concentration of reagents, heating time, or temperature.

Consequently, due to its rapid and accurate measurements matched with its environmentally friendly nature, the TOC method has recently attracted much attention as an alternative method to COD for the online measurement of organic matter.

Continuous wastewater monitoring system at Shimadzu main works
TOC and TN by Total Organic Carbon/Total Nitrogen Continuous Monitor, TOCN-4100
Heavy metals (Ni, Cu) by Atomic Absorption Spectrophotometer, AA-6650