# Reliable Operation of BioTector in High TIC Applications

## Problem

Depending on pH and composition of the water sample, the total inorganic carbon (TIC) concentration levels could be relatively high compared to the total organic carbon (TOC) concentrations. Conventional TOC technologies apply a fixed-time TIC removal process. If TIC is not removed efficiently from the sample before the TOC analysis, this could have adverse effects such as carryover of TIC into the TOC measurement—thus higher and inaccurate TOC analysis.

## Solution

The Hach® BioTector Online TOC Analyzer, which utilizes an advanced TIC removal and operation sequence, was developed to handle high TIC concentration samples efficiently. The system monitors the TIC levels continuously using its nondispersive infrared (NDIR) $CO_2$ analyzer, and does not start TOC analysis until all TIC is guaranteed to be removed from the sample.

## Benefits

BioTector's advanced TIC monitoring mechanism leads to an efficient TIC removal from the water sample, and provides accurate, reliable TIC and TOC results in many applications. BioTector's efficient TIC removal process results in reliable analysis, and prevents overestimation of the TOC results and generation of unnecessary alarm signals.

### Background

TIC is defined as the sum of carbon present in water, consisting of elemental carbon, total carbon dioxide, carbon monoxide, cyanide, cyanate, and thiocyanate (in water analysis guidelines and norms). TOC instruments mostly register TIC as the $CO_2$ originating from carbonates and hydrogen carbonates. TIC is removed by the acidification of the sample to a pH of typically less than 2 and purging of the $CO_2$ gas with a carrier gas such as oxygen ($O_2$). TIC is regarded as a non contaminant in water treatment plants and in most applications.

In conventional TOC technologies (e.g. thermal combustion and UV persulfate) a small quantity of acid is mixed with the sample, and a fixed TIC removal time is applied. If the TIC concentrations are high or when the TIC levels increase unexpectedly in the water sample, the injection of the small quantity acid and the use of fixed time results in incomplete removal of the TIC from the sample. The consequence of inefficient TIC removal is critical because the TOC, which is a contaminant, will be measured inaccurately due to insufficient removal of TIC from the sample.

In Hach BioTector analyzers, surplus quantity of acid injection is applied, and the TIC removal is automatically extended by monitoring the $CO_2$ levels continuously until all TIC is removed from the sample. This operation guarantees accurate and reliable TIC and TOC analysis.

## How Does BioTector's TIC Removal Work?

BioTector has an "automatic extension" mechanism, which is activated during the TIC analysis if the $CO_2$ level does not drop below a certain checkpoint at the end of the TIC removal phase. When necessary, BioTector automatically extends the TIC sparge time, until all the $CO_2$ coming from TIC is removed from the sample. This mechanism is a "dynamic endpoint detection, which guarantees the complete removal of the TIC from the sample before the TOC measurement is initiated.

During the TIC sparging phase, BioTector monitors the $CO_2$ levels in the sample with its NDIR $CO_2$ analyzer. If the $CO_2$ level is not reduced to the pre-programmed "TIC Check" $CO_2$ concentration level, BioTector automatically extends the TIC phase until all $CO_2$ is removed from the sample.

The "TIC Check" $CO_2$ concentration level is programmed based on system specification, such as the analyzer's detection limit, where the "TIC Check" $CO_2$ gas concentration corresponds to a negligible quantity of TIC. This standard BioTector software feature guarantees that all TIC is completely removed from the sample. Therefore, the possibility of any TIC carryover to the TOC analysis is removed with this mechanism. This feature has been proven to be critical for the analysis of samples containing high or significantly fluctuating concentrations of TIC. Figure 1 illustrates the "automatic extension" with an example TIC $CO_2$ peak endpoint detection.

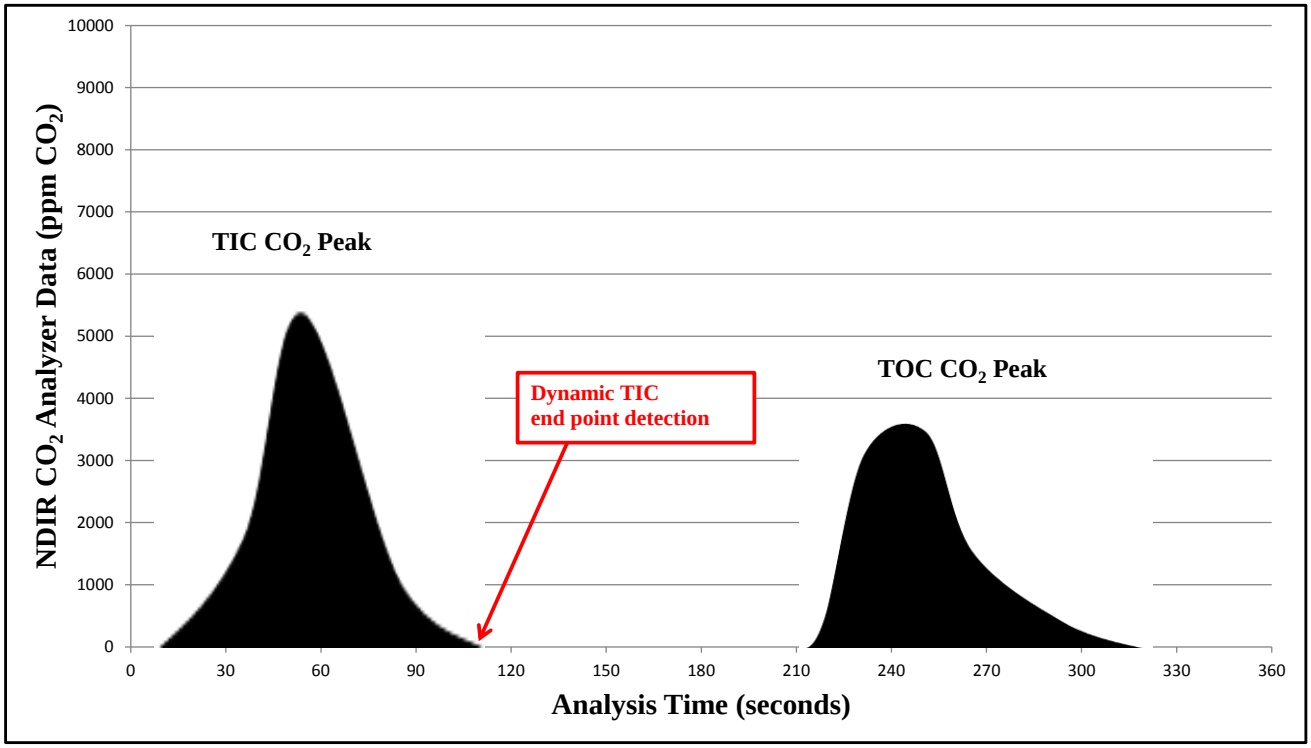


*Figure 1: TIC & TOC CO2 data with dynamic TIC endpoint detection*

*Table 1: TIC Carryover to TOC When Fixed Time TIC Removal is used in Conventional TOC Technologies*

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|---|---|
| **TIC Check** | ▪ TIC CHECK represents the $CO_2$ checkpoint for the TIC phase. If the $CO_2$ level is above the programmed checkpoint at the end of the TIC phase, then the analyzer automatically extends the TIC SPARGE TIME by 1 second and checks the $CO_2$ level again.<br>▪ If the TIC level does not drop below the checkpoint at the end of the maximum 300 seconds extension time, system generates a "TIC OVERFLOW" warning. |
| **TIC SPARGE TIME** | ▪ BioTector sparges and measures the TIC content of the sample during the TIC SPARGE TIME.<br>▪ If the TIC level does not drop below the TIC CHECK level by the end of TIC SPARGE TIME, BioTector automatically extends this time until the TIC level drops below the TIC CHECK level.<br>▪ The "TIC OVERFLOW" warning is generated when the TIC level does not drop below TIC CHECK level by the end of the maximum extension time, which is 300 seconds. |

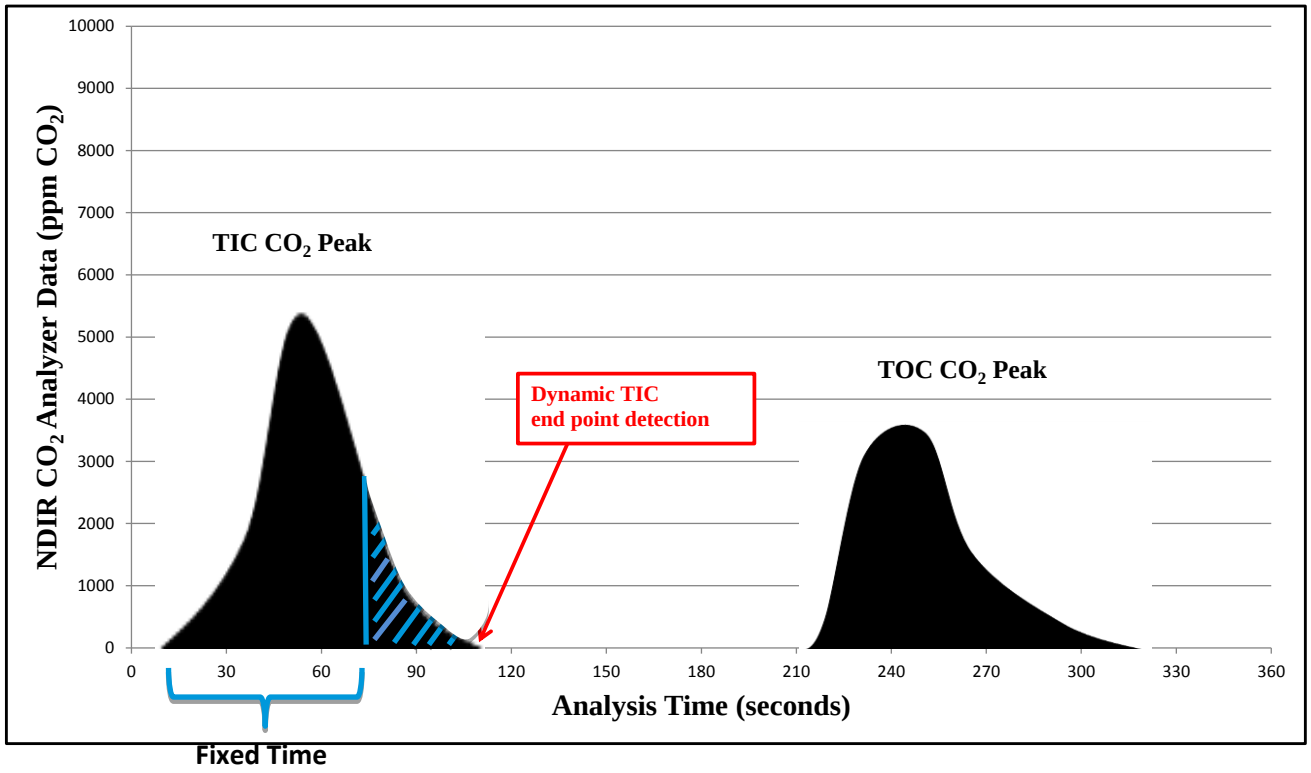


*Figure 2: TIC carryover to TOC in conventional TOC technologies*

When fixed time TIC removal is used, the $CO_2$ gas (shown in the shaded region in Figure 2) carries over to the TOC measurement.

## CONCLUSIONS

The Hach BioTector online TOC analyzer applies an advanced TIC removal process where the system monitors the TIC levels continuously and guarantees the complete removal of TIC from the sample. This operation mechanism provides accurate and reliable measurement of TIC and TOC in the industry, and prevents overestimation of the TOC results and generation of unnecessary alarm signals.

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