

pressurized integrated on-line sampler (PiOS) for low level TOC analysis

introduction

The Pressurized Integrated On-Line Sampler (PiOS) was developed to enhance organics monitoring with Sievers® M9® Total Organic Carbon (TOC) Analyzers in ultrapure water (UPW) systems often used in microelectronics applications. In these applications (typically <5 ppb TOC), it is critical to detect minute variations in water quality to protect the final product and optimize treatment processes.

Total carbon (TC) and inorganic carbon (IC) are so similar in magnitude at these low levels that TOC measurements [TOC = TC-IC] can suffer from signal-to-noise related interferences. One source of these interferences, micro-bubbles from the surrounding environment, can result in unexpected TOC spikes. The PiOS inhibits bubble formation and ensures more accurate analysis at these low levels by pressurizing the sample water between 3-5 psig in the instrument.

validation of the PiOS

Testing was conducted to validate the analyzer's performance using the PiOS compared to the standard iOS for low level TOC analysis under the following conditions:

- Normal mode
- Turbo mode
- TOC recovery with various standards
- Various ambient temperatures, inlet pressures, and sample temperatures

The PiOS does not affect system protocols, such as calibration and verification, or the limit of detection of the instrument. External testing conducted at a microelectronics facility demonstrated stable TOC analysis at sub-ppb levels when using the PiOS. The results of this validation are presented in detail in subsequent sections of this document.

noise and spike reduction

Low level TOC analysis with the PiOS displayed reduction in both the presence of TOC spikes and point-to-point noise compared to analysis with the standard iOS (**Figures 1a and 1b**).

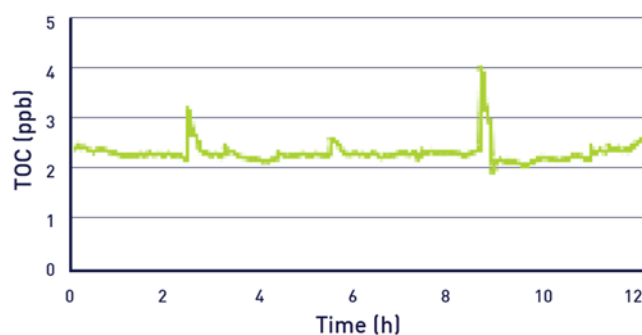


Figure 1a. TOC Analysis with Standard iOS

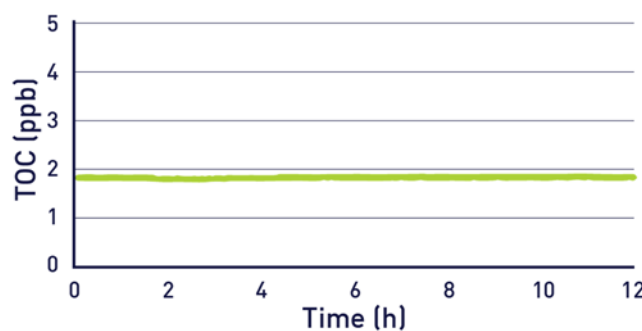


Figure 1b. TOC Analysis with PiOS

Additionally, the PiOS showed stable results and reliable instrument to instrument matching during long term testing at low TOC levels (<1 ppb) as shown in **Figure 2**.

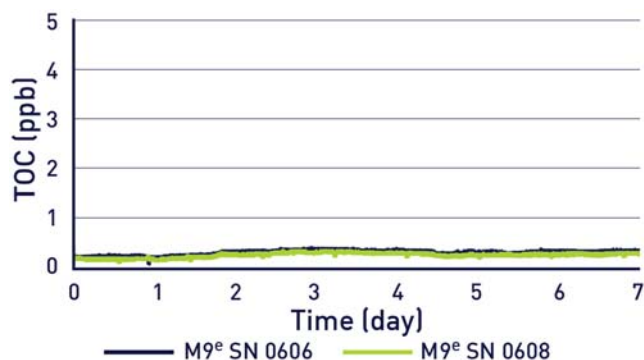


Figure 2. Long Term Testing with PiOS (SN=serial number)

Compared to Sievers 900 TOC Analyzer with standard iOS, the Sievers M9° TOC Analyzer with PiOS showed improved stability and less spiking (**Figure 3**).

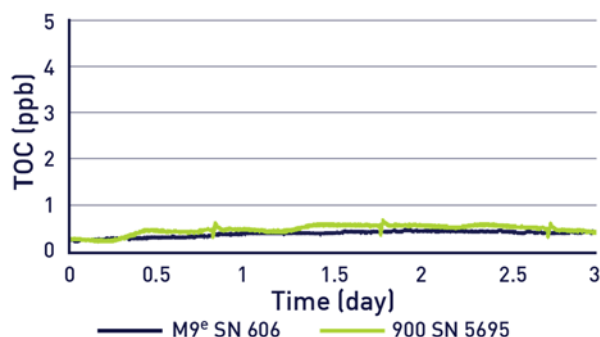


Figure 3. M9° with PiOS Compared to 900 with Standard iOS

TOC analytical performance

Results in **Figure 4** demonstrate consistent recovery of organic compounds using the M9° TOC Analyzer and PiOS, within and between multiple M9° instruments.

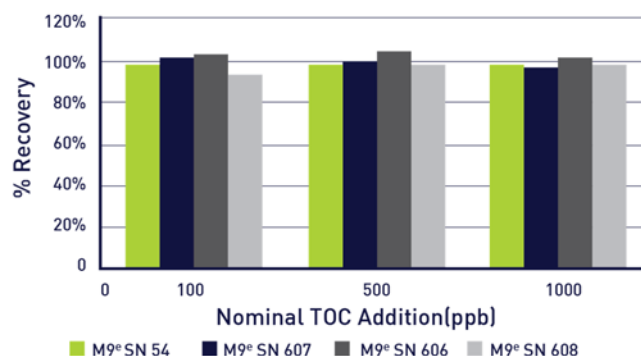


Figure 4. TOC % Recovery of Four M9° Instruments with PiOS

Turbo mode is often used for quick decision-making during reclaim monitoring. Similar to analysis in normal mode, TOC analyzers using the PiOS in turbo mode demonstrated less spiking than instruments using the standard iOS (**Figures 5a and 5b**).

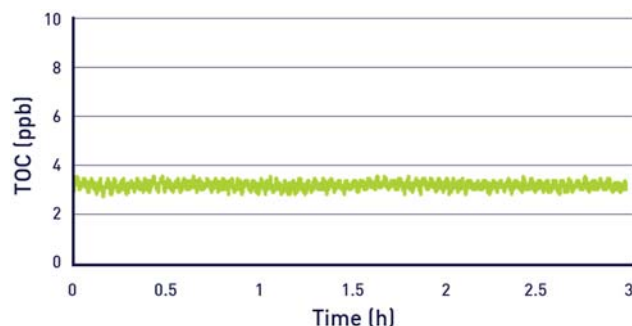


Figure 5a. TOC analysis with PiOS in Turbo Mode

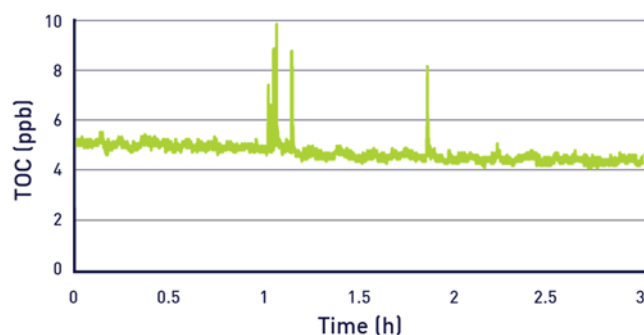


Figure 5b. TOC Analysis with Standard iOS in Turbo Mode

Sample pressures, which can be measured using an optional pressure gauge kit, were found to be ideal between 5–40 psig. M9° instrument performance was not impacted by the PiOS in terms of:

- TOC recovery
- Execution of system protocol

An optional vial port can be added to the PiOS, but is not standard. Optimal instrument performance at low to sub-ppb levels requires a different calibration strategy than in higher TOC applications. An autozero feature forces the calibration curve through zero in the absence of TOC and is more effective than calibration standards, which are not able to address low to sub-ppb operation¹.

conclusions

The PiOS shows improved organics monitoring performance in low level (<5 ppb TOC) applications where stability, accuracy, and instrument to instrument matching are critical to the operation of UPW systems. The PiOS, which is compatible with Sievers M9[®] Portable and M9[®] On-Line Analyzers, can be installed on new instruments or as an upgrade to existing instruments.

With the help of the PiOS, the M9[®] can detect organic contaminants, such as organic nitrogen compounds and organic acids, throughout the UPW treatment process. The PiOS helps optimize online TOC analysis for monitoring UPW systems at low and even sub-ppb levels by providing stable, accurate, and reliable data without interferences.

References:

1. Operation, Calibration, and Autozero Guidance for TOC Monitoring in Microelectronics UPW Applications. GE Analytical Instruments. 2015. Web. 2 Jun 2016.