ELGA VEOLIA

Technology Note

TOC Monitoring in Purelab Pharma Compliance

WATER TECHNOLOGIES

TOC Monitoring in Purelab Pharma Compliance

The ELGA Purelab Pharma Compliance water-purifier boasts a novel TOC monitoring system offering the benefits of real-time results and the confidence associated with USP643 / EP2.2.44 compliance.

A combination of environmental focus and technical know-how has allowed the ELGA team to develop this solution without the addition of further process consumables such as UV lamps.

Benefits

- **Real-time TOC reporting - Displayed TOC of the water being dispensed.**
- **Meets the Pharmacopoeia System Suitability (SST) requirements (USP643 & EP2.2.44)**
- **No additional consumable parts and associated cost**
- **Can be serviced and validated on-site**

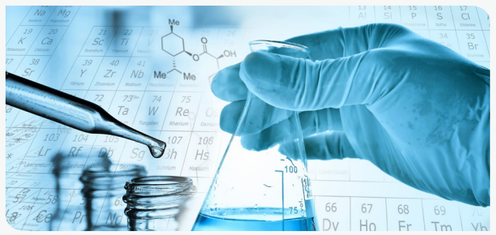
The TOC Parameter

TOC (total organic or oxidisable carbon) is a critical parameter used to indicate the purity of purified water; the value of the TOC is affected by all soluble organic compounds - a vast range of potential contaminants - The sensitivity of TOC to concentrations of specific organic compounds will vary depending on their carbon content but a low TOC level for a particular water confirms low levels of any particular organic molecule that may be of concern. As a result TOC is widely applicable to determine the suitability of purified water for many applications.

Resistivity is a complementary parameter commonly used to indicate water purity; this mainly indicates the presence or absence of ionic contaminants most of which would not be detected as TOC, and vice versa.

In laboratory water purification, product water purity can fluctuate dramatically depending on the impurities in the feed water to the purification system.

Typically, specifications are set for the feed water to protect against high feed water contamination, however, unexpected variations in feed water, reduced efficiency of purifier components with age or misuse, can still result in contamination of product water. Monitoring of TOC and Resistivity for water being dispensed can be used to detect changes in purity and confirm the suitability of the water for particular applications. Clearly, 'real-time' measurement and display of these parameters on the water purification system, enables the detection of sudden changes in purity when the water is dispensed and minimises the risk of contaminated water being used.



TOC Detection

There are two main techniques used to determine TOC in water; both involve oxidation of carbon to carbon dioxide; In the first, an increase in water conductivity is detected; this is caused by the conversion of the CO2, produced by oxidation, into ionic forms with the water; In the second the CO2 is transferred from the water into a flow of gas where it is detected as an absorbance at specific wavelengths as it passes through an NDIR (Non-dispersive Infra-Red) detector. The latter technique is typically used when levels of TOC are relatively high or species that may interfere with a conductivity detection method (for example, those containing sulphur) are present. The first method is particularly suitable for use with purified water due to its high sensitivity and low detection capability.

The oxidation processes used to generate CO2 from the organics in a TOC monitoring process can only oxidise a limited quantity of organics in a given time; It will take longer to oxidise organics within a sample with high TOC compared to that for a sample where TOC is lower.

Oxidation time is a major factor in determining the upper limit for TOC concentration that an analyser can measure. High concentrations require longer oxidation, conversely, where concentrations of organics are very low, oxidation times required can be reduced.

Typical analysis times needed for dedicated TOC analysers range from 4 to 10 minutes. This time is set to ensure full oxidation of organics in a variety of sample types but can be unnecessarily long when testing samples with very low TOC levels such as highly purified water.

The delay in analytical results can be significant, particularly in the case of ultra-pure water which, on exposure to air, following dispense from the purification system, will immediately begin to lose in purity in various ways including TOC. Ideally, water is dispensed and used straight away rather than waiting several minutes for the TOC determination to complete.

The USP643 / EP2.2.44 System Suitability Test (SST)

The 'SST' as defined in the USP 643 and EP 2.2.44 is designed to ensure that the equipment and technology used for TOC determination respond equally to different chemicals that contain the same quantity of carbon.

The test is carried out measuring responses for 500ppbC solutions of 1,4-benzoqunione (a difficult to oxidise compound), sucrose (an easy to oxidise compound), and the reagent water used in solution preparation; the equation below must be satisfied:

$$85 \leq 100[(RSS-RW)/(RS-RW)] \leq 115$$

rw = *is the response to the 'reagent water' used (must have a TOC of ≤500ppbC)*

rss = *is the response to 500ppbC sucrose (dissolved in the reagent water)*

rs = *is the response to 500ppbC benzoquinone (dissolved in the reagent water)*

In summary, the analytical response for benzoquinone at 500ppbC must be within 15% of that for at sucrose 500ppbC. This suitability test focuses attention on TOC analyser performance at much higher TOC concentrations than are typically found in ultrapure water; This is reflected in the intense and time consuming oxidation processes favoured by stand-alone TOC analysers.

The Context of TOC Monitoring within a UPW System

In systems measuring only low TOC in highly purified water such as that within the Purelab Pharma Compliance it is essential to reduce oxidation time, in line with TOC concentration, in order to deliver results quickly to the user of the pure water system. For this reason ELGA have developed a TOC monitoring process that can deliver real-time TOC measurements for the water at the time of dispense, when concentrations are low, but can also increase oxidation treatment, in order to measure TOC at higher levels and successfully meet the Pharmacopoeia System Suitability requirements.

The lower range, real-time TOC measurement of the Pharma Compliance purifier has been shown to deliver results in agreement with commercially available TOC analyzers that meet System Suitability Test requirements.

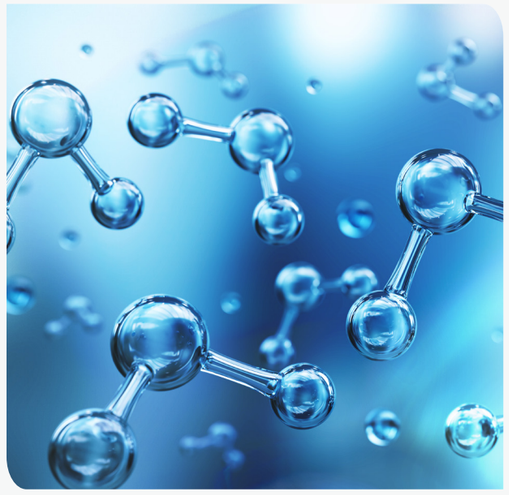
TOC Analyser A (pbbC)	TOC Analyser B (pbbC)	Purelab Pharma Compliance (pbbC)
7	5	5
11	15	11
28	35	30
44	38	40
50	46	50
89	74	70

When results of sufficiently raised product-water TOC concentrations are detected the Pharma Compliance system will initiate a measurement process with increased oxidation treatment in order to match the raised load. This process can measure TOC at up to 1000ppbC and can also meet the requirements of the SST.

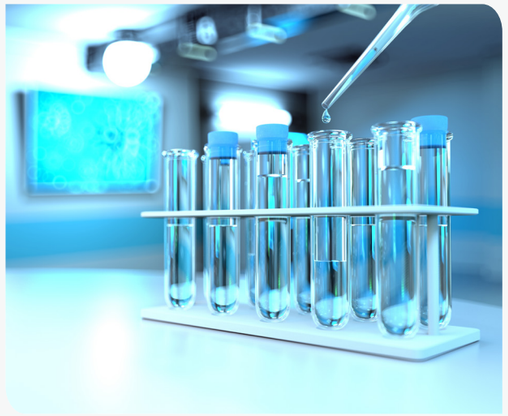
To increase the oxidation in the TOC measurement process, a second dedicated pump is activated to pass the water under test through the ultraviolet light chamber multiple times, giving an increased ultraviolet-light treatment.

TOC Analyser A (pbbC)	Purelab Pharma Compliance (pbbC)
8	5
150	150
550	500
822	750
1300	1000

Results from measurements carried out to validate this ‘increased oxidation’ method, also showed excellent agreement in TOC value (within 10% at values of 150, 500 & 750ppbC), with a dedicated TOC analyser.



Solutions required for testing in the SST can be easily introduced to the system via a purpose-made chamber which temporarily replaces the first purification cartridge. Following testing the purification pack is replaced and the system operates to ‘polish’ the water within itself. This can be done ‘on-site’ following installation minimising disruption to the user’s pure water requirements, and also proving performance in the actual situation in which the equipment is to be used.



Pharmacopoeia System Suitability Tests carried out on the process also gave excellent results, consistently achieving values within the specified 85-115% range.

Test Number	SST Result (%)	Pass/Fail
1	99	Pass
2	98	Pass
3	97	Pass
4	96	Pass
5	102	Pass
6	102	Pass
7	97	Pass
8	98	Pass
9	102	Pass
10	100	Pass

The novel (patent pending) design from ELGA allows the Pharma Compliance purifier to monitor TOC within the water it dispenses in using only existing water treatment components. Alternatives require additional dedicated oxidiser parts and conductivity cells, significantly increasing cost (capital and running) and maintenance requirements. In the Pharma Compliance the oxidising UV lamp is typically replaced annually, and conductivity cells require periodic calibration.

Conclusion

The Purelab Pharma Compliance offers an innovative, novel (patent pending), cost and resource effective, TOC monitoring feature; Measurements have been shown to be in agreement with dedicated TOC analysers over a wide range of values, and meet Pharmacopoeia System Suitability Test requirements.

TOC results given in ‘Real-Time’, for the water dispensed, allows Pharmaceutical Laboratories to use the purified water with confidence. By choosing the Pharma Compliance over alternatives, users can not only reduce spending, but also be kinder to the environment through consumption of fewer parts and reduced maintenance.

ELGA VEOLIA

Dedicated to Discovery

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ELGA Labwater are specialists in the engineering, service & support of water purification systems.

Unrivalled product design has achieved international recognition and awards.

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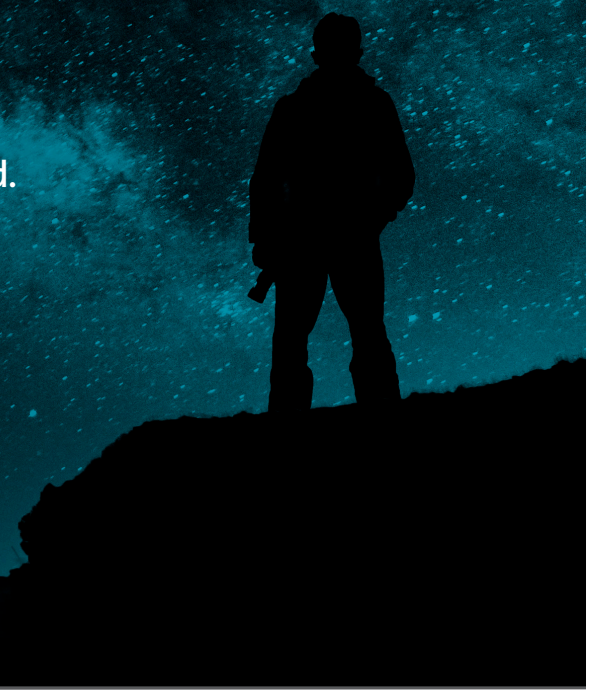

To find your nearest ELGA representative, go to www.elgalabwater.com and select your country for contact details.

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