Technology Note 18

PURELAB® flex Real time TOC System

Why do we monitor TOC?

Resistivity is well established as a good indicator of the level of inorganic ionic impurities in pure water. If the resistivity of water is greater than 17 MΩ-cm we can be sure that only a few parts-per-billion (ppb) of ions can be present. At a resistivity of 1 MΩ-cm ionic levels can be as high as 1000ppb.

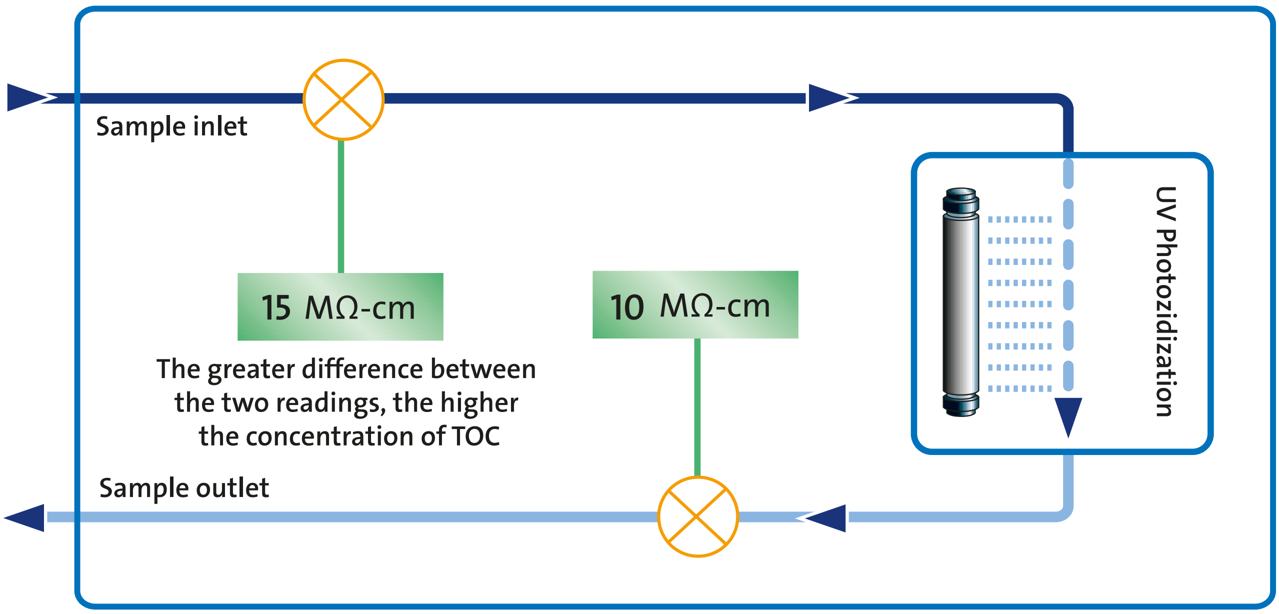
In the same way, total organic carbon (TOC) is a useful universal indicator of the presence of organic impurities in water. By monitoring TOC on-line in real-time, we can be assured of the overall organic purity of the water.

The overall ionic and organic purity of the water can be confirmed by monitoring both resistivity and TOC. Logging these values facilitates the indentification of trends and the detection of changes in the system performance.

Sensitive analysis such as HPLC & GC-MS measures impurities down to sub ppb levels of contaminants. Ultrapure water is used to prepare samples and standards and as a component of the mobile phase in HPLC. Organic carbon compounds remaining in the water can therefore have a dramatic effect on the accuracy and sensitivity of these analyzers.

The limitations of monitoring TOC

In the same way that a resistivity monitor cannot specify the particular inorganic ions in the water, a TOC measurement cannot help us to define which specific organic impurities are present. Furthermore the relationship between the TOC and the equivalent concentrations of various organic compounds will vary according to the percentage of carbon in each contaminant and the effect of other elements in the organic compound, such as chlorine.



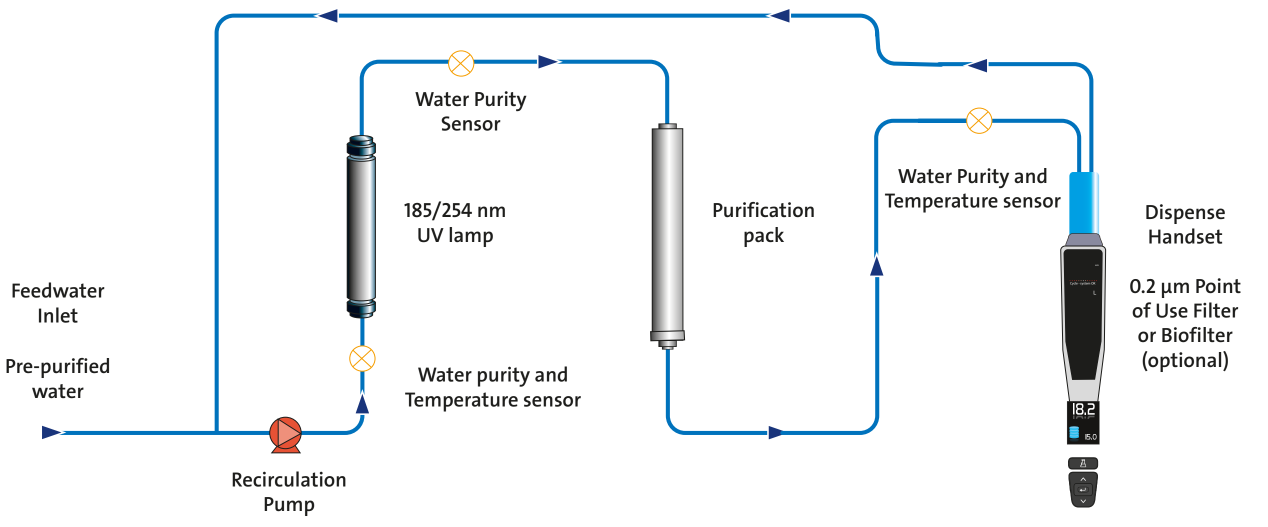
How is TOC monitored in the PURELAB flex?

In a basic on-line TOC monitor the resistivity of the water is measured, the water is exposed to far-UV light, and the resistivity measured again. The TOC value is a function of the difference between the resistivity pre and post oxidization, as shown above.

As water is recirculated or dispensed from the PURELAB flex, the pre-purified feedwater is pumped through a chamber irradiated with high-energy UV light. The organic compounds in the water are oxidized to ionic species which cause the resistivity of the water to fall. As illustrated above, by measuring the change in resistivity caused by the UV-photo-oxidation the TOC of the product water can be estimated. The organic ions produced are removed on the down-stream purification pack. The pack itself is kept clean by intermittent recirculation of highly purified water.

The oxidative efficiency of the UV lamp is monitored periodically to ensure the TOC is measured accurately. When the oxidative efficiency begins to change the TOC monitor recalibrates itself to ensure that the TOC continues to be measured accurately. When the efficiency falls below the recalibration adjustment levels, a UV replacement is indicated. This ensures the UV lamp is changed at the right time.

Process Flow PURELAB flex 2



TOC monitor response time

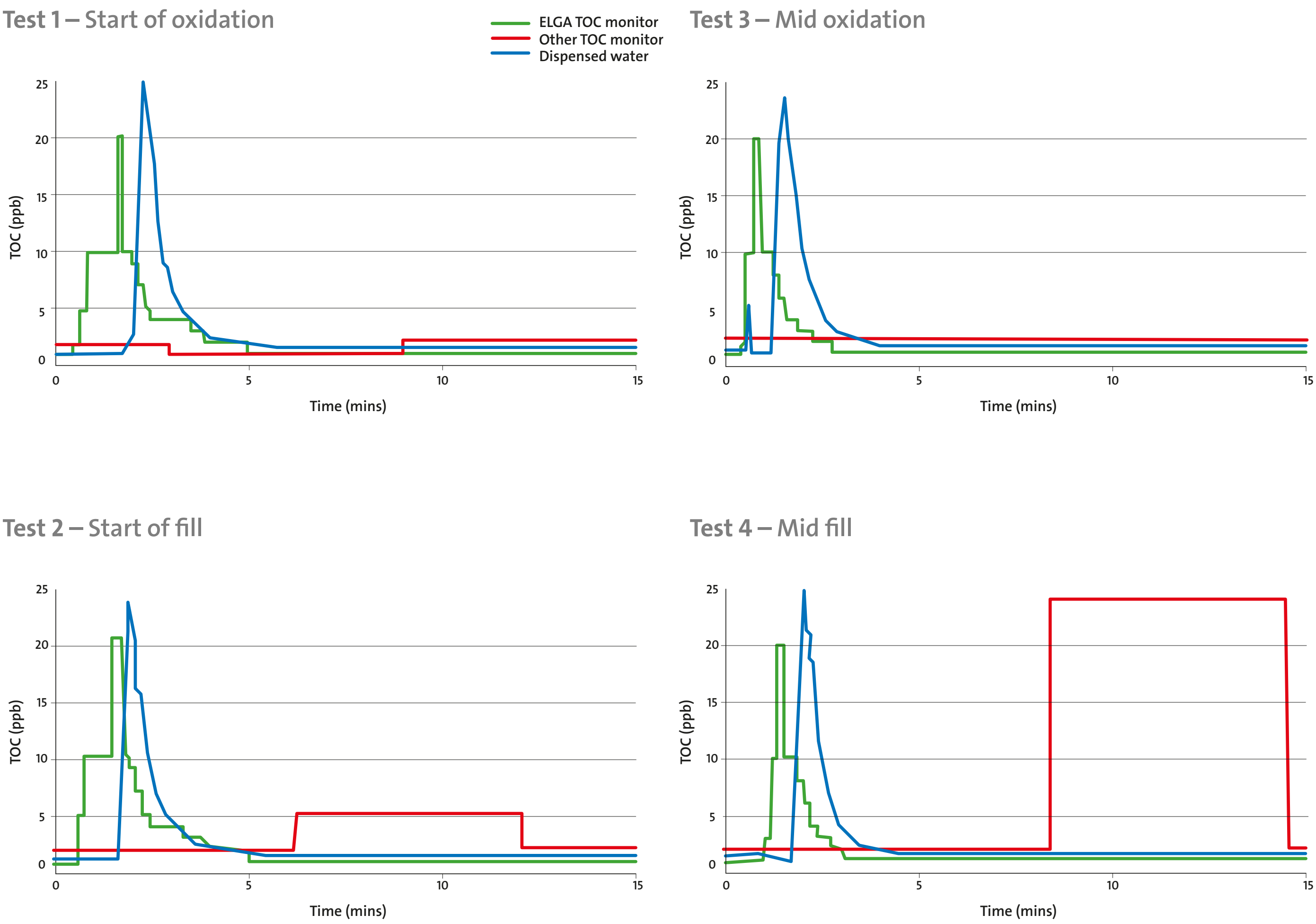
A TOC monitor, as fitted in another widely used laboratory water type I ultrapure water purification system, was connected just before the dispense in a modified EGLA PURELAB type I ultrapure water purification system. Repeat injections of 3ml of a 100 ppm solution of methyl ethyl ketone were made into the feed water. The readings on the TOC monitors were logged and the TOC of the water dispensed was measured continuously.

The other TOC monitor fills for a fixed time and then oxidizes the sample for a further time period before displaying the TOC. Methyl ethyl ketone was injected to coincide with different points in this measurement cycle. The conditions are shown in Table 1 and the results are displayed graphically in Figure 1.

Table 1. Test conditions

Test	1	2	3	4
Injection point in other TOC	Start of oxidation	Start of fill	Mid oxidation	Mid fill
Impurity injected	25	24	23	25

Figure 1 Detection of transient organic contaminants by the EGLA TOC monitor and by the other type of TOC monitor. The methyl ethyl ketone was injected into the feedwater at time 0.



Tests 1 and 3 both show that the other TOC monitor did not detect the increased level of TOC in the water. Any water dispensed at around 1 or 2 minutes is contaminated and if used could affect test work. ELGA's TOC monitor reliably detects the high levels as well as the low levels which would accurately indicate when the water is suitable for use.

Tests 2 and 4 show that the other TOC monitor had a signficant delayed reponse time when detecting any increased levels of TOC. ELGA's TOC monitor reliably detects the high levels of TOC without delay.

ELGA's real-time TOC monitoring guarantees that the water dispensed and used to prepare samples and standards does not add any new organic impurities. Therefore not affecting any test results.

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