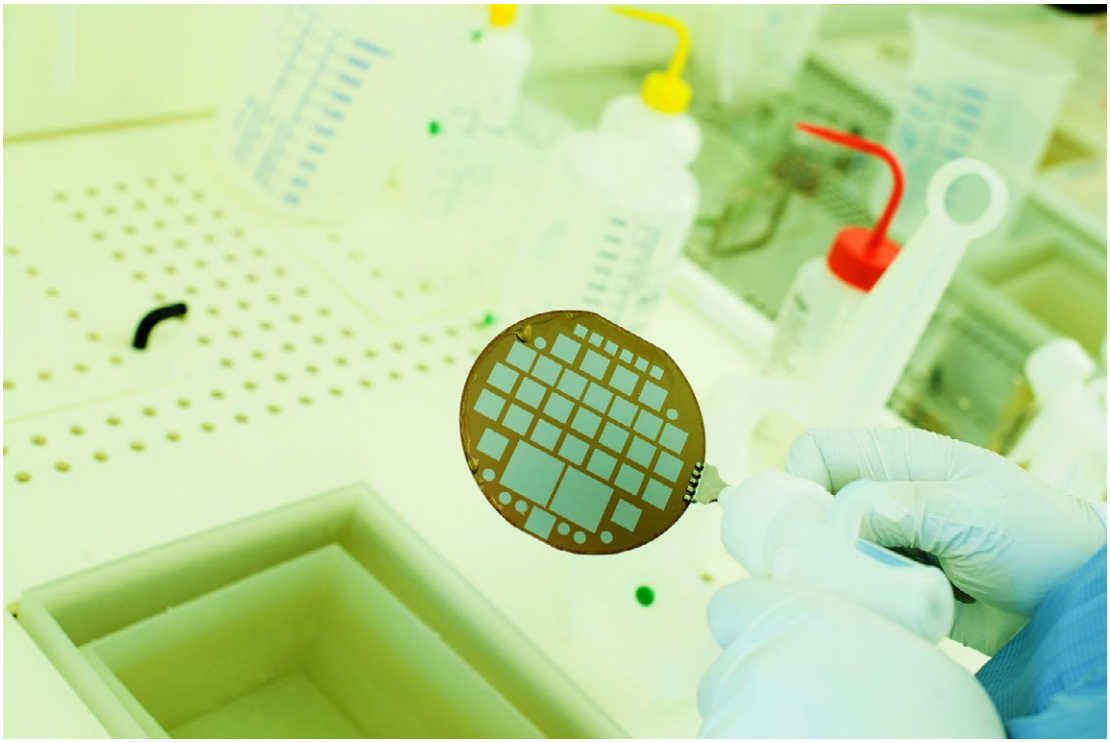
Why Ultrapure Water Demands Ultraprecise Chlorine Analysis



Across a variety of precision-minded industries — semiconductor, pharmaceutical, food, beverage, etc. — concerns about water purity far exceed the demands of municipal drinking water. In applications that depend on reverse osmosis (RO) membranes, and where a delicate chlorination/ dechlorination balance demands extreme sensitivity and reliability, new online chlorine analyzers are smoothing the path to more cost-efficient performance.

With so many potential negative impacts— from chemical costs to RO membrane damage to excessive quality control rejection rates — it is more important than ever to reevaluate both the inputs and outcomes of chlorine measurement and control. Traditionally, either intermittent grab sample analyses or online measurements of oxidation reduction potential (ORP) are employed for chlorine monitoring. The latter method has suffered from too many variables, and previously available online chlorine analyzers could not achieve the required accuracy at ultra-low chlorine ranges to protect RO membranes efficiently. Now, however, the ability of online chlorine analyzers to measure chlorine concentrations directly as low as 0.008 mg/L (8 parts per billion (ppb)) is opening up new opportunities to provide automatic and accurate readings every 2.5 minutes.

The High Stakes Of Chlorine Analysis In Produced Water Applications

Produced water — i.e., water filtered, demineralized, deionized, and prepared for a specific purpose — can affect revenue in several ways, either as a necessity for the manufacturing process (e.g., semiconductor or pharmaceutical manufacturing) or as an integral part of the product itself (e.g., food and beverage production).

Ultrapure produced water typically starts with RO membrane filtration to remove particles down to 0.0005 microns in size, then goes to a demineralization/ deionization process to remove dissolved solids that could compromise the product quality or the process. Proper chlorine dosing is an important part of neutralizing any biological growth that could cause fouling of the RO membrane. But dechlorinating that water — via sodium bisulfite (SBS) addition or by passing through granular activated carbon (GAC) — to prevent damage to chlorine- sensitive polyamide membranes is equally critical. Being able to control that dechlorination process more accurately helps manufacturers protect both their volume and quality of ultrapure water production. It also reduces their risk of downtime caused by shutdowns for an online ultra-low-range (ULR) chlorine analyzer (Figure 1) is advantageous for repetitive, automated measurement

Photo courtesy of Hach.

Figure 1. With automated operation and sufficient reagent storage, new ULR chlorine analyzers can provide precise readings of chlorine concentrations as low as to 8 ppb for up to a month in continuous production line operations.

of chlorine levels in feedwater going into RO membrane, demineralization, and deionization treatments. It lets manufacturers:

- Have confidence in using chlorine to control biofouling that can clog membrane pores.
- Detect chlorine as low as 8 ppb with reliable, accurate, proven colorimetric DPD chemistry sensitive enough to maximize membrane service life.
- Obtain accurate digital readouts of total chlorine levels— including a cumulative chlorine counter that tracks chlorine exposure in ppm-hours — without the influence of temperature or pH variables that plague ORP readings.
- Capitalize on comprehensive diagnostics and flow sensing to monitor ongoing instrument operation and receive notification of unexpected changes.

This comparison sheet shows how significant the difference in the latest generation of online ULR chlorine analyzers can be for a variety of ultrapure water users (Figure 2).

Who Can Benefit From Better Chlorine Analysis For Ultrapure Water Consistency?

- **Semiconductor And Electronics Manufacturing.** With dechlorination being so critical for ultrapure water chemistry as well as protection of critical RO membranes, achieving direct chlorine readings at ultra-low ranges from online sensing provides multiple advantages for primary processes and process water reuse. This ASTM International *Standard Guide for Ultrapure Water Used in the Electronics and Semiconductor Industries* provides water treatment guidelines for achieving increased circuit densities and reducing quality control (QC) rejection rates when growing crystals, slicing wafers, cleaning and etching their surfaces, preparing photomasks, etc.
- **Pharmaceutical Manufacturing.** ULR chlorine analysis helps to achieve cost-effective water treatment for satisfying critical stages of manufacturing and for preparing research formulations for disintegration and dissolution testing. This ASTM International *Standard Specification for Reagent Water* includes detailed specifications for Types I, II, III, and IV water used in various laboratory and pharmaceutical applications to prevent costly waste from high rejection rates of compromised products.
- **Food And Beverage Applications.** In addition to promoting consumer product purity, generating ultrapure water in food and beverage applications affords manufacturers control over the addition of specific minerals to give its products a consistent flavor profile. This is particularly helpful for establishing consistency for flagship global brands, regardless of local water quality where the product is being produced and packaged.

	CL17	CL17sc	Ultra Low Range CL17sc
Accuracy	± 5% or ± 0.04 mg/L (ppm) as Cl_2 (whichever is greater)	± 5% or ± 0.04 mg/L from 0 to 5 mg/L (whichever is greater) as Cl_2 ± 10% from 5 to 10 mg/L as Cl_2	± 5% or ± 0.01 mg/L as Cl_2 (whichever is greater) from 0–4 mg/L ± 10% from 4–5 mg/L as Cl_2
Communication Capabilities	4–2mA Output	Current output, relays and bus communication via SC controller	Current output, relays and bus communication via SC controller
Cycle Time	Fixed 2.5 min.	Fixed 2.5 min.	Fixed 2.5 min.
Dimensions (H x W x D)	45.4 cm x 31.4 cm x 17.9 cm (17.9 in. x 12.4 in x 7.0 in.)	32.9 cm x 34.2 cm x 17.7 cm (12.9 in. x 13.5 in x 7.0 in.)	32.9 cm x 34.2 cm x 17.7 cm (12.9 in. x 13.5 in x 7.0 in.)
Controller	No	Hach SC controllers	Hach SC controllers
Enclosure Rating	IP62	IP66	IP66
Flow Meter	No	Yes	Yes
Measurement Range	0–5 mg/L (ppm)	0–10 mg/L (ppm)	0–5 mg/L (ppm)
Limit of Detection (LOD)	0.03 mg/L (ppm)	0.03 mg/L (ppm)	0.008 mg/L (ppm)

Chart courtesy of Hach.

Figure 2. Building upon proven colorimetric DPD technology from previous generations, next-generation ULR chlorine analyzers provide a more accurate way to automate monitoring of precise chlorine levels in dechlorination processes meant to protect RO membranes.

- **Data Center Cooling.** Another growing application for RO-filtered and deionized makeup water is for closed- circuit cooling water systems at major data centers. It helps to protect the longevity of the infrastructure and the efficiency of thermal transfer by reducing the potential for both biofouling and mineral deposits.

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