ThermoFisher SCIENTIFIC

Ion chromatography

Municipal water analysis by ion chromatography technology summary

Inorganic anions and cations, toxic contaminants, disinfection byproducts

Keywords
Drinking water, surface water, Dionex Inuvion IC system, Dionex ICS-6000 system, oxyhalides, DBP, water analysis

Introduction

Drinking water quality is a universal health concern with global impact. The water discharged by municipal waste water treatment plants and industrial facilities must be monitored to ensure strict compliance with regulatory requirements. These agencies have developed standards for water analysis to assure that communities are consuming only safe drinking water.

The Safe Drinking Water Act (SDWA) is a US federal law which sets legal limits on the levels of certain contaminants in drinking water. Under the SDWA, the United States Environmental Protection Agency (EPA) enforces the National Primary Drinking Water Regulations (NPDWR or primary standards) that apply to all public water systems. The NPDWR mandates maximum concentration levels of certain drinking water contaminants, also called “maximum contaminant levels” or “MCLs.” The EPA also provides a list of acceptable techniques for treating drinking water to reduce regulated contaminants to acceptably low levels. In Europe, the Drinking Water Directive provides the essential quality standards. These quality standards were developed using guidelines from the World Health Organization and the European Commission’s Scientific Advisory Committee. Member States of the European Union can add additional requirements for substance regulation; however, they cannot set lower standards for these substances. The drinking water quality must be reported to the European Commission every three years.

Contaminant levels in drinking water are continuously subject to reassessment by the above regulatory bodies, both in regard to revised levels, as well as the addition of new contaminants to the list of existing regulated substances. For example, perchlorate has been identified as an environmental contaminant found in drinking water which impairs normal thyroid function by interfering with iodine uptake by the thyroid gland.

thermo scientific

Similarly, in 2011 they recommended enhanced monitoring for Hexavalent chromium (Cr(VI)) based on results from an independent survey showing that 35 drinking water samples exceeded the regulatory limits for Cr(VI). Cr(VI) is of particular concern because of its high toxicity as a carcinogen. As a result of this toxicity, some states such as California imposed a more stringent limit of 10 µg/L Cr(VI).

Thermo Fisher Scientific is committed to enhancing the quality of our global water resources. Our Thermo Scientific™ Dionex™ ion chromatography (IC) instruments are used by governmental and industrial laboratories to provide solutions for environmental water testing for a wide range of regulated and emerging inorganic elements and organic compounds. These analytical instruments have evolved over many generations, each providing enhanced performance, greater reliability, and easier operation.

Ground and surface waters are a vital resource for a healthy environment. They are also the largest source of fresh water. These waters can comprise complex matrices that interfere with detection of analytes of interest. Another major challenge for qualifying drinking water is the analysis of disinfection byproducts (DBP) used to make the water potable. Drinking water is treated with disinfectants to remove potentially harmful bacteria. These disinfectants also react with ions and residual organic matter resulting in the formation of DBPs. DBPs are highly toxic, are regulated, and require mitigation of their concentrations prior to distribution of treated water. As the technology leader in IC, we have developed innovative techniques which overcome common challenges in the analysis of drinking water contaminants and DBPs.

As your partner for drinking water analysis, we promise to deliver the technology, experience, and support necessary for you to provide safe drinking water and ultimately protect our environment.

Ion analysis

Since the development of IC analysis in 1975, Thermo Fisher Scientific has continually developed new and innovative IC technology.

Our High-Pressure™ Ion Chromatography (HPIC™) systems include the Dionex ICS-6000 HPIC system which is optimized for flexibility, modularity, and ease-of-use, combining the highest chromatographic resolution with convenience.

Reagent-free ion chromatography (RFIC) eliminates daily tasks of eluent and regenerant preparation, saving time, preventing errors, and increasing convenience. Reagent-free ion chromatography with eluent generation (RFIC-EG) systems use electrolytic technologies to generate eluent on demand from deionized water to the suppressor where the eluent is converted back to pure water, delivering unmatched sensitivity.

At the heart of our IC systems is a unique set of column chemistries that provide high selectivities and efficiencies with excellent peak shape and resolution. Thermo Scientific™ Dionex™ IonPac™ polymeric columns address a variety of chromatographic separation modes including ion exchange, ion exclusion, reversed-phase ion pairing, and ion suppression. Our column chemistries are designed to solve specific application challenges, and we offer a variety of selectivities and capacities for simple to complex sample matrices. Additionally, our Dionex IonPac column line is available in standard bore and microbore formats for the ultimate application flexibility.

Learn more about our IC innovations **thermofisher.com/IC**

The complete family of Thermo Scientific Dionex IC systems.
Left to right: Thermo Scientific™ Dionex™ Inuvion™ Core IC System, Thermo Scientific™ Dionex™ Inuvion™ IC System, Thermo Scientific™ Dionex™ Integrion™ HPIC™ System, Thermo Scientific™ Dionex™ ICS-6000 HPIC System™

HPIC

HPIC systems allow continuous operation up to 5000 psi when configured as an RFIC system for standard and microbore scale flow rates. As a result, these instruments can use high resolution, smaller 4 µm particle-size ion exchange columns which create higher back pressures. Higher backpressures are possible with the Dionex HPIC systems.

The Dionex IonPac 4 µm particle-size columns, in the case of reversed-phase HPLC columns with smaller particles, require higher system operating pressures to utilize these small particle columns. HPIC systems enable the use of 4 µm columns, thus yielding fast separations with short (150 mm) columns and high resolution with standard length (250 mm) columns.

RFIC

Advances in eluent generation and electrolytic suppression technologies are enabling a wider variety of applications and increased productivity. RFIC systems are available with eluent generation in all Thermo Scientific Dionex HPIC systems. These systems combine automated eluent generators and electrolytically regenerated suppressors to electrolytically create the required eluents and regenerants used for IC applications. Laboratories using RFIC systems spend less time on equilibration, calibration, method verification, troubleshooting, and consistency checks because the systems minimize unintentional variations in the preparation of eluents and regenerants.

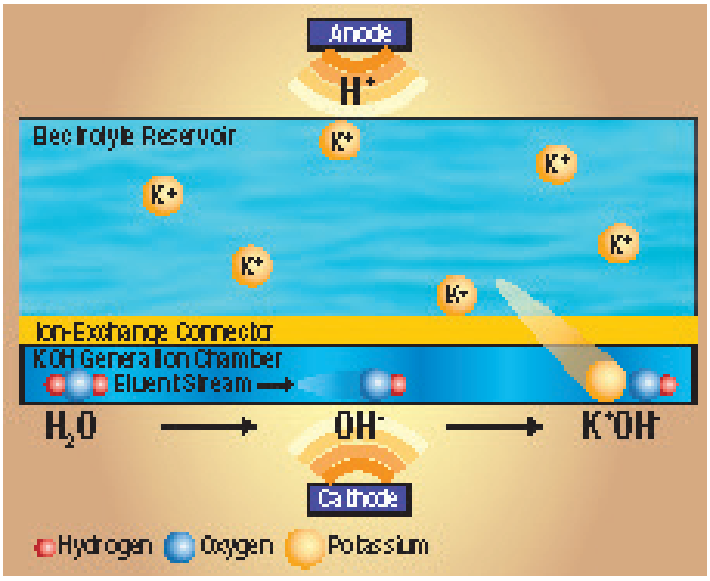
Eluent generation allows the automatic production of high-purity IC eluents. This is made possible through precise control of the electric current applied to the electrolysis of water to generate hydroxide and hydronium ions. Eluent generation eliminates the need to manually prepare eluents from concentrated acids and bases. The only reagent needed is deionized water. Furthermore, because the instrument pump seals and pistons only come in contact with deionized water, overall pump maintenance is significantly reduced.

With eluent generation, a pair of electrodes is positioned with an ion exchange membrane separating them; when a current is applied to the electrodes, electrolysis of water generates hydroxide at the cathode and hydronium at the anode. An ion exchange membrane prevents the species from recombining into water and allows a counter-ion from the Thermo Scientific™ Dionex™ Eluent Generator Cartridge (EGC) to migrate across the membrane to form the eluent. The eluent concentration is varied by changing the applied current to within a given range: 0–100 mM (2 - 4 mm) or 0–200 mM (1 mm). This entire process can be done without the use of extra pumps, fittings, valves, or moving parts.

The EGC is at the core of the patented eluent generation technology used in RFIC-EG systems. A range of Dionex EGC cartridges are available for the production of hydroxide, carbonate, and methanesulfonic acid (MSA) eluents, frequently used for cation-exchange applications. For anion-exchange applications, hydroxide cartridges such as KOH EGC produce potassium hydroxide eluents. The Dionex K_2CO_3 EGC cartridge produces carbonate-only eluent, and the Electrolytic pH Modifier (EPM III) can be added for generating carbonate/bicarbonate eluents.

RFIC-EG systems have redefined IC by making it possible to just add water to operate an IC system. These systems allow for a simpler and more reliable way to deliver superior results while simultaneously saving time and labor. RFIC-EG systems facilitate drinking, waste, and groundwater analyses for regulatory compliance. Furthermore, they provide the accuracy and reproducibility needed for the analysis of high-purity water.

Learn more about our eluent generation solutions.



The KOH EGC cartridge consists of a KOH generation chamber and a K^+ electrolyte reservoir, connected by a cation exchange connector. A high-pressure connector permits the passage of K^+ ions from the K^+ electrolyte reservoir into the electroytic chamber.

References

Useful Links

- U.S. Environmental Protection Agency (EPA). Current Drinking Water Regulations. http://water.epa.gov/lawsregs/rulesregs/sdwa/currentregulations.cfm (accessed November 20, 2024).
- U.S. Environmental Protection Agency (EPA). Safe Drinking Water Act (SDWA). http://water.epa.gov/lawsregs/rulesregs/sdwa/ (accessed November 20, 2024).
- European Commision. The Directive Overview. http://ec.europa.eu/environment/water/water-drink/legislation_en.html (accessed November 20, 2024).
- Thermo Scientific Dionex Product Specification Sheet: Reagent-Free Ion Chromatography Systems with Eluent Regeneration. Sunnyvale, CA, 2010. [Online] https://assets.thermofisher.com/TFS-Assets/CMD/Specification-Sheets/ps-70627-ic-rfic-eg-ps70627-en.pdf (accessed November 20, 2024).
- U.S. Environmental Protection Agency (EPA). Basic Information about Chromium in Drinking Water. https://www.epa.gov/sdwa/chromium-drinking-water (accessed November 20, 2024).
- Thermo Scientific Dionex Brochure: Water Analysis for a Global Market. Sunnyvale, CA, 2010. [Online] http://www.dionex.com/en-us/webdocs/86525-Bro-Water-Analysis-03May2010-LPN2527.pdf (accessed November 20, 2024).
- Jack, Richard., Rohrer, Jeffrey., Chen, Lillian., De Borba, Brian. Review of U.S. EPA Methods for Perchlorate Using Suppressed Conductivity Detection. American Laboratory. [Online] Jan 22, 2013 http://www.americanlaboratory.com/913-Technical-Articles/129226-Review-of-U-S-EPA-Methods-for-Perchlorate-Using-Suppressed-Conductivity-Detection/ (accessed November 20, 2024).
- Jack, Richard., Rohrer, Jeffrey., Basumallick, Lipika. Changes from EPA Method 218.6 to 218.7 Yield Improved Detection Limits for Hexavalent Chromium. LCGC ChromatographyOnline. [Online] Feb 22, 2012 https://www.chromatographyonline.com/view/changes-epa-method-2186-2187-yield-improved-detection-limits-hexavalent-chromium (accessed November 20, 2024).
- Davis, Rachel. Safeguarding Our Water: Another Step Forward in the Battle Against Hexavalent Chromium Blog, June 6, 2024. https://www.thermofisher.com/blog/analyteguru/safeguarding-our-water-another-step-forward-in-the-battle-against-hexavalent-chromium (assessed November 20, 2024).

Learn more at **thermofisher.com/ic**