Disinfection Byproducts

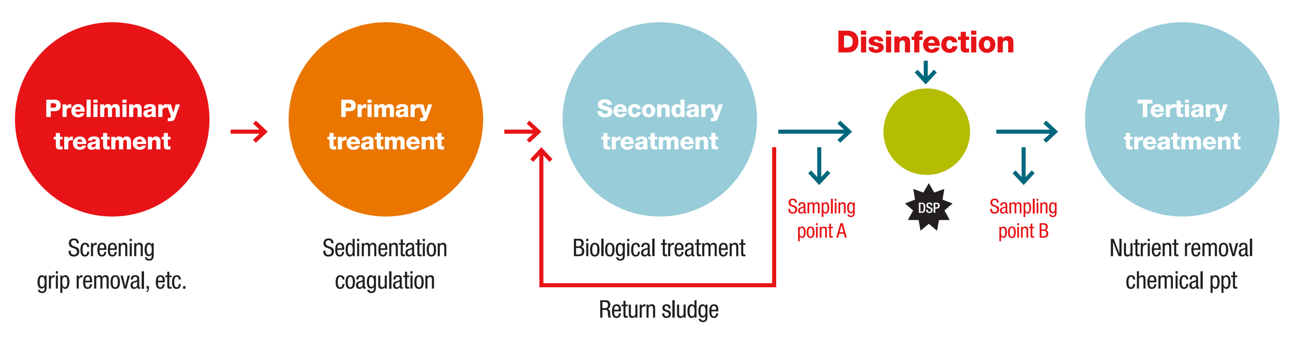
You know the benefits of water treatment. But what are the risks?

Disinfection in the drinking water treatment process aims to inactivate pathogenic microorganisms in water and protect human health. However, the disinfection process, itself, is often accompanied by production of disinfection byproducts (DBPs) that may cause other public health problems. Because unknown risks still exist, including the uncertainty of all organic materials, ongoing research and development to improve standards and implement safer disinfection methods continue to be applied.

WHAT'S REALLY IN YOUR WATER? 1

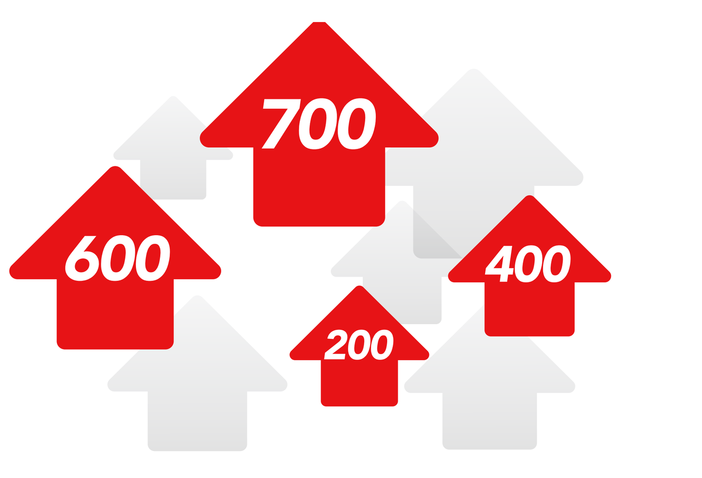
> "When we drink a glass of water, we ingest an unknown number of byproducts that are formed in the treatment process. And we don't know what many of them are. However, using advanced technology, researchers have been able to detect new compounds – where every water treatment plant has a unique combination."
> **-Linkoping University, Sweden**

Drinking water disinfection is getting more and more difficult. The process can be compounded by byproducts that may need to meet certain regulatory standards. How? Read on.



DISINFECTION OF OUR REGULATED CONTAMINANTS IS JUST THE BEGINNING 2

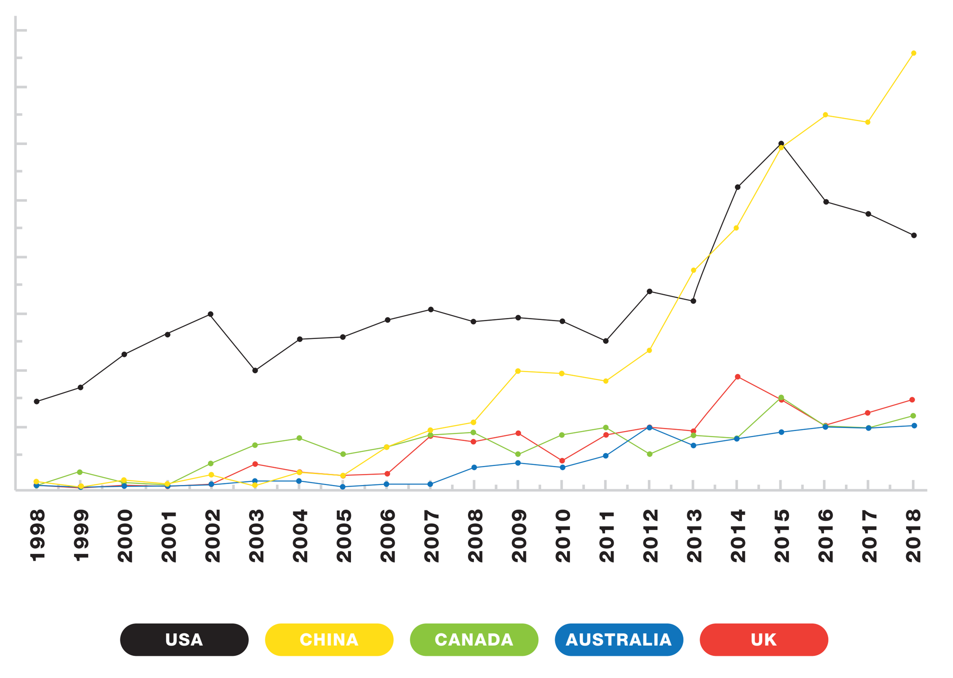
Over 700 DBPs have been identified to date, and many of these are much more toxic than those that may be globally regulated. Drinking water today is not the same as it was in the past. It's being affected more and more by the increasing use of alternative disinfectants such as chloramine, ozone, chlorine dioxide and UV — all of which can form other types of DBPs. In addition, climate change, population increases, wastewater intrusion and energy exploration can all lead to an increased use of disinfectants — negatively impacting our source waters.



The number of DBPs continues to grow, increasing the dangers to human health.

THE NUMBER OF DBP RESEARCH PUBLICATIONS INCREASES EVERY YEAR 3

The Science Citation Index lists 3,750 publications from highly respected institutions focusing on current research and future trends related to DBPs in drinking water. The number of related publications has gradually increased each year. The United States leads the way with 1,405 published articles, followed by China and Canada.



Historical review of DBPs from 1974-2017

- **1974** trihalomethanes
- **1984** chlorite
- **1986** haloacetonitriles
- **1989** haloacetic acids
- **1990** aromatic DBPs
- **1991** furanone
- **1992** aldehydes, bromate, chlorate, halogenated nitromethane, mucochloric acid, chloramine
- **1993** haloketones
- **1994** trichloroethylene
- **1996** cyanogen chloride
- **1997** ketoacids
- **1998** perchlorate
- **1999** cyanogen bromide
- **2001** chloroimides
- **2003** iodo-trihalomethanes
- **2004** chloroformates iodoacetic acid
- **2005** halogenated furanones n-chloroaldimines
- **2006** nitrosamines n-nitrosopiperidine n-nitrosopyrrolidine
- **2007** dimethyldithiocarbamate
- **2008** haloacetamides
- **2009** mucobromic acid
- **2011** bromochlorodimethylhydantoin chlorosyringols methylhydroxylamine perbromate
- **2012** bromamines
- **2013** 2,3-dioxosuccinic acid peroxyacetic acid
- **2015** 13-hydroperoxy-9, 11-octadecadienoic acid
- **2016** halogenated peptides
- **2017** performic acid

Today's questions include whether current screening techniques effectively identify organic compounds that may adversely cause DBPs and whether we're regulating the right DBPs to protect human health. And if the answers are "No" to both questions, what should be done?

The presence of pharmaceuticals, pesticides, personal care products and other organic unknown compounds in drinking water can lead to the formation of potentially carcinogenic disinfection byproducts including HAAs, bromate, chlorate and others during treatment processes such as chlorination, ozonation and UV/hydrogen peroxide.

Pharmaceuticals

Personal care products

Agricultural pesticides

Because water can be infinitely repurposed, this is concerning — and the reason agencies continue to look for alternative treatment processes and adapt how they currently screen for unknown compounds. Countries around the globe continue to update guidelines for DBPs in drinking water as they adopt stricter standards.

Both municipalities and independent laboratories adapt testing strategies to meet demands to ensure water safety quality and cost efficiencies. Government agencies and academic research play a key role in understanding the public health impact and researching new water testing and treatment approaches.

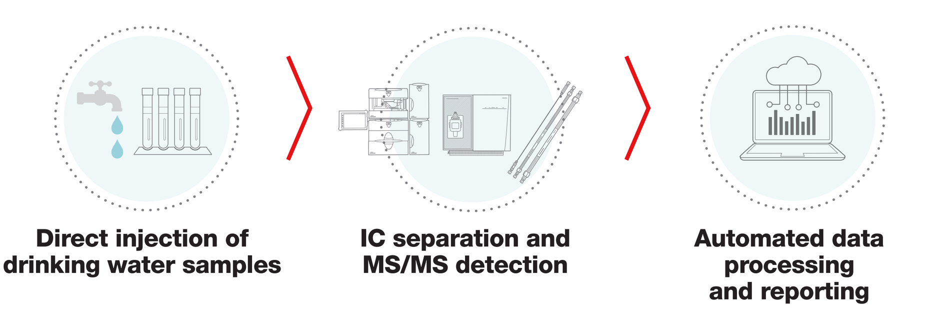
In researching DBPs, three aspects should be given particular attention:
- analytical techniques
- toxicity and health effects
- water quality standards and control methods

Focusing on analytical techniques, it is possible to identify known and unknown emerging DBPs using a number of chromatographic techniques.

ANALYTICAL TECHNIQUES / ADVANCED TECHNOLOGY FOR ANALYZING DPBS 4

Thermo Fisher Scientific offers the only integrated high-performance solutions supported by a single trusted manufacturer for analyzing common DBPs produced in drinking water, providing confidence and time savings. Below are the techniques supported using our IC-MS/MS, gas chromatography and liquid chromatography instrumentation.

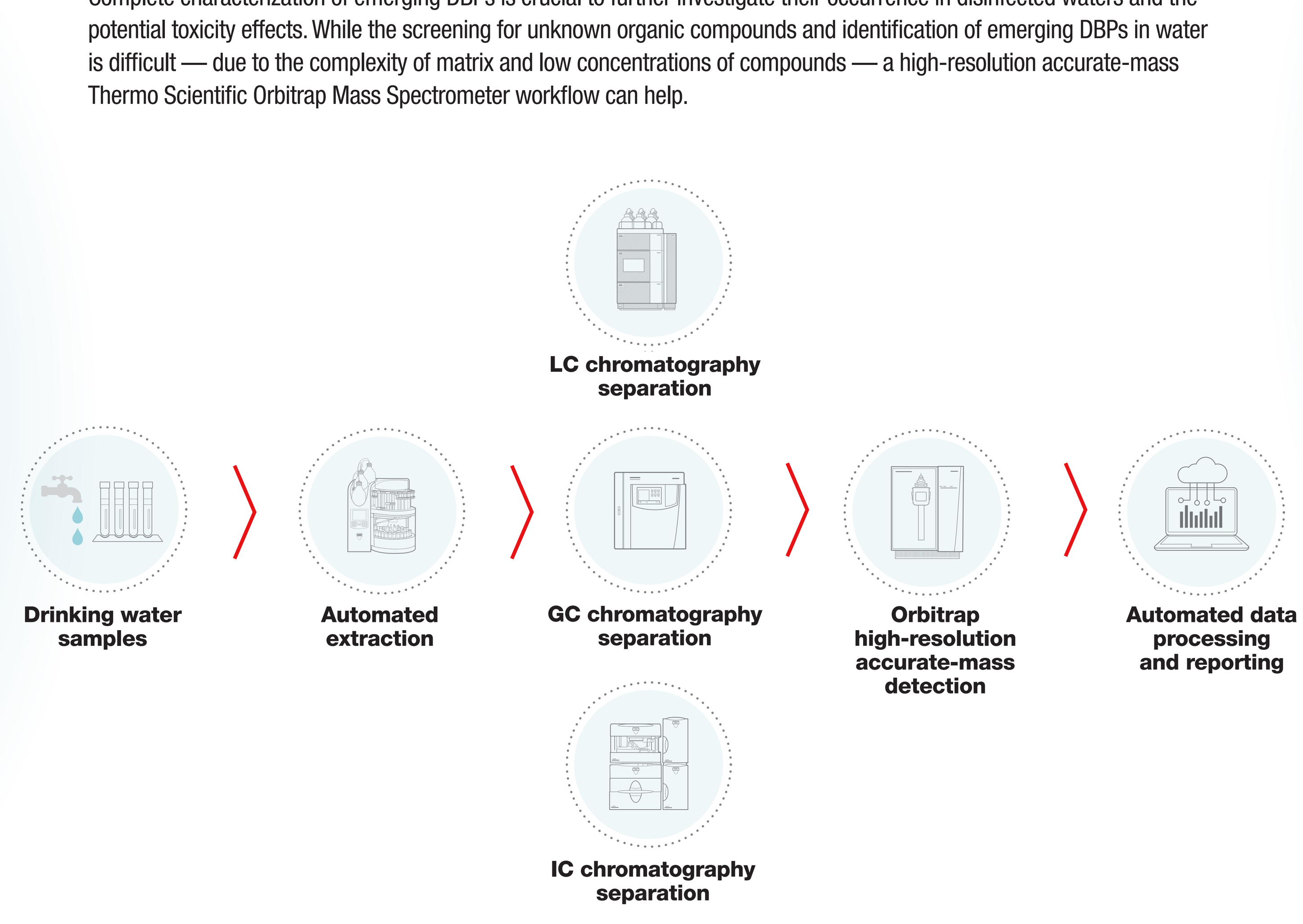
DISINFECTION BYPRODUCTS	ANALYTICAL METHODS (IC OR OTHER METHODS)
TOTAL TRIHALOMETHANES	- EPA 501.1 (GC purge and trap). EPA 502.2 (GC-ECD), (GC)
HAAS	- EPA 552.3 (GC-ECD), EPA 557 (IC-MS)
CHLORITE AND CHLORATE	- EPA 300.0 (B) AND 300.1 (B), ISO 15061, EPA 317.0, E (colorimetric method)
BROMATE	- EPA 300.0 (B), 300.1 (B), ISO 15061;
	- EPA 302 (2-D IC); EPA 317, 326, ISO 11206
	- EPA 321.8 (IC-ICP-MS), EPA 557 (IC-MS)



An example of a validated workflow using IC-MS/MS, in accordance with EPA 557.

DISCOVER EMERGING DISINFECTION BYPRODUCTS 5

Complete characterization of emerging DBPs is crucial to further investigate their occurrence in disinfected waters and the potential toxicity effects. While the screening for unknown organic compounds and identification of emerging DBPs in water is difficult — due to the complexity of matrix and low concentrations of compounds — a high-resolution accurate-mass Thermo Scientific Orbitrap Mass Spectrometer workflow can help.



Look to Thermo Fisher Scientific for the advanced technology to meet your needs.

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