BALAZS™ nanoanalysis

Water Analysis

Speciation of Organic Compounds in Municipal Drinking Waters

Although not all compounds present in water pose health concerns, most organics cause issues in water treatment systems for municipal and industrial applications. Treatment of waters containing organics may be complicated and costly without prior knowledge on the type of compound present. Many methods used for measurement of these compounds are limited in the efficiency and specificity of their analyses. Some methods are very specific for identification of certain compounds, but limited in their ability to detect others. Bulk methods, such as TOC or COD provide good ability to detect most of the organics, as total, but cannot speciate their composition.

In particular Natural Organic Matter (NOM) can pose fouling risks to filters and reverse osmosis systems. Depending on the levels present, organics in drinking water can also cause acute or chronic health problems and have effects on the taste, odor, and color of affected water. Contaminants present in water sources may include:

- Biopolymers and other organic matter from sewage discharge into surface water
- Biopolymers from algal activity
- Chlorinated solvent spills from industrial or residential usage
- Disinfection byproducts from humic matter

Organic Speciation using LC-OCD

NOM is often difficult to measure and treat, yet it has a profound effect on the quality of water and water treatment processes. Balazs™ Nanoanalysis offers organic speciation using liquid chromatography-organic carbon detection (LC-OCD) which provides an effective analysis of organic compounds within the tested water. This method allows for identification of biopolymers, humics, low molecular weight (LMW) acids, volatile organic compounds, and more, while characterizing nearly 100% of the organic composition. LC-OCD is a non-target complementary method to existing target methods for detection of synthetic compounds. When accurate determination of specific compounds is required, more specific techniques may need to be used. LC-OCD analysis can help design treatment systems, monitor changes in water quality, and define solutions for a large array of problems without the need for expensive specialized tests.

Case Study

The LC-OCD method uses multiple detectors to determine the contents of the water sample. Illustrated in Figure 1 are the levels of organic compounds present in three different natural water sources, tested using the LC-OCD method. The figure shows the main difference between surface waters and groundwater. Biopolymer levels in river water are high and have a high nitrogen to carbon ratio, likely stemming from top soil and sewage run-off. Biopolymers in lake water may originate from algal activity and have a low nitrogen to carbon ratio. Groundwaters are free of biopolymers unless there is an underground contamination or ingress of surface water.

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AIR LIQUIDE ELECTRONICS

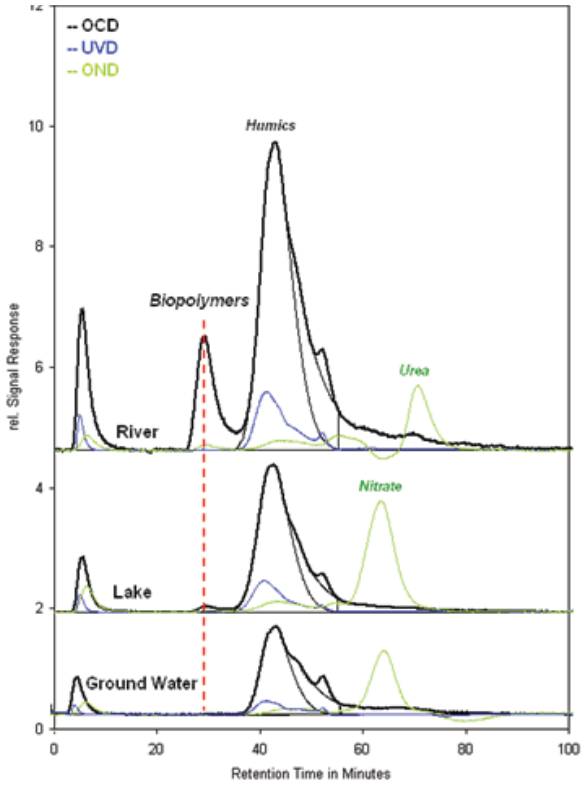

Figure 1. Organic compound analysis for different source waters

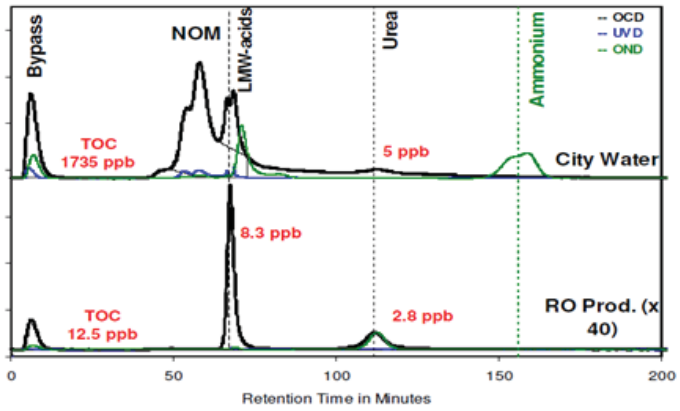

Figure 2. Change in organic content following reverse osmosis

Figure 2 illustrates the change in organic levels for city water after reverse osmosis treatment. High molecular weight (HMW) compounds are being treated effectively by reverse osmosis; however, there is an added risk of fouling. The treatment failed to effectively remove urea and other low molecular weight (LMW) neutral compounds.

LC-OCD Method Overview and Definitions

The LC-OCD process begins with the injection of a small sample into a size exclusion chromatography column where HMW compounds are separated from LMW compounds. The sample is then fed to UV and organic nitrogen detectors, where all compounds containing nitrogen will be analyzed. A UV thin film reactor serves as the heart of the process where organic compounds are oxidized producing carbon dioxide, whereas the originally present CO_2 is removed through acidification and N_2 sparging. The resulting CO_2 is measured using a non-dispersive infrared detector (NDIR). The output of this analysis is a report containing the chromatogram (see Figure 2) and the spreadsheet providing organic speciation to the following content:

DOC – Dissolved Organic Carbon
DON – Dissolved Organic Nitrogen
HOC – Hydrophobic Organic Carbon (organic compounds that do not elute during the period of time of the test)
CDOC – Chromatographic (hydrophilic) Dissolved Organic Carbon (organic compounds that elute completely during the period of time of the test)
NOM – Natural Organic Matter
SOM – Synthetic Organic Matter > 10 ppb

Quantification and Characterization of

- Humics
- Biopolymers
- Building Blocks
- LMW-acids

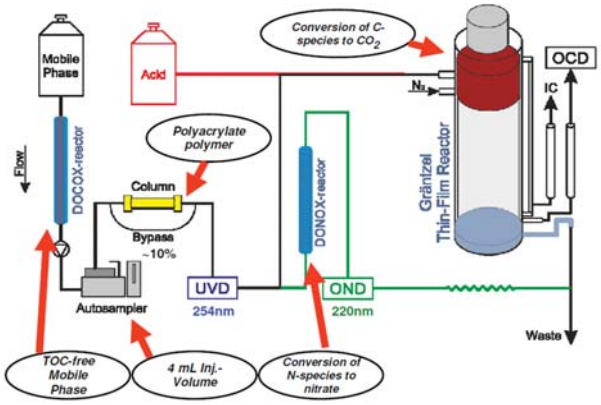

Figure 3. LC-OCD schematic diagram

In addition to the above categories, specific organic compounds are identified based on the instrument library, characterized by chromatography retention time, nitrogen content, and presence of unsaturated bonds (identified by UV detector). Balazs™ also includes interpretations help for practical conclusions.

References

- Huber, S.A.; Balz, A.; Abert, M., Pronk, W.: Characterisation of aquatic humic and non-humic matter with size-exclusion chromatography - Organic Carbon Detection - Organic Nitrogen Detection (LC-OCD-OND). Water Research 45 (2011), 879-885.
- Huber, S.A., Balz, A., Abert, M.: New method for urea analysis in surface and tap waters with LCOCD-OND (liquid chromatography-organic carbon detection-organic nitrogen detection). Aqua, 60.3, (2011), 159-165.
- Libman V. and Huber S. Part 1: An Overview of LC-OCD - Organic Speciation For Critical Analytical Tasks In the Semiconductor Industry ULTRAPURE WATER® , May/June 2014