USEPA method 415.3: Quantifying TOC, DOC, and SUVA

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The US Environmental Protection Agency (USEPA) has developed a reproducible method that supports the monitoring requirements found in the Disinfectants/Disinfection Byproducts Rule (D/DBPR). Method 415.3 provides for the quantification of total organic carbon (TOC) and dissolved organic carbon (DOC) in source waters and drinking waters, as well as the determination of specific ultraviolet absorbance (SUVA) at 254 nm, protocols for inorganic carbon interference removal, and DOC filter evaluation and selection.

Disinfectants such as chlorine and ozone are used in the production of drinking water to reduce the risk of microbial disease. However, these disinfectants also react with the natural organic matter (NOM) present in the water to form disinfection by-products (DBPs) that pose possible long-term health risks. The number and nature of DBPs make it difficult to fully characterize all of the by-products formed during treatment; therefore, it is more cost-effective to minimize the formation of DBPs rather than to remove them after they have formed.

One technique that has been used to control DBP formation is to reduce the amount of NOM available for reaction with the disinfectants. Because TOC is often used as a surrogate indicator of NOM, the D/DBPR (USEPA, 1998) requires water systems that treat surface water to remove a percentage of the TOC in the source water influent based on concentration and alkalinity. Many drinking water utilities are using enhanced coagulation/softening in the treatment process to improve removal of DBP precursors and are monitoring compliance by comparing raw and finished water TOC levels.

An alternative compliance criterion for the D/DBPR precursor removal requirement is to monitor source water by SUVA. SUVA is an indicator of the aromatic content of DOC (Weishaar et al., 2003; Krasner et al., 1996) and is considered a useful predictor of TOC removal by coagulation (Archer & Singer, 2006). SUVA is calculated by dividing the ultraviolet (UV) absorbance measurement of a 0.45-µm filtered sample at 254 nm (UVA_254_) by the DOC concentration and multiplying by 100 to give a value reported as litres per milligram of carbon per meter. Low SUVA values (≤ 2 L/mg-m) are generally indicative of water that is not amenable to enhanced coagulation.

BACKGROUND

The work reported here was initiated at the request of the USEPA Office of Ground Water and Drinking Water in Washington, D.C., to assist water systems in demonstrating compliance with the quality control (QC) requirements and procedures outlined in the D/DBPR for TOC, DOC, UVA_254_, filter blanks, sample collection, preservation, holding times, and detection limits. The QC requirements and procedures established by the D/DBPR served as method performance goals and guidance during the development of USEPA method 415.3, revision 1.1 (USEPA, 2005).

This article details the results of experiments performed during the development of method 415.3 (USEPA, 2005) and explains features of the revised method. The method uses the same technologies already approved for TOC, DOC, and UVA_254_ analyses (Standard Methods, 1998a, 1998b) and documents the accuracy and precision that can be expected when proper QC procedures are implemented. The method was developed with an emphasis on comprehensive QC, including an initial demonstration of capability, which ensures the method is functioning properly (i.e., when a new instrument is set up or a new analyst trained) before data are collected.

Three main objectives were established to optimize and establish method performance: perform side-by-side comparisons of the major instrument technologies available for TOC analyses in order to define their performance capabilities and reduce the percent relative difference between TOC instrument responses, incorporate information needed for a SUVA determination into one method rather than separate UV and DOC methods, and develop a filtration protocol to assist in the selection and preparation of filters before use.

During method development experiments, it was determined that significant error in the quantification of TOC and DOC can be reduced by removing the inorganic carbon in advance of analysis. Although the membrane filters tested during method development varied in...
extractable TOC, given time, the background for most of the membranes could be eliminated by washing with deionized water. Background problems can occur frequently when it becomes necessary to mount an individual membrane in a reusable apparatus. In these cases, the apparatus must be thoroughly cleaned (preferably by muffle furnace) between samples, or disposable filtration units must be used.

A schematic of the filter blank preparation is depicted in Figure 1. Figure 2 shows a schematic of method sample preparation steps.

**CONCLUSION**

Method 415.3 (USEPA, 2005) fulfills the goal of USEPA's Office of Ground Water and Drinking Water to develop an improved method for the analysis of TOC, DOC, and SUVA in support of the monitoring requirements of the D/DBPR (USEPA, 1998) and was ultimately approved as part of the Stage 2 D/DBPR (USEPA, 2006). The method introduced formal QC protocols for ensuring the reproducibility of TOC and DOC analyses and improving the reliability of SUVA determinations. In addition, the method allows the analyst to use alternate filter type, apparatus, filtration, and inorganic carbon procedures, provided equivalent results are achieved.

**REFERENCES**


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