



Designation: D5904 – 02 (Reapproved 2024)

Standard Test Method for Total Carbon, Inorganic Carbon, and Organic Carbon in Water by Ultraviolet, Persulfate Oxidation, and Membrane Conductivity Detection¹

This standard is issued under the fixed designation D5904; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of total carbon (TC), inorganic carbon (IC), and total organic carbon (TOC) in water in the range from 0.5 mg/L to 30 mg/L of carbon. Higher levels may be determined by sample dilution. The test method utilizes ultraviolet-persulfate oxidation of organic carbon, coupled with a CO₂ selective membrane to recover the CO₂ into deionized water. The change in conductivity of the deionized water is measured and related to carbon concentration in the oxidized sample. Inorganic carbon is determined in a similar manner without the requirement for oxidation. In both cases, the sample is acidified to facilitate CO₂ recovery through the membrane. The relationship between the conductivity measurement and carbon concentration is described by a set of chemometric equations for the chemical equilibrium of CO₂, HCO₃⁻, H⁺, and the relationship between the ionic concentrations and the conductivity. The chemometric model includes the temperature dependence of the equilibrium constants and the specific conductances.

1.2 This test method has the advantage of a very high sensitivity detector that allows very low detection levels on relatively small volumes of sample. Also, use of two measurement channels allows determination of CO₂ in the sample independently of organic carbon. Isolation of the conductivity detector from the sample by the CO₂ selective membrane results in a very stable calibration, with minimal interferences.

1.3 This test method was used successfully with reagent water spiked with sodium bicarbonate and various organic materials. It is the user's responsibility to ensure the validity of this test method for waters of untested matrices.

1.4 This test method is applicable only to carbonaceous matter in the sample that can be introduced into the reaction zone. The injector opening size generally limits the maximum size of particles that can be introduced.

1.5 In addition to laboratory analyses, this test method may be applied to on line monitoring.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

- [D1129 Terminology Relating to Water](#)
- [D1192 Guide for Equipment for Sampling Water and Steam in Closed Conduits \(Withdrawn 2003\)](#)³
- [D1193 Specification for Reagent Water](#)
- [D2777 Practice for Determination of Precision and Bias of Applicable Test Methods of Committee D19 on Water](#)
- [D3370 Practices for Sampling Water from Flowing Process Streams](#)
- [D5810 Guide for Spiking into Aqueous Samples](#)
- [D5847 Practice for Writing Quality Control Specifications for Standard Test Methods for Water Analysis](#)

3. Terminology

3.1 *Definitions:*

¹ This test method is under the jurisdiction of ASTM Committee [D19](#) on Water and is the direct responsibility of Subcommittee [D19.06](#) on Methods for Analysis for Organic Substances in Water.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

3.1.1 For definitions of terms used in this standard, refer to Terminology D1129.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *inorganic carbon (IC)*, *n*—carbon in the form of carbon dioxide, carbonate ion, or bicarbonate ion.

3.2.2 *potassium hydrogen phthalate (KHP)*, *n*— $\text{KHC}_8\text{H}_4\text{O}_4$.

3.2.3 *refractory material*, *n*—that which cannot be oxidized completely under the test method conditions.

3.2.4 *total carbon (TC)*, *n*—the sum of IC and TOC.

3.2.5 *total organic carbon (TOC)*, *n*—carbon in the form of organic compounds.

4. Summary of Test Method

4.1 *Fundamentals*—Carbon can occur in water as inorganic and organic compounds. This test method can be used to make

independent measurements of IC and TC and can also determine TOC as the difference of TC and IC. If IC is high relative to TOC it is desirable to use a vacuum degassing unit to reduce the IC concentration as part of the measurement. Alternatively, the IC can be removed by acidifying and sparging the sample prior to injection into the instrument.

4.2 The basic steps of this test method are:

4.2.1 Removal of IC, if desired, by vacuum degassing;

4.2.2 Conversion of remaining inorganic carbon to CO_2 by action of acid in both channels and oxidation of total carbon to CO_2 by action of acid-persulfate, aided by ultraviolet (UV) radiation in the TC channel;

4.2.3 Detection of CO_2 that is swept out of the reactors by the liquid stream over membranes that allow the specific passage of CO_2 to high purity water where change in conductivity is measured; and

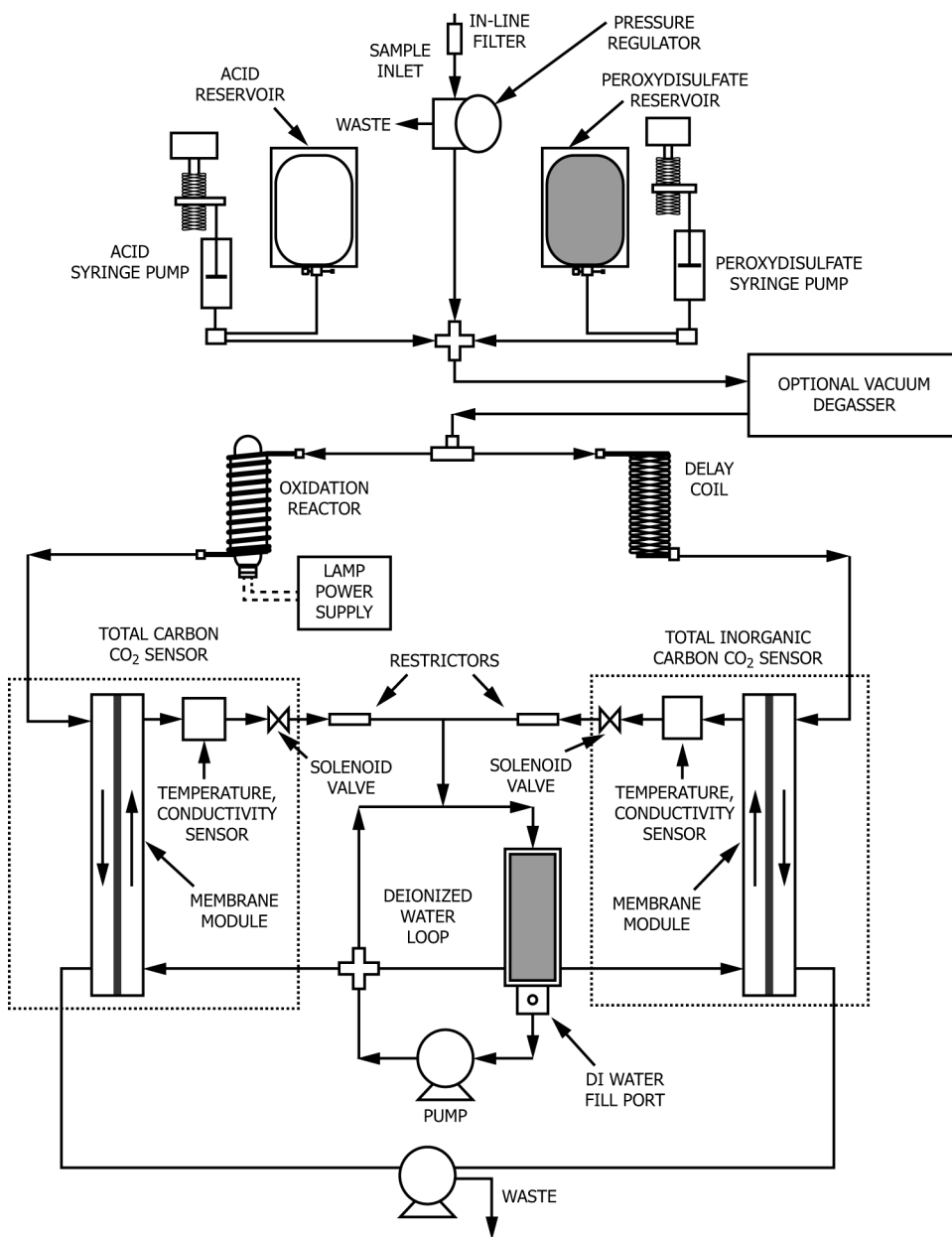


FIG. 1 Schematic Diagram of TOC Analyzer System