METHOD #: 415.1	Approved for NPDES (Editorial Revision 1974)	
TITLE:	Organic Carbon, Total (Combustion Or Oxidation)	
ANALYTE:	CAS # Total Organic Carbon (TOC) C 7440-44-0	
INSTRUMENTATION:	N/A	
STORET No.	Total 00680 Dissolved 00681	

- 1.0 Scope and Application
  - 1.1 This method includes the measurement of organic carbon in drinking, surface and saline waters, domestic and industrial wastes. Exclusions are noted under Definitions and Interferences.
  - 1.2 The method is most applicable to measurement of organic carbon above 1 mg/L.
- 2.0 Summary of Method
  - 2.1 Organic carbon in a sample is converted to carbon dioxide  $(CO_2)$  by catalytic combustion or wet chemical oxidation. The  $CO_2$  formed can be measured directly by an infrared detector or converted to methane  $(CH_4)$  and measured by a flame ionization detector. The amount of  $CO_2$  or  $CH_4$  is directly proportional to the concentration of carbonaceous material in the sample.
- 3.0 Definitions
  - 3.1 The carbonaceous analyzer measures all of the carbon in a sample. Because of various properties of carbon-containing compounds in liquid samples, preliminary treatment of the sample prior to analysis dictates the definition of the carbon as it is measured. Forms of carbon that are measured by the method are:
    - A) soluble, nonvolatile organic carbon; for instance, natural sugars.
    - B) soluble, volatile organic carbon; for instance, mercaptans.
    - C) insoluble, partially volatile carbon; for instance, oils.
    - D) insoluble, particulate carbonaceous materials, for instance; cellulose fibers.
    - E) soluble or insoluble carbonaceous materials adsorbed or entrapped on insoluble inorganic suspended matter; for instance, oily matter adsorbed on silt particles.
  - 3.2 The final usefulness of the carbon measurement is in assessing the potential oxygen demanding load of organic material on a receiving stream. This statement applies whether the carbon measurement is made on a sewage plant effluent, industrial waste, or on water taken directly from the stream. In this light, carbonate and bicarbonate carbon are not a part of the oxygen demand in the stream and therefore should be discounted in the final calculation or

removed prior to analysis. The manner of preliminary treatment of the sample and instrument settings defines the types of carbon which are measured. Instrument manufacturer's instructions should be followed.

## 4.0 Sample Handling and Preservation

- 4.1 Sampling and storage of samples in glass bottles is preferable. Sampling and storage in plastic bottles such as conventional polyethylene and cubitainers is permissible if it is established that the containers do not contribute contaminating organics to the samples.
  NOTE 1: A brief study performed in the EPA Laboratory indicated that distilled water stored in new, one quart cubitainers did not show any increase in organic carbon after two weeks exposure.
- 4.2 Because of the possibility of oxidation or bacterial decomposition of some components of aqueous samples, the lapse of time between collection of samples and start of analysis should be kept to a minimum. Also, samples should be kept cool (4°C) and protected from sunlight and atmospheric oxygen.
- 4.3 In instances where analysis cannot be performed within two hours (2 hours) from time of sampling, the sample is acidified (pH  $\leq$  2) with HCl or H<sub>2</sub>SO<sub>4</sub>.

## 5.0 Interferences

- 5.1 Carbonate and bicarbonate carbon represent an interference under the terms of this test and must be removed or accounted for in the final calculation.
- 5.2 This procedure is applicable only to homogeneous samples which can be injected into the apparatus reproducibly by means of a microliter type syringe or pipette. The openings of the syringe or pipette limit the maximum size of particles which may be included in the sample.
- 6.0 Apparatus
  - 6.1 Apparatus for blending or homogenizing samples: Generally, a Waring-type blender is satisfactory.
  - 6.2 Apparatus for total and dissolved organic carbon:
    - 6.2.1 A number of companies manufacture systems for measuring carbonaceous material in liquid samples. Considerations should be made as to the types of samples to be analyzed, the expected concentration range, and forms of carbon to be measured.
    - 6.2.2 No specific analyzer is recommended as superior.
- 7.0 Reagents
  - 7.1 Distilled water used in preparation of standards and for dilution of samples should be ultra pure to reduce the carbon concentration of the blank. Carbon dioxide-free, double distilled water is recommended. Ion exchanged waters are not recommended because of the possibilities of contamination with organic materials from the resins.
  - 7.2 Potassium hydrogen phthalate, stock solution, 1000 mg carbon/liter: Dissolve 0.2128 g of potassium hydrogen phthalate (Primary Standard Grade) in

distilled water and dilute to 100.0 mL.

NOTE 2: Sodium oxalate and acetic acid are not recommended as stock solutions.

- 7.3 Potassium hydrogen phthalate, standard solutions: Prepare standard solutions from the stock solution by dilution with distilled water.
- 7.4 Carbonate-bicarbonate, stock solution, 1000 mg carbon/liter: Weigh 0.3500 g of sodium bicarbonate and 0.4418 g of sodium carbonate and transfer both to the same 100 mL volumetric flask. Dissolve with distilled water.
- 7.5 Carbonate-bicarbonate, standard solution: Prepare a series of standards similar to step 7.3.

NOTE 3: This standard is not required by some instruments.

7.6 Blank solution: Use the same distilled water (or similar quality water) used for the preparation of the standard solutions.

## 8.0 Procedure

- 8.1 Follow instrument manufacturer's instructions for calibration, procedure, and calculations.
- 8.2 For calibration of the instrument, it is recommended that a series of standards encompassing the expected concentration range of the samples be used.
- 9.0 Precision and Accuracy
  - 9.1 Twenty-eight analysts in twenty-one laboratories analyzed distilled water solutions containing exact increments of oxidizable organic compounds, with the following results:

Increment as	Precision as	Accuracy as		
TOC	Standard Deviation	Bias,	Bias,	
mg/liter	TOC, mg/liter	%	mg/liter	
4.9	3.93	+15.27	+0.75	
107	8.32	+1.01	+1.08	
(EWDCA Mathe of Studes 9 Demond Anglence)				

(FWPCA Method Study 3, Demand Analyses)

## Bibliography

- 1. Annual Book of ASTM Standards, Part 31, "Water", Standard D 2574-79, p 469 (1976).
- 2. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 532, Method 505, (1975).