Organic Carbon, Total

For water and wastewater **Direct Method**

Introduction

Total Organic Carbon (TOC) testing is important in drinking water treatment as an indicator of potential disinfection by-product formation. In wastewater, TOC is valuable as a surrogate for COD testing and has applications in domestic wastewater pre-treatment standards, effluent discharge limitations, and industrial process waters.

The colorimetric TOC test measures the total amount of non-volatile organic carbon in a sample. The method is based on controlled digestion/diffusion in a sealed glass assembly*. Sample carbon is oxidized to carbon dioxide by persulfate oxidation. The carbon dioxide diffuses into a colored pH indicator solution where it is converted into carbonic acid. The resulting color change is proportional to the concentration of carbon present in the sample.

Chemical reactions

Inorganic carbon is removed from the sample by adjusting the sample to pH 2 with a buffer, and stirring vigorously for 10 minutes:

TOC = Total Carbon – Inorganic Carbon

A suitable volume of treated sample and potassium persulfate is added to a 16-mm screw top digestion vial containing Acid Digestion Solution Reagent. A 9-mm sealed glass ampule containing the TOC Indicator Solution is opened and placed inside the digestion vial. The whole assembly is then sealed with a screw cap and digested at 103–105èC (217–221 °F) for 2 hours.

In the presence of acidic persulfate and with increased pressure and elevated temperature, the sample's organic carbon is oxidized to carbon dioxide. For example, in the persulfate digestion of a sample that contains formate, the chemical reaction is:

$S_2O_8^{2-} + HCOO^- \text{ ç } HSO_4^- + SO_4^{2-} + CO_2$

The evolved CO_2 then diffuses and is trapped in an aqueous solution containing a pH indicator. The absorbed CO_2 forms carbonic acid according to:

$CO_2 + H_2O \text{ ç } 2H^+ + CO_3^{2-}$

The pH indicator (prior to CO_2 absorption) is in its deprotonated, or basic, form ($D^{-)}$. As the absorbed CO_2 level increases, the hydrogen ion level will also increase, resulting in an increase of the protonated form of the indicator:

D^- (Color A) + H^+ ç DH (Color B)

The concentration of the carbon in the sample is proportional to the color change, either the change in Color A (DD^-), or the change Color B (DDH) or the sum (DD^- + DDH).

* U.S. Patent 6,368,870