Instrumental Technique

Total Organic Carbon Analyzer

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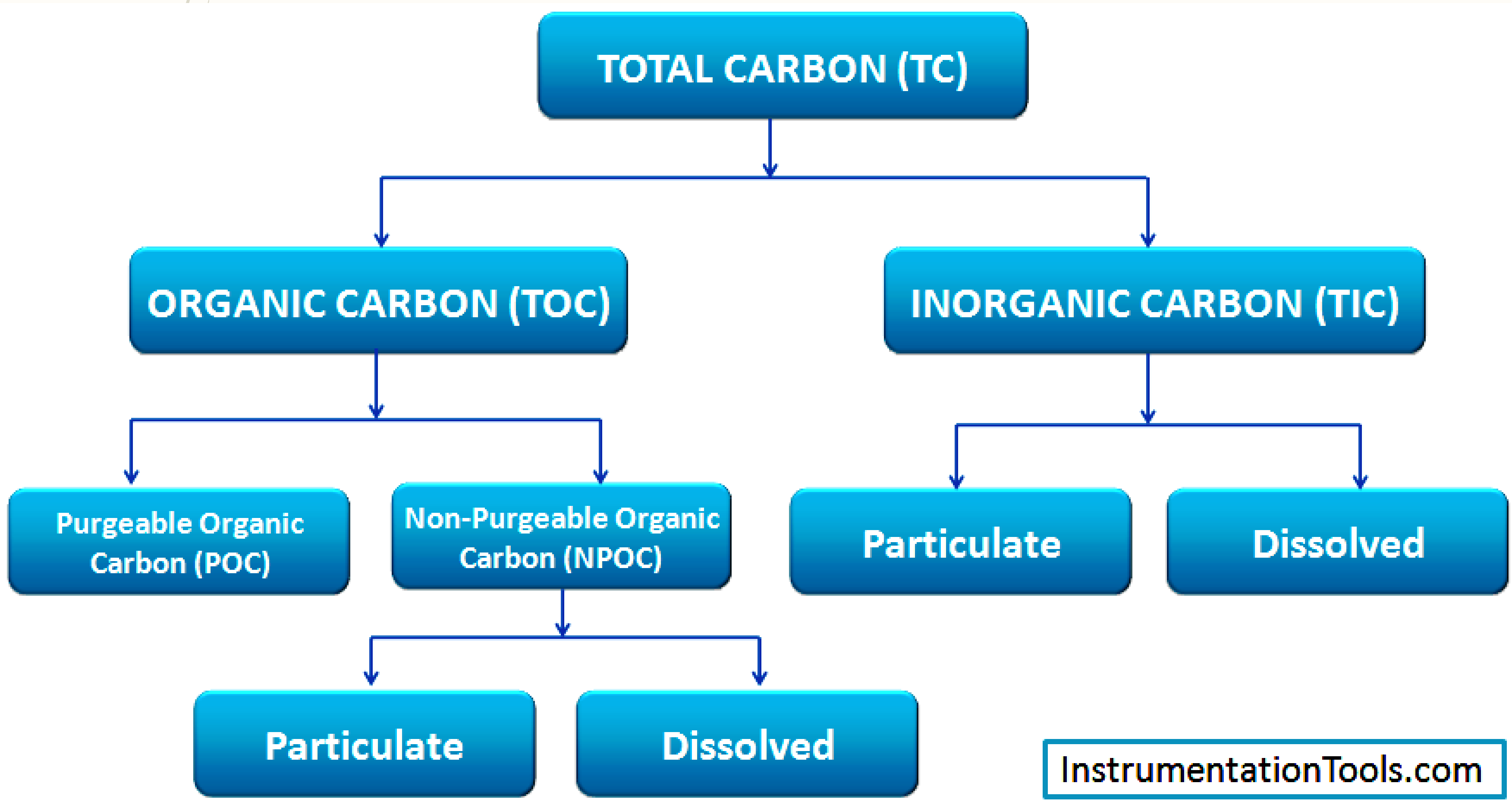
- Total organic carbon (TOC) is the amount of carbon found in an organic compound and is often used as a non-specific indicator of water quality or cleanliness of pharmaceutical manufacturing equipment.
- Since the early 1970s, TOC has been an analytic technique used to measure water quality during the drinking water purification process. TOC in source waters comes from decaying natural organic matter (NOM) as well as synthetic sources.
- Humic acid, fulvic acid, amines, and urea are examples of NOM.
- Detergents, pesticides, fertilizers, herbicides, industrial chemicals, and chlorinated organics are examples of synthetic sources.
- Before source water is treated for disinfection, TOC provides an estimate of the amount of NOM in the water source.



TOTAL CARBON (TC)
ORGANIC CARBON (TOC)
INORGANIC CARBON (TIC)
Purgeable Organic Carbon (POC)
Non-Purgeable Organic Carbon (NPOC)
Particulate
Dissolved
Particulate
Dissolved
InstrumentationTools.com

A **total organic carbon analyzer** determines the amount of carbon in a water sample. By acidifying the sample and flushing with nitrogen or helium the sample removes inorganic carbon, leaving only organic carbon sources for measurement. There are two types of analyzers. One uses combustion and the other chemical oxidation. This is used as a water purity test, as the presence of bacteria introduces organic carbon

Since all TOC analyzers only actually measure total carbon, TOC analysis always requires some accounting for the inorganic carbon that is always present. One analysis technique involves a two-stage process commonly referred to as TC-IC. It measures the amount of inorganic carbon (IC) evolved from an acidified aliquot of a sample and also the amount of total carbon (TC) present in the sample. TOC is calculated by subtraction of the IC value from the TC the sample.

The analysis of TOC may be broken into three main stages:

- Acidification
- Oxidation
- Detection and Quantification

Acidification
Addition of acid and inert-gas sparging allows all bicarbonate and carbonate ions to be converted to carbon dioxide, and this IC product vented along with any POC that was present.

Oxidation
The second stage is the oxidation of the carbon in the remaining sample in the form of carbon dioxide (CO2) and other gases. Modern TOC analyzers perform this oxidation step by several processes:

High Temperature Combustion
High temperature catalytic oxidation (HTCO)
Photo-oxidation alone
Thermo-chemical oxidation
Photo-chemical oxidation
Electrolytic Oxidation

Detection and quantification
Accurate detection and quantification are the most vital components of the TOC analysis process. Conductivity and non-dispersive infrared (NDIR) are the two common detection methods used in modern TOC analyzers.

2350 cm^{-1}

Combustion

In a combustion analyzer, half of the sample is injected into a chamber where it is acidified, usually with phosphoric acid, to turn all of the inorganic carbon into carbon dioxide as per the following reaction:[clarification needed]

$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons 2H^+ + CO_3^{2-}$

This is then sent to a detector for measurement. The other half of the sample is injected into a combustion chamber which is raised to between 600–700 °C, some even up to 1200 °C. Here, all the carbon reacts with oxygen, forming carbon dioxide. It's then flushed into a cooling chamber, and finally into the detector. Usually, the detector used is a non-dispersive infrared spectrophotometer. By finding the total inorganic carbon and subtracting it from the total carbon content, the amount of organic carbon is determined.

Chemical oxidation

Chemical oxidation analyzers inject the sample into a chamber with phosphoric acid followed by persulfate. The analysis is separated into two steps.
One removes inorganic carbon by acidification and purging. After removal of inorganic carbon persulfate is added and the sample is either heated or bombarded with UV light from a mercury vapor lamp. Free radicals form persulfate and react with any carbon available to form carbon dioxide. This method is often used in online applications because of its low maintenance requirements.

Oxidation	Detection Technique	Analytical Range	Official Methods
UV/persulfate	NDIR	0.002 to 10,000 mg/L	EPA 415.1, 9060A Standard Methods 5310C ASTM D2579, ISO (Draft) 8245, AOAC 973.47, USP 643
Heated persulfate	NDIR	0.002 to 1,000 mg/L	EPA 415.1, 9060A Standard Methods 5310C ASTM D2579, ISO (Draft) 8245, AOAC 973.47, USP 643
Combustion	NDIR	0.004 to 25,000 mg/L	EPA 415.1, 9060A Standard Methods 5310B ASTM D2579, ISO (Draft) 8245, AOAC 973.47, USP 643
UV/persulfate	Membrane/conductivity	0.0005 to 50 mg/L	Standard Methods 5310C, USP 643
UV	Conductivity or NDIR	0.0005 to 0.5 mg/L	USP 643

Thank you