

Sensors vs. Analyzers for TOC testing: Do you know the difference?

Pharmaceutical companies rely on instrumentation to measure total organic carbon (TOC) to ensure compendial compliance before releasing water and equipment for the manufacturing of drug product. The two primary instruments used for measuring TOC include sensors and analyzers. The difference between TOC sensors and analyzers is the method and process in which TOC is measured within the instrument.

What is a TOC Sensor?

TOC sensors use direct, or non-selective, conductometric technology to quantify TOC. Conductivity readings before and after oxidation of the test sample generate a TOC measurement that is derived from an algorithm assuming the measured conductivity is a function of organic carbon's conversion to CO_2 . Because the conductivity of a solution is a function of the concentration of ions, the type of ions, and temperature, erroneous TOC measurements arise through neglecting to detect the difference between ions and their concentration. Ultimately, these interfering ions will cause over- or under-reporting of TOC due to their effect on conductivity measurements. Additionally, there is no differentiation between CO_2 from inorganic carbon (IC) and organic carbon as required by USP <643>.



What is a TOC Analyzer?

TOC analyzers often employ membrane conductometric technology to quantify TOC. A gas-permeable membrane is incorporated in membrane conductometric analyzers to isolate CO_2 produced from the oxidation of organic compounds. As CO_2 diffuses through the membrane, it dissolves in deionized water to produce bicarbonate, carbonate, and hydrogen ions that can be detected and quantified through a conductivity measurement; therefore, complying with USP <643>. The membrane's selectively permeable properties mitigate ionic interference experienced with TOC sensors, improving accuracy and precision of TOC measurements.



Characteristics & Applications of TOC Sensors and Analyzers

The differentiating characteristics of sensors vs. analyzers align with their respective applications. Sensors are more commonly limited to monitoring applications and analyzers are leveraged for applications that require process control and reporting. The table below indicates the characteristics and applications of sensors and analyzers.

	TOC Sensors	TOC Analyzer
General Characteristics	Less Accurate	More Accurate
	Faster Response	Fast Response
	Less Sensitive	Sensitive
	Harder to maintain data integrity	Easier to maintain data integrity
Potential Applications	Process Monitoring	Process Control
	Diagnostics	Process Validation
	Trending	Quality Management
		Cleaning Validation
		Real Time Release

Understanding the difference between TOC sensors and analyzers is essential when deciding which technology to integrate into pharmaceutical water testing/monitoring practices. While sensors are more cost effective and accommodate faster response time, analyzers' ability to report on critical quality decisions for pharmacopeia compliance may serve as a better solution for customers searching for a robust, accurate, and precise instrument to measure TOC. TOC analyzers are also available in portable, bench-top, or online configurations, allowing customers to choose what fits their application best. Ultimately, it is up to the customer to identify the needs of their process to source the appropriate TOC instrument that will serve as a solution.