Comparison of COD, BOD and TOC Methods for organics - How does the PeCOD Method compare?

There are several common methods to test wastewater and drinking water for organic pollutants, natural and chemical. Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD) and, Total Organic Carbon (TOC) compromise the three main methods of testing water samples. BOD and COD methods differ from TOC because they measure the amount of oxygen that is depleted by organic species in water. Moreover, TOC is a measure of all carbon (both organic and inorganic), rather than the oxygen that is reduced by these species. As written by a TOC manufacturer, "***TOC on its own sheds no light on the oxidizability of the measured carbon or the amount of oxygen needed for its biodegradation.***" Specific to COD, it measures the reactive fraction of the TOC. This is also known as oxidizability in the European Union.

The following table summarizes the advantages and disadvantages of the COD, BOD and TOC methods, and compares them to the PeCOD method.

Method	BOD	COD	TOC
Advantages	• Complies with APHA and ISO standard methods	• Complies with APHA and ISO standard methods	• Not subject to interferences • Less than 10-minute analysis time • Complies with APHA and Standard Methods
Disadvantages	• 5-day measurement time, therefore, not applicable for internal and effluent controls • Poor precision and reproducibility • Prone to interferences that prevent microbial activity • Highly matrix dependent	• Standard method requires 2-4-hour digestion and cooling time • Dichromate does not oxidize all organic species • Inorganic and organic carbons cannot be differentiated • Prone to interferences from halides, peroxide and nitrites • Toxic and environmentally unfriendly reagents • Known to be a carcinogen, reproductive toxin and mutagen • Not applicable to natural and drinking waters due to relatively high method detection limit • Results can vary by measuring when warm or room temperature • Vials have exploded during digestion and cooling	• Doesn't quantify the overall reactivity of the organics which form the disinfection by—products • Scale of response is smaller than COD • Measures little or no change even when reactivity of organics has increased, while carbon loading remains at the same concentration • High capital cost • High cost per sample • Complicated analysis

		• Requires personal protective equipment and should be analyzed in laboratory environment	
PeCOD			
• 10-minute analysis for wastewaters • 3-5 min for natural and drinking waters • Strong correlation to BOD5 • Correlates to standard COD method for many matrices • Does not use mercury, sulfuric acid, or dichromate • Titanium dioxide, a photocatalyst, has a very strong oxidation potential • Fully oxidizes a wide range of organic species • Conforms to ASTM International Method D8084		• Can detect COD in the range of 0.7 ppm to 15,000 ppm; 3rd party determined and published • PeCOD is the first analyzer to directly measure the reactive fractions of TOC, **empirically**; • Directly measure in any water source without need for a laboratory correlation • Dubbed: "Instantaneous DBP data" by 2 Academics at IWA NOM7 in Tokyo 2019 • Simple to use, direct shipped, set-up and analyzing samples in 60 minutes.	

The PeCOD Analyzer reaps the benefits of all three methods while minimizing the disadvantages. The PeCOD quantifies COD and BOD in 10 minutes in a simple, safe, and effective manner. For natural and drinking waters the analysis 3-5 minutes, thus an "optimized" TOC. In the EU it effectively replaces the permanganate method used for oxidizability. Permanganate also suffers from being a laboratory-based test, complicated and time consuming. PeCOD has proven to generate a strong correlation to BOD5 and can be used as a BOD screening tool, providing results in just minutes rather than days. MANTECH estimates that 50% of the peCOD endusers use it for internal BOD5 measurements on the day of sampling.

The PeCOD also correlates to the dichromate standard COD method, but does not use mercury, sulfuric acid, or dichromate; rather, it uses safe and green reagents. In addition, the PeCOD uses titanium dioxide which has a very strong oxidation potential and fully oxidizes a wide range of organic species. Lastly, the PeCOD is robust, reliable and simple to operate. It has a detection limit of 0.7 ppm and can measure samples with concentrations as large as 15,000 ppm undiluted.

In the drinking water applications, many engineers have attempted to use SUVA as a reactive measure of the TOC fraction, however it is not reliable and requires both a Dissolved Organic Carbon (DOC) and UV254 measurement, thus time consuming. PeCOD now provides reactivity easily, quickly and empirically. Event detection, coagulation control, taste and odour control and DBP prediction has never been simpler. At the International Water Association Natural Organic Matter 7 (IWA NOM7) Conference in Tokyo in October 2019, PeCOD as presented as the "***Instantaneous DBP Data***" Analyzer.