

What is the difference between BOD, COD or TOC? Why do I have to measure them?

Almost all treatment plants are required to measure one of these three items as a measure of the pollution value in the water. COD should always measure higher than TOC and then BOD.

COD or Chemical Oxygen Demand is the total measurement of all chemicals in the water that can be oxidized. TOC or Total Organic Carbon is the measurement of organic carbons. BOD or Biological Oxygen Demand is supposed to measure the amount of food (or organic carbons) that bacteria can oxidize.

COD is usually measured and the test is simple and easy to perform with the right equipment and can be done in 2 hours. BOD usually takes 5 days and TOC used to require large expensive pieces of equipment that could measure the sample in minutes, but was cost prohibitive. There are now test in tube kits that utilize COD digestors to run a test similar to a COD test method. Below are more detailed specifics on each test.

Why do I have to measure them?

The government came up with these test methods as a way to determine the amount of pollution in a water stream to try to control and limit the amount of chemicals that can pollute the lakes and rivers if left in a final effluent or discharge stream. Some municipalities want to measure the amount of chemicals in the incoming stream in order to assess surcharges as a way of measuring how much additional treatment their plant will have to do in order to get the incoming water clean.

It is not only important to know which test you are being measured on, but why, how the sample is pulled and the variations on how they perform the test method. Garbage in, garbage out, correct sampling procedures and methods are critical and can make the difference in violating a permit or not.

Just because a lab says they perform BOD does not necessarily mean they perform the procedures the exact same way. Check on the exact methods used.

Did you know some labs do not add bacterial seed cultures? If there are few or very little bacteria in the sample, it will show that the BOD is low. If there are biocides present, it will show the result as low. If there are high levels of ammonia present in the sample or bits of algae present, a false high BOD reading will show up. If the sample sits for a few days and turns septic before the test is run, it will require more oxygen and if not set up properly, again a false reading will occur.

What is Chemical Oxygen Demand?

A COD test measures all organic carbon with the exception of certain aromatics (benzene, toluene, phenol, etc.) which are not completely oxidized in the reaction. COD is a chemically chelated/thermal oxidation reaction, and therefore, other reduced substances such as sulfides, sulfites, and ferrous iron will also be oxidized and reported as COD. NH₃-N (ammonia) will NOT be oxidized as COD.

The use of COD results for wastewater compliance monitoring is increasing.

To measure oxygen demand, biochemical oxygen demand (BOD) relies on bacteria to oxidize readily available organic matter during a five-day incubation period. COD uses strong chemicals to oxidize organic matter. Generally, COD is preferred to BOD for process control measurements because results are more reproducible and are available in just two hours rather than five days. By the time you have the results from a five day test, the plant conditions are no longer the same, so real time monitor and control can not be relied upon by the use of BOD. COD is a quick and easy measurement to get a snap in time picture of what is going on in the system, and with trending, long term predictions can be made and monitor and control of the process at the wastewater treatment plant can be optimized and controlled.

BOD simulates the actual treatment plant process by measuring the organic material microorganisms can oxidize. Although COD is comparable to BOD, it actually measures chemically oxidizable matter. The COD test is not a direct substitute for the BOD test; however, a ratio usually can be correlated between the two tests. This requires COD versus BOD testing over a specified period of time.

For industrial samples, COD may be the only feasible test because of the presence of bacterial inhibitors or other chemical interferences, which would interfere with a BOD determination. COD testing also gives the fast measurements required in many treatment systems for informed decisions regarding process control adjustments. Many industrial and municipal laboratories find that parallel COD and BOD testing is beneficial because the COD test can be used to target a specific BOD range. The need for multiple BOD dilutions is minimized or eliminated.

What is Total Organic Carbon?

Organic matter content is typically measured as total organic carbon and dissolved organic carbon, which are essential components of the carbon cycle. The Total Organic Carbon test measures all organic carbon as CO₂. Therefore, all inorganic CO₂, HCO₃⁻, etc. Must be removed prior to the analysis.

TOC is often used when levels of organic matter (OM) are low. Total organic carbon is a good parameter to measure and actually a more accurate indication of some of the pollutants that cause the most problems than a BOD test. TOC doesn't differentiate between that portion of organic carbon, which can be metabolized (assimilated).

TOC used to be measured by expensive analyzers. Below are some of the older methods with analyzers. Typically TOC analyzers are composed of three primary categories: combustion oxidation, wet oxidation and photocatalytic oxidation. Some analyzers use a combination or mixture of technology.

(1) Combustion Oxidation/ NDIR Method (non-dispersive infrared gas analyzer)

(2) WET OXIDATION- Persulfate oxidation / NDIR Method

There are two types of this method, persulfate oxidation supported with UV (Ultraviolet) irradiation activation and heated persulfate oxidation.

(3) CONDUCTIVITY- UV oxidation / Conductivity based TOC methods oxidize the TOC that is present to CO₂ using UV radiation typically in the presence of a titanium oxide catalyst.

COMBUSTION OXIDATION

The combustion method measures total carbon (TC). It requires samples injection by syringe into a high temperature furnace with a platinum or cobalt catalyst. This process oxidizes all of the carbon materials present to CO₂.

For example, in one of these analyzers, TOC concentration is not directly measured; the Analyzer measures total carbon (TC) and total inorganic carbon (TIC) and subtracts TIC from TC to obtain TOC. An oxidizer and an acid are added to the sample. The acid reacts with bicarbonate and carbonate ions present in the sample to release carbon dioxide (CO₂).

The CO₂ released from bicarbonate and carbonate ions represents the TIC in the sample.

The sample is then subjected to ultra-violet (UV) radiation, which reacts with the oxidant and breaks down all remaining carbon bonds in the sample to release CO₂. The CO₂ released from both the acid reaction and the UV radiation represents all the carbon (TC) released from the sample. TOC is then obtained by subtracting TIC from TC.

Newer methodology for TOC Analyses.

One type of new methodology for TOC analyses is using closed-loop photocatalytic oxidation. The new TOC methodology includes a titanium dioxide slurry and a 400 nm light source for the oxidation process. The closed-loop TOC system incorporates a closed-loop design to eliminate the need for carrier gases and uses what is called dynamic endpoint detection, where all of carbon in the sample is oxidized to completion. The reaction is measured using a non-dispersive infrared (NDIR) detector. This new technology can directly measure TOC from a single sample eliminating the loss of purgable organics and results in comparable recoveries of various organic compounds when compared to the combustion TOC method. This new methodology can be used for the same applications where the traditional TOC methods have been employed.

There are now also Test N Tube reagents that can be used with COD digestors and

Spectrophotometer analyzer. The test is performed in two hours, but the cost for capital equipment is nowhere in the same range. The method involves the oxidation of sample carbon to carbon dioxide by persulfate digestion. The carbon dioxide diffuses into a colored pH indicator solution where it is converted to carbonic acid. The resulting color change is directly proportional to the concentration of carbon present in the sample.

What is the meaning of C-BOD vs. BOD? There are too many terms and it is getting confusing to me.

There are two completely different tests—a C-BOD test and a BOD test. Many times a C-BOD vs. BOD5 test is needed due to conditions at a plant. In some places where the nitrification of ammonia may not be complete (i.e., incomplete conversion of ammonia (NH₃) to nitrate (NO₃)) or where too high levels of amines or ammonia are present, false BOD readings may occur. This can occur in municipal lagoons, wineries and general industry. For lagoon (pond) treatment systems or other situations where this may occur, it is recommended that a Carbonaceous Biochemical Oxygen Demand (CBOD or Inhibited BOD) should be reported and used in place of 5-day Biochemical Oxygen Demand (BOD5). Nitrification is inhibited so that only the oxidation of COD occurs.

What is the difference between BOD vs. CBOD?

BOD5 measures the oxidation of carbons and possibly nitrogenous compounds present in a water sample. CBOD only measures oxidation of carbons.

Where did BOD5 come from? The BOD test Originated in the United Kingdom due to pollution in the Thames River. Legend has it that the 5-day BOD (**Biological Oxygen Demand**) test was developed in England. Sewage was dumped in a river and it took five days for it to reach the ocean, hence the five-day incubation requirement in the BOD method.

It is rumored that a ferry tipped over and that many of the people who fell in the river got sick or died. This was not due to drowning, but due to the effects of the pollution in the river. The Royal Commission on Sewage Disposal recommended and adopted the BOD5 test in 1908. The duration of the test is normally 5 days. The Average temperature is = 20 degrees C. 300 ml are usually used. Dark Incubation is needed to restrict the growth of algae. The final measurement is usually expressed as O₂ mg/l. BOD measures all biodegradable organic carbons, and under certain conditions, oxidizable nitrogen present in the waste.

The biochemical oxygen demand (BOD) test tries to closely model an aerobic wastewater treatment system and the natural aquatic ecosystem. It measures oxygen taken up by the bacteria during the oxidation of organic matter. The test usually runs for a five-day period, but can run 7 or 10 days as well, depending on specific sample circumstances.

BOD uses and limitations: BOD testing has its widest application in measuring waste loadings of treatment plants, and in evaluating the efficiency of treatment processes. It is of

limited use in industrial wastewaters containing heavy metal ions, cyanides, and other substances that may be toxic to the microorganisms.

Unfortunately, the test has flaws. It is usually seeded with the type of bacteria found in municipal plants. The types of bacteria needed in wineries and general industry usually differ in species from the standard procedures method. The hard to degrade organics found in some of these systems also may take longer than 5 days to break down, so a BOD test will give an inaccurate measurement of the amount of pollution that may be present in a waste stream.

Well, I guess it is really important to know these terms, how and where I sample my system as well as who runs the tests. ..

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