Surface water Oxygen Demand (SOD)

Scope:

Chemical Parameters:
Dissolved Oxygen by Titration (Winkler) method;
Biochemical Oxygen Demand (BOD);
Chemical Oxygen Demand (COD).

Total parameters: 3

Rationale:

Surface water is any body of water above ground, including streams, rivers, reservoirs, lakes, tanks, and ponds[1]. Most water utilities source raw water from surface water bodies. For example; the Hyderabad metro water supply is sourced from reservoirs built across several rivers, namely; Musi, Manjeera, Krishna and Godavari. After satisfying drinking and domestic water supply needs, surface water is used for several important purposes, such as irrigation, recreation, fishery, etc. Pristine water stored in a protected reservoir, can be used for drinking with minimal treatment, would be a good aquatic habitat, useful for fishery and suitable for irrigation. In addition, water reservoirs provide excellent opportunities for recreation, by way of a scenic water front, healthy for bathing and swimming, or for that matter sailing, boating etc.

Dynamic interaction of atmosphere, rainfall pattern, and geochemical conditions of drainage basins are natural determinants of water quality characteristics of freshwater bodies. If surface waters were totally unaffected by human activities, up to 90-99 per cent of global freshwaters, would have natural chemical concentrations suitable for aquatic life and most human uses (Chapman, 1996). However, various human activities introduce pollutants and constrain natural regenerative potential of surface water bodies. The Central Pollution Control Board uses the concept of designated-best-use for monitoring and assessment of water quality in surface water bodies. A particular water body may have several uses and the quality criteria for each would vary. For any given water body meant for several purposes, the use which demands highest quality of water is called its designated-best-use. Five quality classes are identified adopting a minimal set of primary water quality criteria. (Table 1).

Table 1: Use based classification of surface waters in India.

Quality Class	Designated Best Use	Primary Water Quality Criteria			
		pH	Dissolved Oxygen	Biochemical O_2 Demand	MPN (Total coliforms)
A	Drinking water source without any treatment, except for chlorination.	6.5-8.5	≥ 6 mg/L	≤ 2mg/L	≤ 50
B	Organised outdoor bathing	6.5-8.5	≥ 5 mg/L	≤ 3mg/L	≤ 500
C	Drinking water source with conventional treatment	6.0-9.0	≥ 4 mg/L	≤ 3mg/L	≤ 5000
D	Propagation of wildlife and fisheries	6.5-8.5	≥ 4 mg/L	Ammonia ≤ 1.2 mg/L	
E	Irrigation, industrial cooling, and controlled disposal.	6.0-8.5	EC≤ 2250 µS/cm; Sodium Adsorption Ratio < 26; Boron < 2 mg/L		

Source: Based on Table 1 in CPCB. 2008. Guidelines for Water Quality Management. Government of India, Ministry of Environment & Forests - Central Pollution Control Board (CPCB), New Delhi.

[1] Although, oceans, seas, salt-water lakes and lagoons are surface water bodies, we restrict here to fresh-water bodies only.

Oxygen is essential to all forms of aquatic life, including those organisms responsible for the self-purification processes in natural waters. Water in streams, rivers, lakes and reservoirs contain small amounts of dissolved oxygen (DO). Although the amount is small, dissolved oxygen is a crucial component of natural water bodies as it is the source of oxygen for survival of fish and other aquatic life. When organic matter from sewage, decaying vegetation and other effluents entering a water body, is broken down by bacteria that consume some of the dissolved oxygen. Although, bacteria consume small amounts of oxygen the cumulative impact of large number of bacterial colonies breaking down continuous inflow of organic matter, can be serious. When DO levels fall below a certain level, it adversely impacts aquatic life, sometimes causing mass fish kills. Hence, measurement of DO is a fundamental part of surface water quality assessment. DO indicates the degree of pollution and the level of self-purification of the water.

Biological and chemical processes in nature help in self-purification of water bodies. The biological processes include breaking down of organic pollutants by bacteria, nitrification and denitrification of ammonia and nitrate, respectively. Chemical processes related to the removal of pollutants from a water body are oxidation by oxidants such as ultraviolet, ozone and oxygen, reduction by reductants, and neutralization. Chemical oxidation is faster. Microbes take longer, However, biological processes contribute the most in self-purification of natural water bodies. Oxygen demand is a measure of the amount of oxidizable pollutants in a water sample.

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen needed by aerobic bacteria to break down organic waste in water. Discharge of effluents with high levels of BOD can severely deplete dissolved oxygen in receiving water bodies affecting survival of fish and aquatic life. The biochemical oxygen demand (BOD) is an approximate measure of the amount of biochemically degradable organic matter present in a water sample. Higher BOD indicates more pollution.

While BOD measures oxygen required by microbes to break down organic waste in water, chemical oxygen demand (COD), on the other hand, measures the amount of oxygen needed for chemical oxidation of pollutants in water.

DO, BOD and/or COD tests are essential for determination of pollutant load in waste water for treatment, monitor residual pollutant load in treated effluents, and to assess to degree of pollution in a surface water body. Ideally, DO should be measured on site. BOD test requires special purpose bottle and careful sample collection. Hence, we have packaged these three tests separately. SOD together with the Surface water Basic Profile (SBP) provides a cost-effective and essential set of parameters to assess health of most surface water bodies. SOD tests are also useful for assessment of pollutant load and monitoring of effluent quality by sewage treatment plants, and various industrial effluent treatment units. This test package along with SBP is suitable to monitor and evaluate quality of water in urban water bodies, lakes, reservoirs, rivers, streams, etc.

Sample - Collection, Storage & Transportation:

Follow methods of sampling specified in APHA Standard Method 1060 or IS 17614 Part 1:2021 for chemical tests. Choice and appropriate preparation of container is important.

Ste-1: Gather all that you need for collection of water sample:

You will need one 300 ml BOD bottle (BODB), and one 1000 ml clean dry polypropylene bottle (CBWS). The BOD bottle is designed with an airtight cap. Use the BODB for DO sample. Use the 1L polypropylene bottle for BOD & COD sample. You will also need DO fixing reagents, namely; (a) manganous sulfate solution and (b) alkaline -iodide-azide. Both these reagents can be harmful when in contact with skin, cause severe burns and eye damage and are also harmful to fish in lake. Hence, carry protective glass, nitrile gloves and handle these reagents carefully. In addition, have two black or dark colour polythene bags (small garbage bag will do) to minimise exposure of samples to sunlight, ice packs to keep the sample bottles cool during transport and a carry bag for convenient transport.

Both BODB and CBWS are available from the IHS Laboratory. It is desirable chemically fix the samples immediately after collection. When you come to collect the sample collection bottles, A person from the IHS Laboratory will provide you the DO fixing reagents and train you up, so that you can chemically fix the DO-sample on site, before transporting to laboratory.

Step-2: Identify sampling point and time:

Quality of water often varies in different parts of surface water bodies. Therefore, a single sampling-point is usually not enough. The number of sampling-locations and -depths depend on size of the water body and study objectives. However, a single sample coupled with contextual data can help determine prima-facie suitability for intended use and yield useful clues about possible sources of pollution, if any. If you plan to take a single sample, prefer the deeper ends, or clear areas where water is more than one meter. If feasible, approach the sampling point by a boat or from an accessible platform on water. Otherwise, slowly wade in towards the spot, up to about your waist deep, taking care to minimise disturbance of the bottom, so that you do not kick up any sediment to rise to surface. After reaching the sampling spot, wait for a few minutes for kicked up sediments around you to settle down. Then extend your arm to collect sample from a spot minimally affected by your entry. If this is not feasible, identify a spot on the bank from where you can draw water using a pole and a clean bucket.

For nalas, streams and rivers, identify a spot upstream of any bridge, culvert, crossing. Collect sample slightly below surface of flowing water, while avoiding bottom of the stream. If depth of stream permits, immerse the bottle completely about 4 inches deep. If stream is too shallow to immerse the bottle fully, collect as much as possible, being very careful not to touch the bottom where sediments can be disturbed and make sure no surface film flows into the bottle.

Step-3: Collect sample.

a. Always have an assistant to standby, just in case you need help as you wade into the waterbody or stream, to help draw water, hold bottles, etc. Both you and the assistant should wash both hands with soap and water, either at a distance from the intended sampling point, or by drawing a bucket of water to the bank for this purpose.
b. Label the sample collection bottles, and ask the assistant reach them to you one by one.
c. Start with the 1L bottle to collect sample for BOD & COD. Use both hands. Remove the cap of the bottle. Slowly lower the bottle into the water, pointing downstream until the lower lip of the opening is submerged about four inches under surface. Slightly tilt bottle to fill it gradually. Slowly turn the bottle upright and fill completely. Keep the bottle under water and allow it to overflow for 2-3 minutes to ensure that no air bubbles

are trapped. Cap the bottle while it is still submerged. Lift it out of the water and look around just below the bottom of the stopper. If you see any air bubble, pour out the sample and try again.

d. Then proceed with collection of DO-sample.

i. *Remember that the water sample must be collected in such a way that you can cap the bottle while it is still submerged. That means that you must be able to reach into the water with both arms and the water must be deeper than the sample bottle.*

ii. *Remove the cap of the BOD bottle. Slowly lower the bottle into the water, pointing it downstream, until the lower lip of the opening is just submerged. Allow the water to fill the bottle very gradually, avoiding any turbulence (which would add oxygen to the sample and affect results). When the water level in the bottle has stabilized (it won't be full because the bottle is tilted), slowly turn the bottle upright and fill it completely. Keep the bottle under water and allow it to overflow for 2 or 3 minutes to ensure that no air bubbles are trapped.*

iii. *Cap the bottle while it is still submerged. Lift it out of the water and look around the "collar" of the bottle just below the bottom of the stopper. If you see an air bubble, pour out the sample and try again.*

iv. *Before fixing the sample, examine the filled BOD bottle for any bubbles that may have adhered to the walls. If any bubbles are present, the sample is discarded and drawn again.*

v. *Remove the stopper and first add 2 ml of the first fixing reagent labelled – 'M' (Manganese sulfate) to the sample. Use the calibrated dropper provided with the reagent bottle. This reagent must be added slowly by touching the dropper tip to inside of the BOD bottle neck, so that the reagent flows in and mixes with sample without introducing any air bubble.*

vi. *Then, add 2 mL of the second fixing reagent labelled 'I' (alkaline iodide-azide solution) to the sample contained in the BOD bottle. This reagent must also be added gently by touching the reagent dropper to inside of sample bottle-neck and gradually releasing the reagent.*

vii. *Replace stopper of the BOD bottle immediately and mix the contents thoroughly.*

viii. *An orange-brown flocculent precipitate will form if oxygen is present.*

ix. *Wait a few minutes until the floc in the solution has settled.*

e. Put each sample bottles in separate dark bags, wrap ice packs and place in carry bag.

First aid in case of skin contact: rinse and wash with plenty of soap and water; Take off contaminated clothing, if any and wash in water.
First aid in case of eye contact: Rinse cautiously with bottled water for several minutes. Remove contact lenses, if any, and continue rinsing with bottled water.

Step-4: Transport to laboratory:

Transport the samples to laboratory as soon as possible, preferably within two hours. If you have multiple errands in the same trip, plan to first deposit sample the laboratory and then continue with other activities.

Step-5 Store sample, if required:

If immediate transport is not feasible, store the sample inside the regular chamber (not the freezer compartment) of a refrigerator until you are ready to transport it to the Laboratory, and definitely within 24 hours from the time of collection.

Information About Source, Context, Intended Use & Concerns:

Provide as much detail as you can about the water body, sampling point, activities & environment around the sampling point. Click some photos and record GPS coordinates, if you can. Mention about intended use of the water, the reason why you are ordering the test, as well as doubts and concerns, if any. These information help in interpretation of test results. Occasionally, the IHS Laboratory may contact you for clarifications and additional information about the source and its environment, to help interpretation of test results.

Test Method & Duration:

BOD in accordance with IS 3025 part 44 oxygen consumed after 3-day incubation at 27°C in air-tight BOD-bottle. COD as per IS 3025 part 58. Closed reflux titrimetry: Reflux digestion of sample with known amount of potassium dichromate and sulfuric acid medium at 150°C for 2-hours and titration of excess potassium dichromate. Dissolved Oxygen as per IS 3025 part 38 Titrimetry (Winkler) method, with azide modification / alum flocculation depending on the level of turbidity/TSS. Results will be available in 3-5 days.

To pick up sample collection bottle and/or schedule collection of samples:
Email: ihslab@ihs.org.in; WhatsApp: +919848011251; Call:040-23211013/4

Water Quality Testing
@ IHS Laboratory

For various water quality test packages: https://www.ihs.org.in/lab/wqt.html &
To download complete water quality test catalogue in tabular form, click:
https://www.ihs.org.in/lab/wqt/pdf/IHSLabWaterQualityTestsCatalogue.pdf

References:

CPCB. 2008. Guidelines for Water Quality Management. Government of India, Ministry of Environment & Forests - Central Pollution Control Board (CPCB), New Delhi.

Chapman Deborah. 1996. Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring. London: published on behalf of WHO by F & FN Spon.

---------- © 2022-2025, The Institute of Health Systems, Hyderabad, India. ----------