Module #5

Calculating Water Quality Index

Adapted and excerpted from Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools by Mark M. Mitchell and William B. Stapp

Materials

small water sample bottle and rod sampler if needed *(constructed from a series of metal rods that can be extended and rubber tubing that holds a sample bottle)*
dark bottle
gloves
incubator (optional)

Testing materials can be purchased as individual test kits from Hach or LaMotte. Biochemical Oxygen Demand tests also are available in Multiple Water Quality Test kits from these manufacturers as well. The materials and instructions that follow are based on a LaMotte test kit. If you use the Hach kit or another method, please follow the directions you receive with your test kit.

BACKGROUND INFORMATION

Biochemical Oxygen Demand (BOD) measures the rate of oxygen uptake by micro-organisms in a sample of water at a temperature of 20°C and over an elapsed period of five days in the dark. It is not an precise quantitative test, although it is widely used as an indication of the quality of water. BOD can be used as a gauge of the effectiveness of wastewater treatment plants. It is listed as a conventional pollutant in the U.S. Clean Water Act.

Most pristine rivers will have a 5-day carbonaceous BOD below 1 mg/L. Moderately polluted rivers may have a BOD value in the range of 2 to 8 mg/L. Municipal sewage that is efficiently treated by a three-stage process would have a value of about 20 mg/L or less. Untreated sewage varies, but averages around 600 mg/L in Europe and as low as 200 mg/L in the U.S., or where there is severe groundwater or surface water infiltration. (The generally lower values in the U.S. derive from the much greater water use per capita than in other parts of the world.)

When organic matter decomposes, it is fed upon by aerobic bacteria. In this process, organic matter is broken down and oxidized (combined with oxygen). Biochemical oxygen demand is a measure of the quantity of oxygen used by these microorganisms in the aerobic oxidation of organic matter.

When aquatic plants die, they are fed upon by aerobic bacteria. The input of nutrients into a river, such as nitrates and phosphates, stimulates plant growth. Eventually, more plant growth leads to more plant decay. Nutrients, then, can be a prime contributor to high biochemical oxygen demand in rivers.

A. BIOCHEMICAL OXYGEN DEMAND (BOD) Sampling Procedure

A dissolved oxygen bottle strapped to the extended rod sampler can be used to take a BOD sample. Remember, samples taken near the river bottom may hold more oxygen-demanding materials and organisms; therefore, to get a representative sample it is best to sample between the surface and river bottom, and away from the shore.

One of the dissolved oxygen bottles should be blackened or purchased as a "dark bottle." One approach is to wrap the bottle with black electrical tape. It is always a good idea if several bottles are available to run several BOD samples.

Like the dissolved oxygen tests, it is important to run all tests for comparison at the same time of day.

B. BIOCHEMICAL OXYGEN DEMAND (BOD) Testing Procedure

1. Fill two dissolved oxygen bottles (one clear and one black) with sample water, holding them for two to three minutes between the surface and the river bottom. If sampling by hand remember to use gloves.
2. Prepare the clear sample bottle according to the directions for the dissolved oxygen test. Determine the DO value for this sample in mg/L.
3. Place the black sample bottle in the dark and incubate for five days at 68°F (20°C). This is very close to room temperature in many buildings. If there is no incubator, place the blackened sample bottle in a "light-tight" drawer or cabinet.
4. After five days, determine the level of dissolved oxygen (in mg/L) of this sample by repeating steps four through eleven of the DO testing procedure.
5. The BOD level is determined by subtracting this DO level from the DO level found in the original sample taken five days previously:

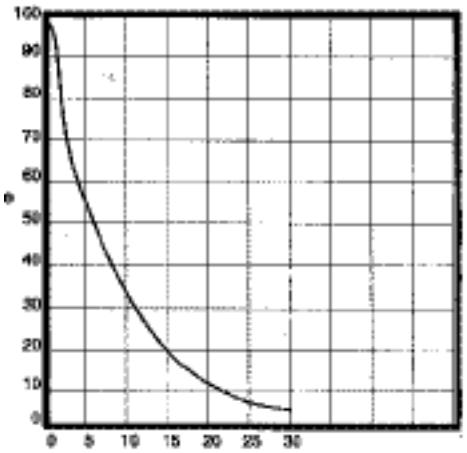
BOD=mg/LDO(original sample)-mg/LDO(after incubation)

The BOD measure is, the amount of oxygen consumed by organic matter and associated microorganisms in the water over a five-day period.

In waters suspected of carrying large amounts of organic waste/sewage, the oxygen demand may be so great that all oxygen is consumed before the 5-day period. The above approach would not reveal the true oxygen demand over the
5-day period.

Alternative approaches require the use of a dissolved oxygen meter to periodically measure dissolved oxygen levels, and re-saturate the sample with oxygen. Another alternative is to make buffered dilution water and dilute the sample until oxygen demand is more in balance with oxygen supply.

BOD Weighting Curve Chart



BOD : mg/L Note: if BOD5>30.0, Q=2.0

C. BIOCHEMICAL OXYGEN DEMAND (BOD)

Calculating the Result

To compute the Q-value for the BOD test, follow these steps:

1. Find the weighting curve chart (upper right);
2. Locate your test result on the bottom (horizontal or "x" axis) of the chart;
3. Interpolate the Q-value for your test result using the following steps;
4. From your test result value on the horizontal ("x") axis of the chart, draw a vertical line up until it intersects the weighting curve line;
5. From this point of intersection, draw a horizontal line to the left hand side (the vertical or "y" axis) of the chart;
6. Where this horizontal line intersects the vertical ("y") axis of the chart, read off the value. This is the Q-value for this test; it should be recorded in Column B on the WQI chart on the Calculating Water Quality Index (Module 10).

The Q-value for each test should then be multiplied by the weighting factor listed in the chart on the Water Quality Index page. Record the product of this calculation in Column D of the chart.