Dissolved Oxygen

Oxygen is important to life in water. Most aquatic plants and animals require oxygen to survive. The amount of oxygen in water is called the dissolved oxygen (DO) concentration. Oxygen dissolves into the water from the atmosphere. Aquatic plants, algae, and plankton also produce oxygen as a by-product of photosynthesis.

DO is an important measure of water quality. Presence of oxygen in water is a positive sign, while absence of oxygen from water often indicates water pollution. Aquatic organisms require different levels of DO. Dissolved oxygen levels below 3 ppm are not good to most aquatic life. DO levels below 2 or 1 ppm will not support fish. Levels of 5 to 6 ppm are usually required for healthy growth and activity of aquatic life.

Some of the factors affecting DO are:
- Temperature (water can't hold as much dissolved oxygen at higher temperatures)
- Altitude/atmospheric pressure
- Turbidity
- Plant growth/photosynthesis
- Amount of decaying organic material

Causes

- Rapid decomposition of organic materials, including dead algae, shoreline vegetation, manure or wastewater decreases oxygen.
- Less oxygen can dissolve in water at higher temperatures.
- Lack of mixing to expose water to atmospheric oxygen results in low dissolved oxygen concentrations.

Measuring

Disolved Oxygen (DO) is measured in mg/L (milligrams per litre)
The typical range for DO is 5.4 to 14.2 mg/L (Hong Kong's average is about 4mg/L)

1. Turn on data logging computer and plug the dissolved oxygen probe into the data logging computer
2. Take the cover bottle off the dissolved oxygen probe by unscrewing the top.
3. Put the dissolved oxygen probe into the water sample and wait for 1 minute.
4. Read the number on the data logging computer.
5. Write down the number on the table.

pH (acidity of the sample)

The pH test is one of the most common analyses in water testing. The pH level is an important measure of water quality because aquatic organisms are sensitive to pH. In acidic water, some aquatic organisms may survive but others may not be able to adapt. A pH range of 6.5 to 8.2 is optimal for most organisms

Most natural waters have pH values of 5.0 - 8.5. Freshly fallen rainwater has a pH of 5.5 - 6.0 due to the presence of CO_2 in the atmosphere, but air pollution due to automobiles and coal-burning power plant creates acid rain which is even more acidic. Alkaline soils and minerals (limestone) buffer the effects of acid rain and may raise pH to 8.0 - 8.5.

How to measure:

1. Triple rinse the sample collection container with water to be tested, then collect the sample.
2. Dip one test strip into the sample for 10 seconds
3. Remove the strip and shake once to remove excess sample.
4. Wait 20 seconds and match the color with the closest color on the chart.
5. Record the pH level.

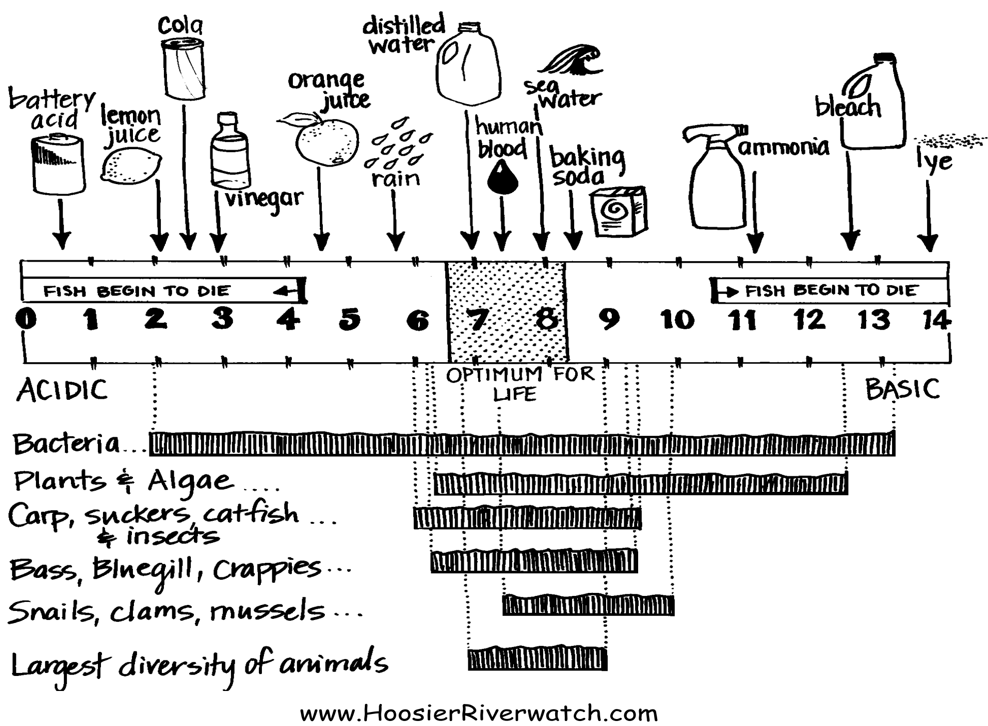

Image source: water quality testing, chapter 4 by Hoosier Riverwatch

Biological Oxygen Demand

Biochemical oxygen demand (BOD5) is a measure of the amount of oxygen used by aerobic (oxygen-consuming) bacteria as they break down organic wastes over five days. Polluted streams, or streams with a lot of plant growth (and decay), generally have high BOD5 levels. High levels indicate that large amounts of organic matter are present in the stream. Streams that are relatively clean and free from excessive plant growth typically have low BOD5 levels.

In slow moving and polluted waters, much of the available dissolved oxygen (DO) is consumed by bacteria, which rob other aquatic organisms of the oxygen needed to live. (See eutrophication diagram on page 9)

The following is a rough guide to what various BOD5 levels indicate:

1-2 mg/L BOD5	Clean water with little organic waste
3-5 mg/L BOD5	Fairly clean water with some organic waste
6-9 mg/L BOD5	Lots of organic material and bacteria
10+ mg/L BOD5	Very poor water quality. Very large amounts of organic material in the water

Problem

High levels of organic matter - including leaves, dead fish, garbage, some industrial waste, fertilizer, pet waste, and sewage from poor functioning septic systems or combined sewer overflows can lead to rapid exhaustion of dissolved oxygen.

Eutrophication and hot weather can cause algae blooms. When bacteria decompose dead algae, oxygen is consumed which increases BOD.

Typical range for BOD5 = 0 to 6.3 mg/L

How to Measure:

1. Lower a sealable bottle below the water's surface. Allow water to flow into the bottle for approximately 1 minute. Ensuring that no air bubbles exist.
2. Gently place the DO probe into the sample to ensure that there is no splashing of the sample and record the DO.
3. Replace the stopper or lid
4. Place the BOD sample in a light-free location (e.g., desk drawer or cabinet) at room temperature and allow it to sit undisturbed for approximately 5 days.
5. After 5 days, remove the BOD bottle and gently place the DO probe into the sample again. Make sure not to splash the sample (splashing will change the DO in the sample).
6. Determine the BOD5 level by subtracting the mg/L of the BOD sample from that of the original DO sample taken 5 days prior.

Example: 11 mg/L (original DO - day 1) - 6 mg/L (DO 5 days later) = 5 mg/L (BOD5)

Water Temperature:

Water temperature is very important to overall water and stream quality. Temperature affects:

- Dissolved Oxygen Levels – Colder water can hold more dissolved oxygen than warmer water. Lower oxygen levels weaken fish and aquatic insects, making them more susceptible to illness and disease.
- Rate of Photosynthesis – Photosynthesis by algae and aquatic plants increases with increased temperature.
- Aquatic Organisms – Many animals require specific temperatures to survive. Most organisms live within a limited temperature range. Aquatic organisms die when temperatures are too high or too low.

Water temperature varies naturally with changes of the seasons, the amount of rainfall.

Problem
Aquatic organisms have narrow optimal temperature ranges. In addition warmer water holds less dissolved oxygen.

Causes

- Runoff from roads and parking lots
- Discharges from municipal wastewater and industrial sources.

How to measure:

1. Turn on the Hanna EC/TDS/Temperature probe and select the temperature mode with the button on the top.
2. Collect temperature data.
    - Place the tip of the electrode into a cup with sample water from the body of water you are testing. The tip of the sensor should be covered completely.
    - Start data collection.
    - When the reading has stabilized, tap Keep to begin sampling. **Important:** Leave the sensor tip submerged while data is being collected for the next 10 seconds.
3. Record the reading.

Total Dissolved Solids

Total dissolved solids, are materials that have been dissolved into the water such as salts, minerals or organic material. A high concentration of dissolved solids is not, by itself, an indication that a sample is polluted or unhealthy. It is normal for samples to dissolve and accumulate fairly high concentrations of material from minerals and rocks.

There are many possible human induced sources of solids that may contribute to increases in TDS readings. Fertilizers from fields and lawns can add a variety salts and minerals. Increases in TDS can also result from runoff from roads. Organic matter from wastewater treatment plants may contribute higher levels of nitrate or phosphate ions.

However, the test described here will not tell you the specific mineral, salt or organic material responsible for the increase or decrease in TDS. It simply gives a general indication of the level of dissolved solids in the sample.

Problem

If TDS levels are high, especially due to dissolved salts, many forms of aquatic life are affected. The salts act to dehydrate the skin of animals. High concentrations of dissolved solids can cause the water to have an unpleasant mineral taste.

Typical range for TDS is 25 to 500 mg/L

How to measure:

4. Turn on the Hanna probe and select the mode with the button on the top.
5. Collect TDS concentration data.
    - Place the tip of the electrode into a cup with sample water from the body of water you are testing. The tip of the sensor should be covered completely.
    - Start data collection.
    - When the reading has stabilized, tap Keep to begin sampling. **Important:** Leave the sensor tip submerged while data is being collected for the next 10 seconds.
6. Record the reading.

Turbidity

Turbidity is the relative clarity of the water. Turbid water is more cloudy caused by suspended matter including soil, organic and inorganic matter, and algae. These materials scatter and absorb light, rather than allowing it to shine through. If water is very turbid, dissolved oxygen will decrease caused by limited photosynthesis and increased temperature. This can kill fish and other organisms.

Turbidity should not be confused with color, since darkly colored water (like tea) can still be clear and not turbid.

Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances caused by boat traffic or abundant bottom feeding fish.

Typical range for TURBIDITY = 0 to 173 NTU

7. Connect the turbidity sensor to LabQuest2
8. Set up the data-collection mode.
    - On the Meter screen, tap Mode. Change the data-collection mode to Selected Events.
    - Select Average over 10 seconds and select OK.
9. You are now ready to collect turbidity data.
    - Gently invert the sample water four times to mix in any particles that may have settled to the bottom. **Important:** Do not shake the sample. Shaking will introduce tiny air bubbles that will affect turbidity.
    - Use the pipette to rinse the cuvette with sample water, then fill it with sample water so that the bottom of the meniscus is even with the top of the white line.
    - Place the lid on the cuvette. Gently wipe the outside with lens paper.
    - Check the cuvette for air bubbles. If air bubbles are present, gently tap the bottom of the cuvette on a hard surface to dislodge them.
    - Holding the cuvette by the lid, place it into the turbidity sensor. Make sure that the mark on the cuvette is aligned with the mark on the turbidity sensor. Close the lid.
    - Start data collection.
    - After 10 seconds, tap Keep. **Important:** Do not disturb the sensor during the 10 second sampling period.

Phosphates

Phosphates are necessary to plant and animal life, and its presence in the environment is natural. Problems with phosphates as a water pollutant is not from its presence, but from the addition of excessive amounts. The addition of phosphates can lead to problematic algal blooms when added to aquatic systems. (See Eutrophication on page 8).

Phosphate enters surface waters in organic matter (dead plants and animals, animal waste), attached or adsorbed to soil particles, or in a number of man-made products (detergents, fertilizers, industry wastes). Phosphate is an important nutrient in fertilizer because it increases terrestrial plant growth (vegetation).

The addition of phosphate increases aquatic plant growth (e.g. algae, weeds). Plants then begin to die and break down. This break down uses the dissolved oxygen supply in the water - a condition called **hypoxia**, which can lead to fish kills in some cases.

Causes

- Phosphates occur naturally in soil. Sediments from soil erosion and runoff are often a significant source of phosphorus.
- Phosphates can come from manure sources, such as over- fertilized agricultural fields and livestock farms.
- Urban sources may include: storm drains, parking lot and road runoff, construction sites, inadequately treated wastewater, septic tank effluent, and lawn fertilizer.

How to measure:

1. Rinse out the testing container with distilled water.
2. Using a funnel, fill the container with water from the sample container.
3. Add to the solution the package of phosphate reagent to the testing container.
4. Shake until the contents of the package have dissolved into the solution and wait for 2 minutes.
5. Using a pipette, fill the colorimeter and compare the colors to get your reading.
6. Record the reading.

Eutrophication

source: http://www.slideshare.net/seamonr/hydrosphere-2-freshwater

Nitrates:

Nitrogen is found in all living things. It enters the water from human and animal waste, decomposing organic matter, and runoff of fertilizer from lawns and crops.

Nitrates are an essential nutrient for plant growth. Similar to phosphates, these are a main ingredient in fertilizers and can lead to increased aquatic plant growth and eutrophication.
Nitrogen works with phosphorus to increase algae growth and cause eutrophication.

Causes

- Nitrogen can come from manure, such as over fertilized fields and livestock.
- Nitrogen is the most abundant nutrient in commercial fertilizers.
- Runoff from agriculture, golf courses, and Lawns are high in nitrogen, especially if it rains soon after fertilization.
- Sewers are the #1 source of nitrates in surface water.

Typical range for NITRATE (NO3) = 0 to 36.08 mg/L
Drinking water should be less than 3.3 mg/L

How to measure:

1. Rinse out the testing container with distilled water.
2. Using a funnel, fill the container with water from the sample container.
3. Add to the solution the package of nitrate reagent to the testing container.
4. Shake until the contents of the package have dissolved into the solution and wait for 2 minutes.
5. Using a pipette, fill the colorimeter and compare the colors to get your reading.
6. Record the reading.