B. Dissolved Oxygen

i. Why is this test important?/What does it measure?

Oxygen is critical for the animals that live in the water. Just as land-based organisms need oxygen to live, so do aquatic animals. The more oxygen dissolved in water, usually the better it is for aquatic life. You typically have the greatest diversity in waters with high levels of dissolved oxygen.

Oxygen comes into water through two processes. The first is photosynthesis. Plants and algae in the water produce oxygen during the daytime. Those same plants consume oxygen during the night. If there are many plants in the water, oxygen levels may increase as the day goes on and plants are photosynthesizing more.

Oxygen also enters the water directly from the atmosphere. Tumbling water mixes and dissolves atmospheric oxygen. Waterfalls and rapids tend to increase the amount of oxygen in water.

As water heats up, gases are driven out of the water. A can of soda pop has carbon dioxide gas dissolved in it, which we call carbonation. As the pop heats up, the carbon dioxide is driven out, and the pop goes flat. Warmer water will have less oxygen in it than colder water.

ii. Water Quality Standards

Rule 64 of the Michigan Water Quality Standards (Part 4 of Act 451) includes minimum concentrations of dissolved oxygen which must be met in surface waters of the state. This rule states that surface waters designated as coldwater fisheries must meet a minimum dissolved oxygen standard of 7 mg/l, while surface waters protected for warmwater fish and aquatic life must meet a minimum dissolved oxygen standard of 5 mg/l.

Dissolved Oxygen levels of around 100% saturation are good for aquatic life.

iii. How to conduct the test

NOTE: Make sure everyone involved in conducting the test is wearing gloves and goggles. PLEASE USE THESE DIRECTIONS WITH THOSE IN YOUR TEST KIT

1. Pick your location to sample. You want an area of the stream where you can completely submerge the bottle. Try to select a sampling location that is representative of the stream.

2. Rinse the sample bottle with the stream water.

3. After you have rinsed the bottle with stream water, tightly cap the bottle.

4. Submerge the bottle underneath the water completely, and remove the cap with the bottle under the water, and allow the bottle to fill.

5. While the bottle is still underneath the surface of the water, tap the sides of the bottle to get out all the air bubbles.

6. While the bottle is still underneath the surface of the water, put the cap back on the bottle.

7. Retrieve the bottle and make sure there are no trapped bubbles, if you have trapped bubbles, go back to step 3.

NOTE: When adding chemicals, be sure to not add air to the sample.

8. Carefully remove the cap from the bottle.

9. Add Manganous Sulfate Solution (see kit) NOTE: Bottle may overflow, that is ok; that is why you are wearing gloves.

10. Add Alkaline Potassium Iodide Azide (see kit) NOTE: Bottle may overflow, that is ok; that is why you are wearing gloves.

11. Cap the bottle and wipe off any chemical that overflowed the bottle.

12. Mix by inverting several times. Put your thumb over the cap and turn the bottle upside-down, then right-side-up. DO NOT shake it like a bottle of ketchup, it is more likely to go flying out of your hand that way. "Chunky stuff" will form, this is called precipitate.

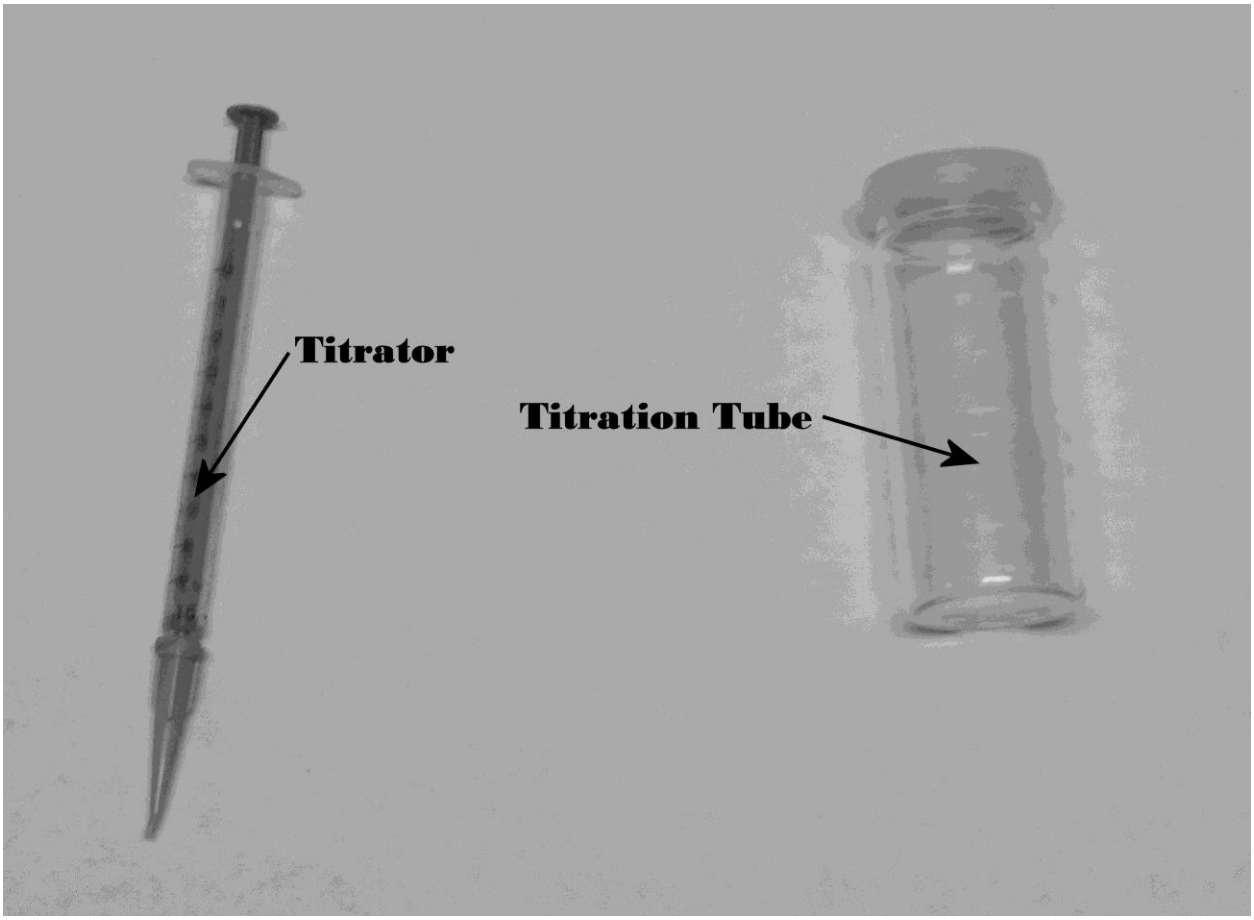
13. Set the bottle down and allow the precipitate to settle down below the "shoulders" or curved part of the bottle. This should take about 5 minutes.

14. Add Sulfamic Acid NOTE: Bottle may overflow, that is ok; that is why you are wearing gloves. This chemical may burn if it gets on the skin, make sure you wash off any chemical on bare skin IMMEDIATELY with water.

15. Cap the bottle and wipe off any chemical that overflowed the bottle.

16. Mix by inverting several times. Put your thumb over the cap and turn the bottle upside-down, then right-side-up. DO NOT shake it like a bottle of ketchup, it is more likely to go flying out of your hand that way. Keep inverting the bottle until all the precipitate is dissolved. If oxygen is present, the sample will turn a yellow or orange color; if it is not yellow or orange, backtrack over your steps or re-test.

NOTE: At this point, the oxygen is "fixed" and the rest of the procedure can be done back at the school, or even on another day. It is more accurate in the field. If a thunderstorm is coming, or you are short on time, this may be a good option.



18. Fill the titration tube to the 20 mL line with the fixed sample. Cap the tube. There is a small hole in the cap to insert the titration tube.

19. Depress plunger of the Titrator The titrator looks like a blunt syringe.

20. Insert the Titrator into the plug in the top of the Sodium Thiosulfate, 0.025N titrating solution.

21. Invert the bottle and slowly withdraw the plunger until the large ring on the plunger is opposite the zero (0) line on the scale. NOTE: If small air bubbles appear in the Titrator barrel, expel them by partially filling the barrel and pumping the titration solution back into the reagent container. Repeat until bubble disappears.

22. Turn the bottle upright and remove the Titrator.

23. Add Starch Indicator Solution (see kit directions). The sample should turn blue.

24. Insert the tip of the Titrator into the opening of the titration tube cap.

25. Slowly depress the plunger to dispense the titrating solution (Sodium Thiosulfate). As you add the titrating solution, the sample will become more pale. Gently swirl the sample as you add the titrating solution.

26. If you go through a complete titrator-full of Sodium Thiosulfate, repeat steps 19-22 to refill your titrator. KEEP TRACK if you fill the titrator more than once.

27. Continue titrating until the blue color disappears and the solution becomes colorless. Holding the titration tube over a white piece of paper helps to determine if the solution is colorless. If you go “too far”, you can re-do the test with the fixed sample.

28. Read the test result directly from the scale where the large ring on the Titrator meets the Titrator barrel. Record as ppm Dissolved Oxygen. Each minor division on the Titrator scale equals 0.2 ppm.
NOTE: If you filled the Titrator more than once, each full Titrator counts as 10ppm

29. Use ppm of Dissolved Oxygen and temperature in degrees Celsius to determine the percent saturation of Dissolved Oxygen in the using the chart below:

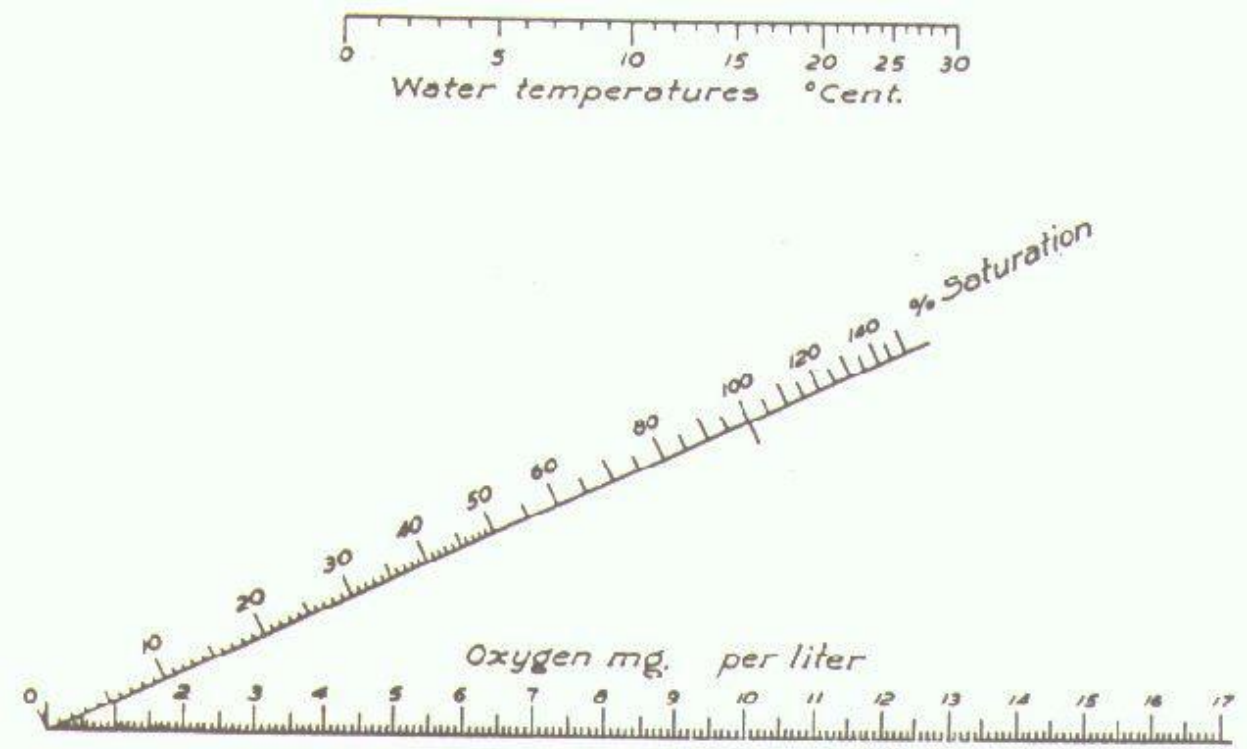


Figure 9. Level of oxygen saturation chart.

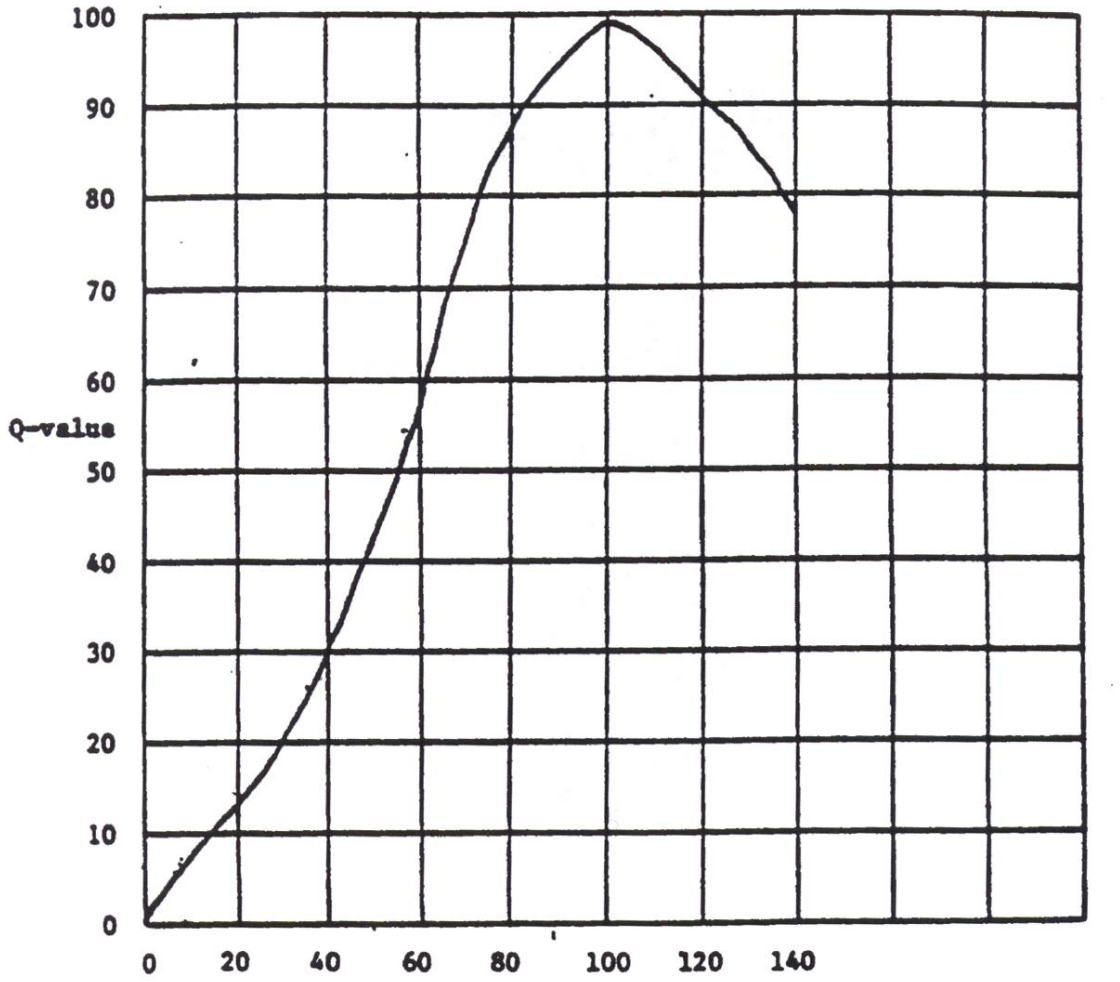
There is also a fairly complicated equation you can use to determine percent saturation available at http://www.waterontheweb.org/under/waterquality/oxygen.html.

There is also a table online to enter the data, and it will do the conversion for you http://water.usgs.gov/software/DOTABLES/. (You do not need to change the barometric pressure or specific conductance)

IV. Determining the Q-Value

FIELD MANUAL FOR WATER QUALITY MONITORING

Chart 1: Dissolved Oxygen (DO) Tests Results



DO: % saturation

Note: if DO % saturation >140.0, Q=50.0

V. What To Watch Out For: Common Mistakes

Unfortunately, the DO test probably has the most opportunities for user error, so conducting multiple tests is beneficial.

1. A very common mistake is having a student collect a sample in a bucket, and bringing it up to the shore of the stream, and then pouring the water from the bucket into the sample bottle. This introduces lots of extra oxygen into the sample leading to an inaccurate result. The DO sample bottle **MUST** be submerged below the surface of the stream and bubbles removed underneath the surface of the water. A student in waders will probably have to get the sample for this test.

2. Be careful not to introduce air bubbles when adding chemicals.

3. Make sure you get all air bubbles out of the bottle.

4. Make sure you remove air bubble from the titrator when adding the Sodium Thiosulfate.

5. Make sure you have temperature in Celsius when calculation percent saturation.

6. Make sure you use percent saturation to determine the q-value, not ppm oxygen.

7. Students who go through multiple titrators of Sodium Thiosulfate, and only get the reading from the last one.

8. Try to get your temperature reading as close to the time of collecting and "fixing" your dissolved oxygen sample as possible. You should also try to take the temperature of the water at the point you take the sample for dissolved oxygen.

VI. Consistency when doing multiple tests

Dissolved oxygen levels can vary widely throughout the day as the temperature of the water changes, and as photosynthesis activity by aquatic plants change. Try to conduct these tests as close together as possible.

VII. Analyzing your results

You want DO levels to have a percent saturation of between 80%-120%. Low dissolved oxygen levels can be explained by a high BOD (which will be explained in the next section), stagnant or slow moving water, or high temperature water.