Experiment C-6
Gas Solubility

Objectives

- To measure dissolved oxygen in water by using an oxygen sensor.
- To learn about physical factors that influence oxygen solubility in water.
- To examine the dissolved oxygen in turbulent water.

Modules and Sensors

- PC + NeuLog application
- USB-200 module
- NUL-205 Oxygen logger sensor

Equipment and Accessories

▪ Utility stand
▪ Right angle clamp
▪ Extension clamp
▪ 50 ml syringe
▪ 250 ml beaker

- The items above are included in the NeuLog Utility accessories, UTL-KIT.

Materials

▪ 200 ml of tap water
▪ DO filling solution (included with the oxygen sensor)

Introduction

Dissolved oxygen (DO) concentrations can be expressed as ppm (parts per million) or milligrams of oxygen per liter of water (mg/L). Oxygen dissolves in water at very low concentrations. The earth's atmosphere contains about 21% oxygen or 210,000 ppm, but a pond has rarely more than 10 ppm of dissolved oxygen. The level of dissolved oxygen in water is influenced by temperature, pressure, salinity, stream structure and biological processes.

As temperature increases oxygen is less soluble. As pressure increases oxygen solubility increases as well. Higher salinity will reduce the solubility of the oxygen in the water. In a water stream, turbulent water has a higher surface interaction between the water and the air, resulting in high levels of dissolved oxygen. Aquatic plants and algae produce oxygen as they photosynthesize, as a result the amount of dissolved oxygen in the water increases. On the other hand, respiration of all aquatic life forms reduces the dissolved oxygen.

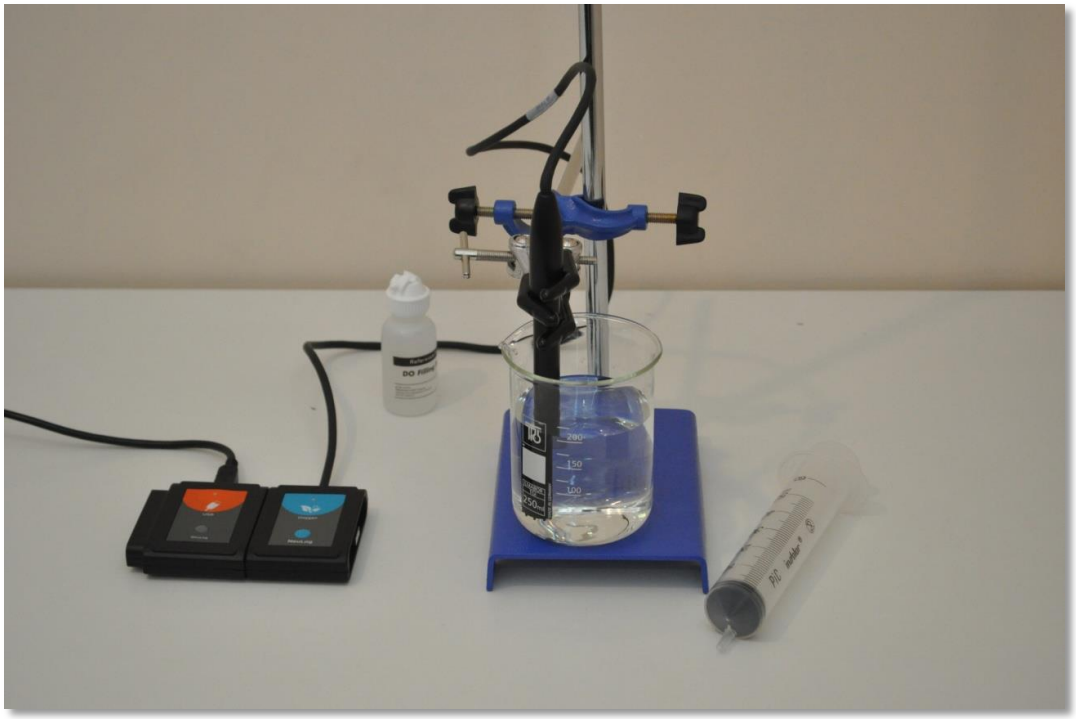
Percent saturation is the amount of oxygen dissolved in a water sample compared to the maximum amount that could be dissolved at that temperature.

In this activity we will saturate water with oxygen and measure the percent saturation of the water after the oxygen comes out (reaches the initial level). We will investigate how turbulence effects oxygen saturation.

Procedure

Experiment setup

1. Set up the experiment as shown in the picture below.



2. Make sure that the temperature in the room is relatively constant.

3. Make sure that you have 200 ml of tap water at room temperature in the beaker.

4. Remove the rubber protection from the oxygen sensor's cap. Unscrew the cap, fill half of it with the included liquid and screw it back.

5. Attach the oxygen sensors probe to the utility stand using the extension clamp. The probe should be a few millimeters above the bottom of the beaker and the metal circle should be beneath the water.

Sensor setup

6. Connect the USB-200 module  to the PC.

7. Check that the oxygen sensor  is connected to the USB-200 module.

Important:

You must wait about 5 minutes after connecting the sensor to the USB-200 module before beginning calibration and measurements. For a more accurate measurement you can look at the module window and wait for the reading to stabilize (it could take longer than 5 minutes).

Note:

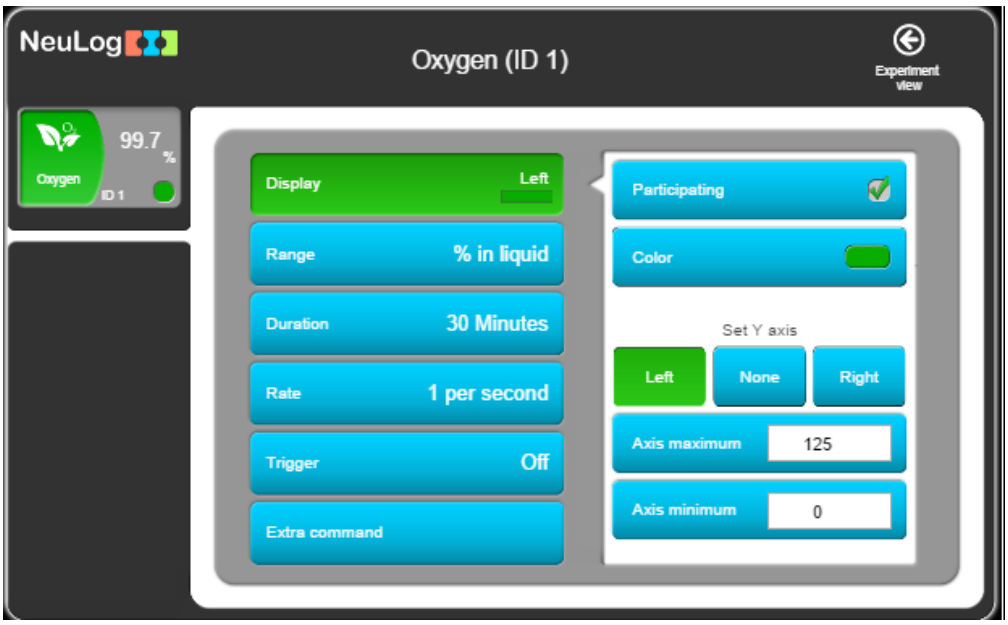
The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

8. Run the NeuLog application and check that the oxygen sensor is identified.

Settings

9. Click on the pressure **sensor's module** box.

10. Select the “% in liquid” button to set the sensor's mode.



11. Click on the  icon to go back to the graph.

12. Click on the **Run Experiment** icon  and set the:

    Experiment duration to 30 minutes
    Sampling rate to 1 per second

Testing and measurements

13. In order to offset the sensor, click on the oxygen sensor's module box.

    Insert the syringe's tip in the water and pump air in it a few times as fast as you can for full saturation.
    When you see you have reached the maximum level you can get on the module box, immediately click on the "calibrate" button.

14. Right after offsetting, click on the **Record** icon  to start the measurement.

15. Click on the **Arrows** icon  in order to see the sensor's values during the measurement.

16. You can click on the **Zoom fit** icon  during the measurement to see better how the graph changes.

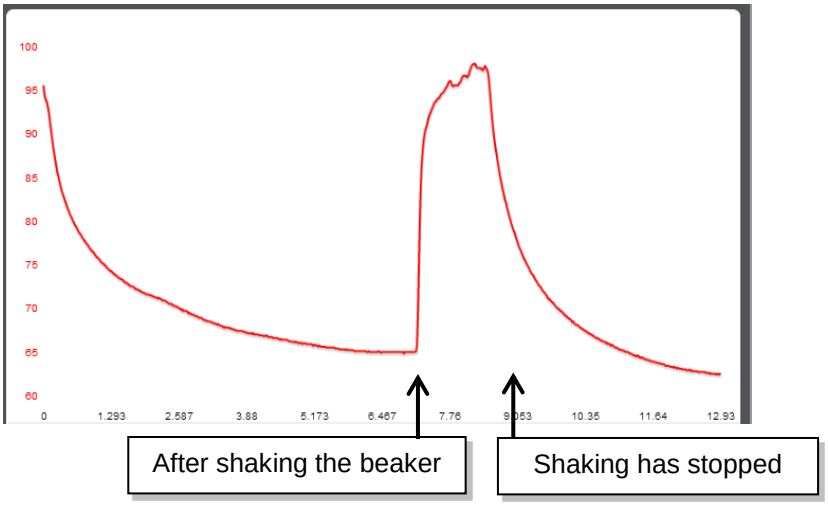
17. To see the entire graph after one minute, use the mouse's scroll wheel.

18. Wait until the percentage of oxygen in water stabilizes.

19. Gently shake the beaker for around one minute.

20. Stop the measurement when the oxygen saturation level reaches the minimum value.

21. Your graph should be similar to the following:



22. Click on the **Export** Icon  and then on the **Save value table (.CSV)** button to save your graph.

23. Click on the  icon to go back to the graph.

24. We can see that after pumping the maximum amount of oxygen into the water and calibrating to 100%, the oxygen saturation level decreased as the oxygen came out of the water. The water reached the original saturation level of oxygen it had before pumping more oxygen in it, which is 65% saturation in our example.

    When we shake the beaker, thus creating turbulence, oxygen from the air is dissolved in the water due to increased surface area between them.

Summary questions

1. Explain why usually gases are more soluble at lower temperatures.

2. It is vital that the oxygen levels in fish tanks will be maintained at 5 to 7 mg per liter of water. Think of three ways for maintaining a high level of oxygen in a tank.