KILROY ACADEMY

DISSOLVED OXYGEN VIDEO FAQs

What does the % represent on the beakers?

The symbol on the beakers was not the percent symbol (%) but rather the similar looking symbol for parts-per-thousand (‰) or ppt. See PARTS PER Hands-on Demo on the Kilroy Academy Resources Page under Salinity→Math.

What are the glass tubes to beakers for?

The flexible tubing to the beakers is aquarium airline attached to air diffusers (airstones) in order to bubble air and deliver oxygen to the water. The goal is to maximize the oxygen available to see how much the water can hold at different temperatures and different salinities.

How is the temperature being kept the same (at 5^{o} then 35^{o})?

The beakers are placed in water baths. The cold water bath contains ice cubes, which naturally maintains a constant temperature (until all the ice melts). The warm water bath has an aquarium heater, which contains a thermostat to maintain a constant temperature (in an air-conditioned cool environment).

What is salinity in parts per thousand actually mean?

Salinity is the measure as the amount of salt (by weight) dissolved in a known weight of freshwater (or volume when using metric units). Seawater that is 35 ppt (or 35 ‰) is equal to 35 grams of NaCl dissolved into 1,000 grams (or 1 kilogram) of fresh water – and in the metric system of measure, 1 kilrogram = 1 liter in volume*.

*Note: One kilogram and one liter are used interchangeably but this is only true at 4^{0} C. At 35^{0} C 1 kg is about 1006 ml of water.

What does D.O. in parts per million (ppm) actually mean?

Parts per million is also measured in terms of weight of gas in water. A dissolved oxygen measurement of 8 ppm means 8 milligrams of the gaseous solute oxygen is dissolved in 1,000 grams of fresh water.

If this is a cause/effect relationship, what's cause & what's effect?

This demonstration is an example of the relationship of two causes (temperature and salinity) on a single effect (dissolved oxygen). An increase in either "cause", temperature or salinity, results in a decline in DO (effect). Therefore, the highest saturation of dissolved oxygen is at the lowest temperature in freshwater, and the lowest saturation of dissolved oxygen is in the warmest, highest saline water.

What (physically) is the reason that temperature allows so much more DO in a beaker of same volume $H^{2}O$ when temp is lower?

The solubility of gases in liquids is describe by Henry's Law — "At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid." The partial pressure of a gas is a measure of

thermodynamic activity of the gas's molecules. Gases dissolve, diffuse, and react according to their partial pressures, and not according to their concentrations in gas mixtures or liquids.

In understanding the effects of temperature on the solubility of gases, it is first important to remember that temperature is a measure of the average kinetic energy. As temperature increases, kinetic energy increases. The greater kinetic energy results in greater molecular motion of the gas particles. As a result, the gas particles dissolved in the liquid are more likely to escape to the gas phase and the existing gas particles are less likely to be dissolved.

What is the reason that dissolved oxygen declines as salinity increases?

Dissolved salts, such as sodium chloride (NaCl), or other solutes – such as sugar, occupy space in water that would otherwise be available for oxygen molecules (O_2) to dissolve in. Thus, as the amount of salts dissolved in water increases, DO decreases.

How does the DO meter actually work? What is being recorded/sensors sensing what?

The typical Dissolved Oxygen meter has a membrane, electrodes, and an electrolyte, which is a substance that ionizes when dissolved in water. Oxygen which has passed through the membrane is reduced (which means gains electrons) by the working electrode. The working electrode uses a noble metal such as platinum, and the opposite electrode uses a different nobel metal such as silver. For the electrolyte, a potassium chloride solution is used, and the membrane is made out of Teflon. Voltage is applied between the two electrodes so that the threshold diffusion current for oxygen is generated there. The oxygen which has passed through the membrane is reduced with the working electrode. A reduction current in proportion to the dissolved oxygen is generated, and then the dissolved oxygen is measured. The current which has flowed in proportion to the concentration of the dissolved oxygen is processed with the current amplifier, and then the concentration of the dissolved oxygen is measured and displayed.

Note: A YSI Model 55 Handheld Oxygen System was utilized during the hands-on demonstration. For more information about this meter, visit http://www.ysi.com/productsdetail.php?55-27.

What months or season are fish most likely to die as temperature increases and DO decreases?

Fish kills typically occur in the summer months when water temperatures are higher and oxygen solubility (DO) is lowest. However, in Florida this is only part of the picture. The warm summer months coincide with the rainy season, resulting in more runoff and more nutrient input to our coastal waters. The warm temperatures, nutrient enrichment, and long, intense daylight periods result in phytoplankton blooms. During the day the algae photosynthesizes resulting in dissolved oxygen saturation, but during the dark evenings the algae respires, consuming O_2 and producing CO_2. Just prior to dawn, the O_2 concentration is at its lowest (often approaching 0) and results in fish mortality. (Typically, catfish farmers will begin the aeration paddles in their ponds around 3:00 am.) In addition, as the algae dies, sinks to the bottom, and begins bacterial decomposition the respiring bacteria create a "Biological Oxygen Demand" that also contributes to a decline in dissolved O_2 concentrations.

If fish can filter/use D.O. in seawater, what about the salt?

Most fish exchange gases using gills on either side of the pharynx (throat). Gills are tissues that consist of fabric-like structures called filaments. Each filament contains a capillary network that provides a large surface area for exchanging oxygen and carbon dioxide. Fish exchange gases by pulling oxygen-rich water through their mouths and pumping it over their gills. The blood in the gills contains hemoglobin, the iron-containing oxygen-transport metalloprotein in the red blood cells of all vertebrates. Hemoglobin in the blood carries oxygen from the respiratory organs (lungs or gills) to the rest of the body (i.e. the tissues). There it releases the oxygen to permit aerobic respiration to provide energy to power the functions of the organism in the process called metabolism.

What type(s) of graphics are appropriate for this type of data?

A 3-axis graph is most appropriate: x-axis salinity, y-axis temperature, and z-axis dissolved oxygen. A 3-dimensional graph may be generated on Excel. Please view the supplemental resources that accompany the Dissolved Oxygen video to access a blank graph.

REFERENCES

http://www.ysi.com/index.php

ACKNOWLEDGEMENTS

Thank you to Sebastian River High School Teacher Holly Hoier, LeRoy Creswell and Dr. Edie Widder for creating this resource. Special thanks to Indian River Impact 100 for funding Kilroy Academy.

Made possible with funding provided by

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