Technical Note
T 2021 - 01

Dissolved Oxygen

VALUES GREATER THAN 100% AIR SATURATION ARE POSSIBLE AND CAN BE BENIFICIAL TO IMPROVE WATER QUALITY

Some of Ultra-Oxygen's customers are occasionally concerned about observing "Percent Air Saturation" dissolved oxygen readings in environmental water (lakes, streams, estuaries, etc.) that are above 100%. The issue is usually one of semantics. How can something be more than 100% saturated?

To understand the overall concept, it is necessary to consider the sources of dissolved oxygen in environmental water and to appreciate that equilibration between air and water is rarely perfect in environmental situations.

Air is certainly one source of dissolved oxygen in environmental water. If air were the only source of oxygen and if environmental water equilibrated with the air above it instantly during temperature changes, then it would indeed be impossible to observe values above 100% air saturation unless the DO sensor was in error. Neither of these "if statements" is true, however, for most bodies of water.

...it is necessary to consider the sources of dissolved oxygen in environmental water and to appreciate that equilibration between air and water is rarely perfect in environmental situations.

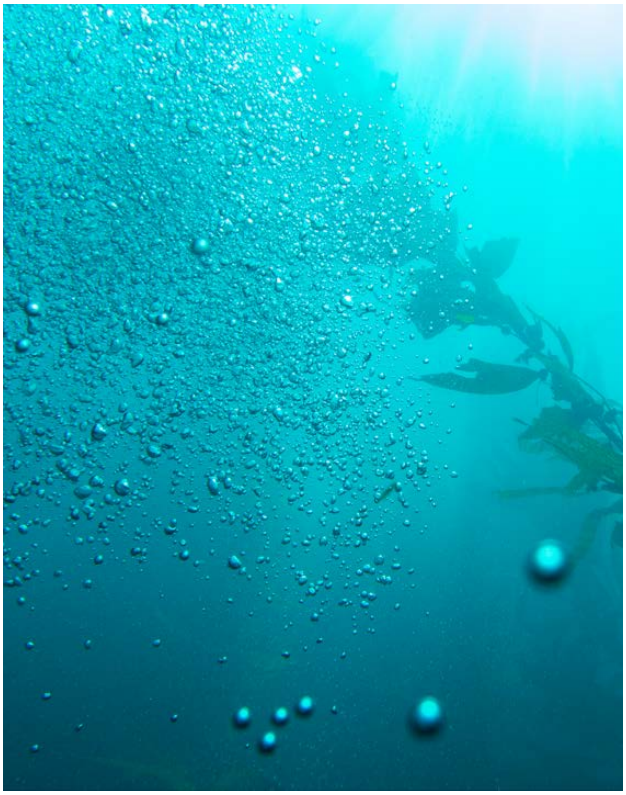


Figure 1. Photosynthetically-active species produce pure oxygen (not air) during photosynthesis.

Oxygen Sources

Photosynthetically-active species (plants, algae, etc.) are common additional sources of dissolved oxygen in the environment and, in many bodies of water, can, in fact, be the dominant factor in determining the dissolved oxygen content. It is important to remember that these organisms produce pure oxygen (not air) during photosynthesis.

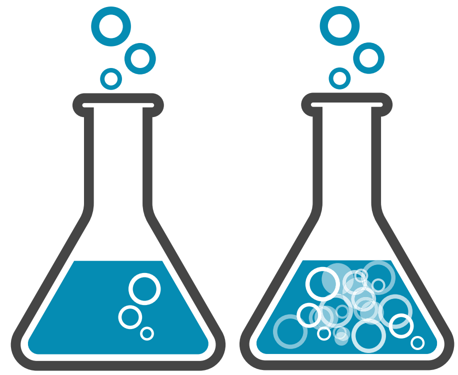
Super oxygen saturation table

Pure % Oxygen	mg/L	% Saturation
normally in air = 21%	8,90	100%
42%	17,80	200%
63%	26,70	300%
84%	35,60	400%
90%	38,00	427%
100%	41,83	470%

% Saturation subject to water temperature and TDS in water

Air is approximately 21% oxygen and thus it contains about five times less oxygen than the pure gaseous element produced during photosynthesis. The oxygen content of any liquid is defined by Henry's Law as being proportional to the partial pressure (or percent) of oxygen in the gas above it. In practical terms, this means that if air and oxygen from compressed gas cylinders are bubbled into separate water samples, the sensor reading from the oxygen-saturated water will be about five times larger than that of the sensor reading from the air-saturated water.

DO sensor is calibrated to 100% in air saturated water or water-saturated air, then the reading in oxygen-saturated water will be about 500% air-saturation. There is no difference between the oxygen from the compressed gas cylinder in the above hypothetical experiment and that produced by photosynthetically active species in environmental water or if added by using oxygen concentrators. Thus, photosynthesis can readily account for "percent air-saturation" values of between 100 and 500% depending on the efficiency and concentration of the photosynthetically-active species present. Ultra-Oxygen for practical reasons uses mostly oxygen concentrators to restore oxygen deprived water bodies.



Ultra-OXYGEN can increase oxygen saturation in water

470%

The oxygen content of any liquid is ...proportional to the partial pressure (or percent) of oxygen in the gas above it.

Non-Ideal Air/Water Equilibration

Another possible cause of dissolved oxygen readings greater than 100% air saturation arises from the fact that equilibration (or equalization) of the oxygen content of water with the air above it is seldom rapid except in fast-flowing streams. This fact allows temperature changes to produce water conditions that lead to dissolved oxygen readings of over 100% air saturation. The following example may be useful in understanding this concept:

The dissolved oxygen reading of a relatively stagnant lake at night is 9.65 mg/L when the temperature is 17°C. This corresponds to 100% air saturation. During the next day, the sun warms the water to 22°C where 8.22 mg/L represents the 100% air-saturated value. However, the temperature change has occurred rapidly enough to prevent the oxygen in the water from "escaping" to the air because of non-ideal equilibration conditions. The lake still contains 9.65 mg/L of dissolved oxygen, but now the temperature is 22°C where 9.65 mg/L corresponds to 117% air-saturation ({9.65/8.22} x 100).

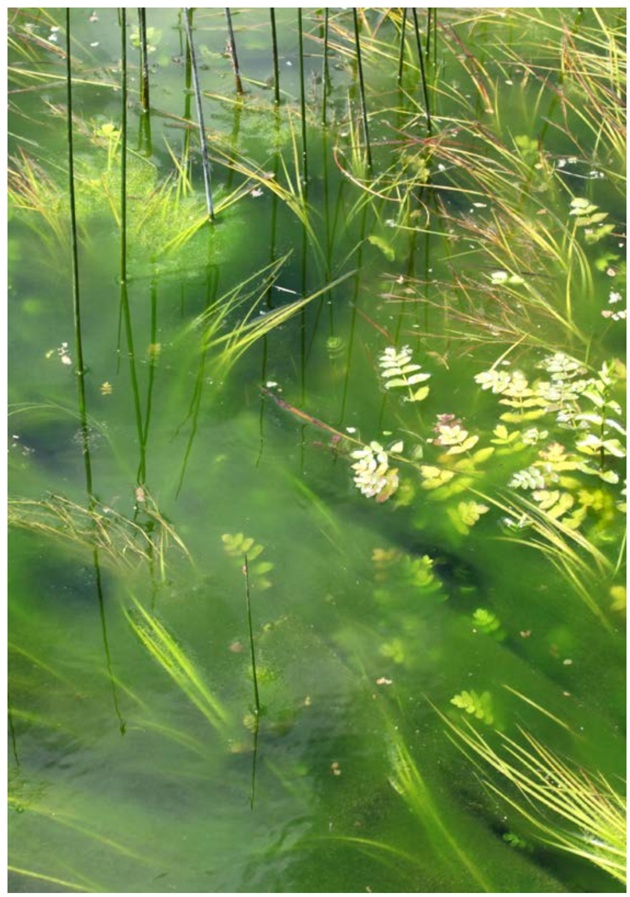
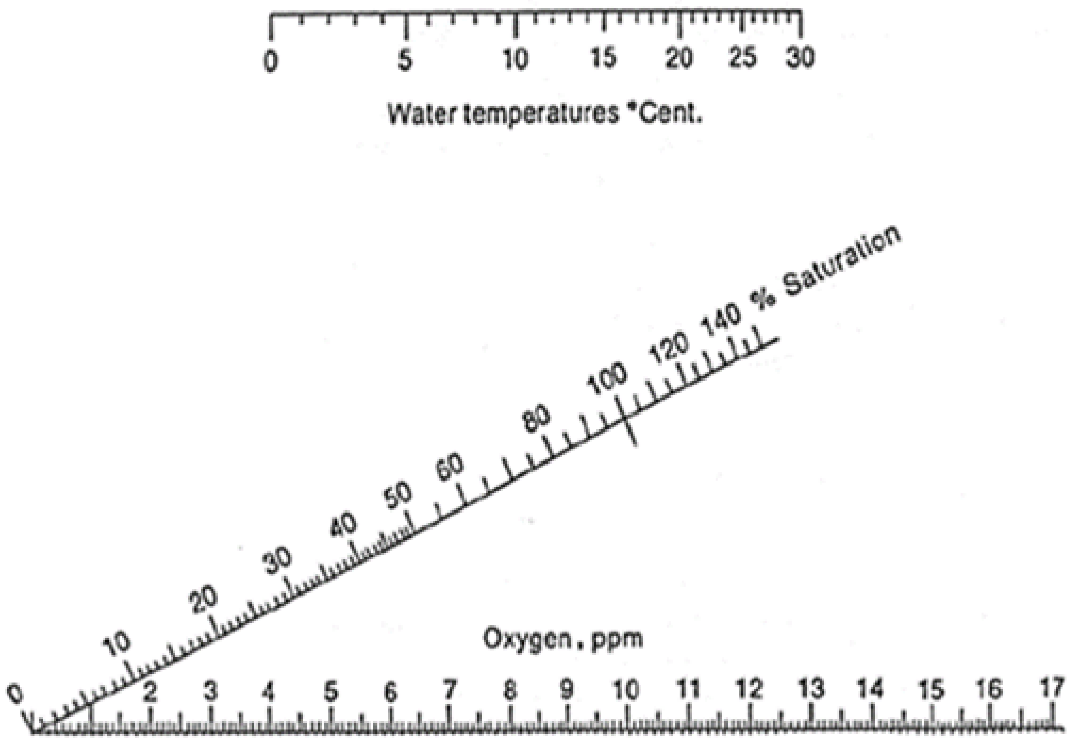


Figure 2. Slow moving lakes produce water conditions that lead to dissolved oxygen readings of over 100% air saturation. This situation allows an incresed incidence of photosynthesis.

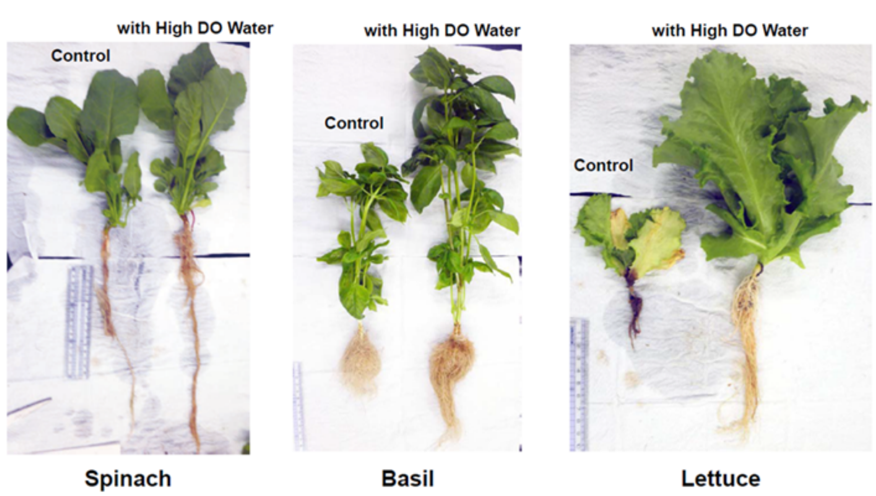
Field Data

For a quick and easy determination of the percent saturation value for dissolved oxygen at a given temperature, use the saturation chart below. Pair up the mg/l of dissolved oxygen you measured and the temperature of the water in degrees C. Draw a straight line between the water temperature and the mg/l of dissolved oxygen. The percent saturation is the value where the line intercepts the saturation scale. Streams with a saturation value of 90% or above are considered healthy, but this of course is only one measure of "health".

DETERMINING PERCENT SATURATION THE "QUICK AND EASY" METHOD.



BENIFITS ACHIEVED BY USING 350% ULTRA-OXYGEN WATER



"High DO water" contained 20 ppm of DO, which was produced with pure oxygen micro-bubbles released from Ultra-OXYGEN.

"*You cant manage it if you cant measure it.*" - Dissolved oxygen (DO) , readings are essential to managing water quality.

Summary

Dissolved oxygen is simply the amount of oxygen (O2) dissolved in water. It's one of the best indicators of the quality, and the life-supporting ability, of water. People need the right amount of oxygen in the atmosphere to survive. And, just as fish need the right amount of dissolved oxygen in the water to survive and thrive, so do plants.

Measured in mg/l, as a percent of saturation (%) or in parts per million (ppm), dissolved oxygen levels are affected by the temperature and salinity of the water, and also by other chemical and/or biological demands (COD/BOD) of the water. Cold water can hold more dissolved oxygen than warm water (see Figure 1) and fresh water can hold more dissolved oxygen than salt water. The maximum amount of DO that the water can hold is called the saturation value. It's possible, and very often desired—especially in a greenhouse—to exceed the natural saturation point of DO in water. This is called super-saturation.

At levels around 5 mg/l of dissolved oxygen, irrigation water is typically considered marginally acceptable for plant health. Most greenhouse crops, however, will perform better with higher levels. Levels of 8 mg/l or higher are generally considered to be good for greenhouse production and much higher levels, as high as 30 mg/l or more, are achievable and can be beneficial. If the DO levels are below 4 mg/l, the water is hypoxic and becomes very detrimental, possibly fatal, to plants and animals. If there's a severe lack of DO, below around 0.5 mg/l, the water is anoxic. No plants or animals can survive in anoxic conditions.

Research shows that higher dissolved oxygen levels in the root zone of most crops results in a higher root mass. A plant with more root mass grows healthier and faster. A plant's roots are where it gets the majority of its inputs for growth, including water and nutrients. Healthy roots with a good supply of oxygen have better respiration and are able to selectively absorb more ions in solution, such as the vital mineral salts nitrogen, phosphorus and potassium.

While it is clear that super-saturation of water is possible, Ultra-OXYGEN advise to always use the correct solution, MB/UFB generating equipment, and DO measuring equipment as specified by Ultra-OXYGEN professionals.

+27 6 0786 1355
heindre@ultra-oxygen
ultra-oxygen.com

ULTRA O_2