

Ocean Acidification

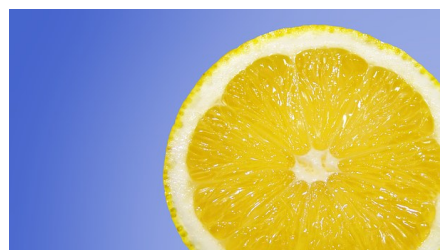
The emission of carbon dioxide (CO_2) by humans into the atmosphere has an enormous impact on Earth's oceans. One of these impacts is the acidification of seawater (lowering of pH). Ocean acidification is predicted to increase by 170 percent this century. So, what does this mean? And how can you explain the changes using basic chemistry? This article will answer those questions.



Human emissions of carbon dioxide have a large impact on Earth's atmosphere and oceans.

Explaining pH value

First, it is important to understand the meaning of pH values. pH is a numeric scale used in chemistry to describe the acidity or basicity of a substance. "Basic" in this context does not mean simple, rather it refers to a chemical property of the substance. While there are many types of ions within a solution, pH value is based on the concentration of hydrogen ions (H^+) and hydroxide ions (OH^-). The pH scale is a set of standard solutions whose pH value has been internationally agreed upon. A substance is acidic if the pH is less than 7, and it is basic if the pH is greater than 7. Acidic liquids contain more H^+ while basic liquids contain more OH^- . The scale generally ranges from 0-14 (although there are

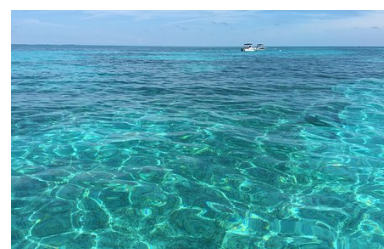


Lemons are very acidic, having a pH value of 2.2.

no official boundaries) with 7 in the middle. Pure water is neutral and therefore has a pH of 7, lemons contain a lot of acids and have a pH of 2.2, chicken soup has a pH of 5.8, and household bleach has a pH of 12.8. The pH value of the surface water of the oceans has decreased since the Industrial Revolution (late 1700s to early 1800s) by 0.1 pH units. To be precise, it decreased from 8.25 to 8.14 in the period between 1751 and 1994. Since the pH scale is logarithmic, this change represents a 30 percent increase in acidity.

The relationship between CO_2 and pH

So how does CO_2 affect the pH value? CO_2 enters water (H_2O) and the two react, forming carbonic acid (H_2CO_3). Soon after carbonic acid is formed, it splits into bicarbonate ions (HCO_3^-) and hydrogen ions (H^+). This increase in the number of hydrogen ions makes the seawater more acidic. This process is called ocean acidification.



Carbon dioxide reacts with water to produce carbonic acid, which splits into bicarbonate and hydrogen ions. Hydrogen ions increase the acidity of seawater.

How does it get there? The global warming issue

Since the Industrial Revolution, beginning in the late 1700s, emissions of CO₂ have skyrocketed. The consequences of increasing atmospheric CO₂ are largely agreed upon by climate scientists. These consequences are summed up as “global warming” or “global climate change”. In short, the gases in the atmosphere (primarily CO₂, but also methane) function as a sort of blanket



Increased gases in the atmosphere, primarily CO₂ and methane, create a blanket effect, preventing the Sun's energy from being reflected into space, thus warming the planet.

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Consequences

Recall that the reaction between CO₂ and water (H₂O) eventually produces bicarbonate ions (HCO₃⁻) and hydrogen ions (H⁺). Many organisms depend on carbonate ions (CO₃²⁻) combined with calcium ions (Ca²⁺) to create calcium carbonate (CaCO₃), which is used to build shells and maintain coral skeletons. When H⁺ ions increase, they react with the carbonate ions, preventing the development of CaCO₃, making it harder for these



Marine species such as corals and clams are negatively affected by ocean acidification.

organisms to develop and grow. Too many H⁺ ions cannot only prevent growth, but can also dissolve shells and coral skeletons. This affects snails, oysters, clams, and several coral species, among others. Weaker shells make the organisms more vulnerable to predators. More acidic water also

acidifies bodily fluids, raising respiratory stress and depressing metabolic rates and

immune responses. Organisms need to expend more energy to sustain their cellular functions. The consequences don't stop here however. These organisms are part of a very complete food web so when their population is altered, it creates a cascade effect that impacts many other species as well.

Put a cap on it!

Since scientists concluded that CO₂ emissions are changing our planet, reduction of atmospheric CO₂ is a top priority. The countries of the United Nations initiated an annual climate change conference in 1995. They began by negotiating the Kyoto Protocol: a set of legally-binding obligations for developed countries to reduce their emissions. During these annual meetings, dubbed "The United Nations Framework Convention on Climate Change (UNFCCC)", emissions are assessed for each participating country and action plans are developed for further reduction.



The UN established an annual climate change conference to monitor participating countries' emissions and plan future emissions reductions.

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Reading Comprehension Questions:

1. What is pH? Which types of ions are mainly involved?
2. Using
3. Which
4. True or false: the presence of HCO_3^- lowers the pH of water. If false, explain your answer.
5. Describe
6. How is ocean acidification related to global warming?
7. What is the

Extension Questions:

8. Describe how ocean acidification leads to weaker shells and coral skeletons.
9. Explain

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References

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