pH and Alberta Lakes

Highlights

- Normal range for pH in Alberta lakes is about 6.5-9.5
- pH higher or lower than the normal range can result in decreased in aquatic species.
- Factors that can influence pH include:
  - Geology
  - Carbon dioxide in the atmosphere
  - Photosynthesis
  - Plant decomposition
  - The age of the lake
  - Natural or human disturbances in the watershed

What is pH?

pH is measured on a scale of 1 to 14. Strongly acidic solutions are assigned a value of 1. Strongly basic solutions are assigned a value of 14. Neutral solutions are assigned a value of 7. When the pH is less than 7 the solution is acidic. When the pH is 7, the solution is neutral. When pH is above 7 the solution is basic

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Acidic Neutral Basic

Highest amount of hydrogen — Lowest amount of hydrogen

The degree of pH is determined by the amount of hydrogen (ions) in a solution. Solutions with a high amount of hydrogen (ions) are acidic. Solutions with a low amount of hydrogen (ions) are basic or alkaline.

Each time the number increases on the pH scale the amount of hydrogen (ions) decrease by ten times (as pH numbers increase, hydrogen ions decrease).
Examples

- A pH of 2 has 10 times less hydrogen than a pH of 1.
- A pH of 3 has 10 times less hydrogen than a pH of 2.

What is a pH test?

A pH test determines the concentration of hydrogen ions in a solution in order to give an indication of the solution's acidity.

For the pH test in the Alberta Water Quality Monitoring Day kit, tablets are added to a sample of water. These tablets cause a reaction and the water sample will change color based on the amount of hydrogen (ions) in the sample. By comparing the color of the sample to a color-coded chart in the kit, the pH of the sample can be determined. This color-based pH test is the most simple and inexpensive method for getting and indication of pH in a sample.

What is the normal range of pH in Alberta?

The rocks and minerals in an area (geology) strongly influence the natural pH of surface water. Over time, the bedrock and soil in a given area weather and will be flushed into lakes as rainwater flows over land and drains into lakes.

Most lakes in Alberta are located in carbonate–rich basins that were deposited a long time ago by glaciers. These lakes tend to be alkaline and have a pH of between 7 and 10. In contrast, lakes in the far northeast area of the province tend to have a pH slightly below 7. This area has different geology. It is Canadian Shield and is mainly made up of carbonate-poor, hard, igneous rock such at granite.

Why is pH important?

Most aquatic organisms can only survive within a certain pH range. Generally, the more neutral the pH, the greater the number and variety of organisms that can survive. Water with a pH of 6.5 to 8.5 is suitable for most aquatic organisms. If pH moves either higher or lower, the number of individuals and the number of species will decline

Water quality is greatly affected by pH. Of greatest concern is the influence of pH on the solubility of common metal elements. With decreasing pH, metals become increasingly solubilized (mobilized) and available for uptake by aquatic organisms. In dissolved form, metals can cause extreme physiological damage to most forms of aquatic life and thus most plants and animals tend to be very sensitive to pH and are intolerant of pH below 5.7. Few organisms can survive below a pH of 4. Fortunately, only a few examples of acidic lakes (pH less than 6.0) exist in Alberta.

pH and Lake Trout

Schindler et al. (1985) found large ecosystem changes when the pH of an Ontario study lake dropped below 6. Fat head minnows and possum shrimp populations stopped reproducing and their numbers declined. As a result, the lake trout relying on the minnows and shrimp for their food supply began to starve and their numbers also dropped.

High pH levels can also be toxic and most aquatic organisms are intolerant of environments with a pH greater than 9. Cyanobacteria are a notable exception. They not only prefer higher pH conditions (up to about 10), but are capable of increasing pH through excessive photosynthesis. This is usually detrimental to the growth of other phytoplankton. This is one reason why cyanobacteria dominate the communities within many of Alberta's alkaline (higher pH) lakes. Due to the predominance of carbonate-rich sedimentary rock and soils, most lakes in Alberta tend to be alkaline.

What influences pH in surface waters?

As indicated above, the **geology** of an area affects the natural pH of a lake. Another natural factor affecting pH is **carbon dioxide in the atmosphere**. As carbon dioxide mixes with water it lowers pH (increases acidity). However, since Alberta's surface waters tend to be alkaline atmospheric carbon dioxide has little effect on overall pH levels.

In contrast, **photosynthesis** by aquatic plants removes carbon dioxide from the water, which can significantly increase pH. This is especially important in slow flowing or still waters that contain abundant plant life (including planktonic algae). An increase in pH can be expected during the growing season. In deep lakes, pH may be higher in the upper illuminated layers of the water column where photosynthesis occurs and be lower in deeper 'darker' depths where photosynthesis does not occur. Also, **carbon dioxide released during the decomposition** of biological material on the lake bottom would of course decrease pH.

Fertilizers and pH

Improper fertilizing can lead to high amounts of nutrients running off into lakes as rainfall washes over the land and drains into a lake. The high amounts of nutrients can lead to large blooms of algae. These algae remove carbon dioxide from the water during photosynthesis. This can also result in an increased in pH.

In lakes and ponds, pH is affected by the continuous build-up of **organic materials**. As organic substances decay, carbon dioxide forms and combines with water to produce a weak acid called carbonic acid. Large amounts of carbonic acid lower the water's pH. Hence, most lakes are basic when they are first formed and become more acidic with time.

Other **events or disturbances** in the watershed may also affect pH. As water percolates though the soil, it absorbs minerals. Eventually this water can drain into lakes and other surface waterbodies. Increased amounts of water during snowmelt or heavy rain can lead to greater mineral absorption, which affect the pH in a lake.

Similarly, **human activities** such as accidental spills, agricultural runoff (pesticides, fertilizers, soil leachates), sewer overflow and discharge of chemicals by communities and industries can have significant affects on pH levels.

Lastly, atmospheric release of sulphur and nitrogen oxides can mix with rain to produce acid rain that can have severe negative impacts on surface waters.

Electricity and pH

The majority of electricity generated in Alberta is produced through burning coal. The emissions produced by burning coal contain nitrogen and sulfur oxides. They combine in the atmosphere to produce sulfuric acid. This product can then end up in rivers and streams through precipitation (acid rain) and cause a decrease in pH (increased acidity).

References:

Schindler, D.W., Mills, K.H., Malley, D.F., Findlay, D.L., Shearer, J.A., Davies, I.J. Turner M.A., Lindsey, G.A. and Cruikshank, D.R. 1985. Long-term ecosystem stress: the effects of years of experimental acidification of a small lake. Science 228, 1395-1401.