# 5.4 pH

## *What Is pH and why is it important?*

pH is a term used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. Acidity increases as the pH gets lower. Fig. 5.9 present the pH of some common liquids.

pH affects many chemical and biological processes in the water. For example, different organisms flourish within different ranges of pH. The largest variety of aquatic animals prefer a range of 6.5-8.0. pH outside this range reduces the diversity in the stream because it stresses the physiological systems of most organisms and can reduce reproduction. Low pH can also allow toxic elements and compounds to become mobile and "available" for uptake by aquatic plants and animals. This can produce conditions that are toxic to aquatic life, particularly to sensitive species like rainbow trout. Changes in acidity can be caused by atmospheric deposition (acid rain), surrounding rock, and certain wastewater discharges.

The pH scale measures the logarithmic concentration of hydrogen ($H^+$) and hydroxide ($OH^-$) ions, which make up water ($H^+ + OH^- = H_2O$). When both types of ions are in equal concentration, the pH is 7.0 or neutral. Below 7.0, the water is acidic (there are more hydrogen ions than hydroxide ions). When the pH is above 7.0, the water is alkaline, or basic (there are more hydroxide ions than hydrogen ions). Since the scale is logarithmic, a drop in the pH by 1.0 unit is equivalent to a 10-fold increase in acidity. So, a water sample with a pH of 5.0 is 10 times as acidic as one with a pH of 6.0, and pH 4.0 is 100 times as acidic as pH 6.0.

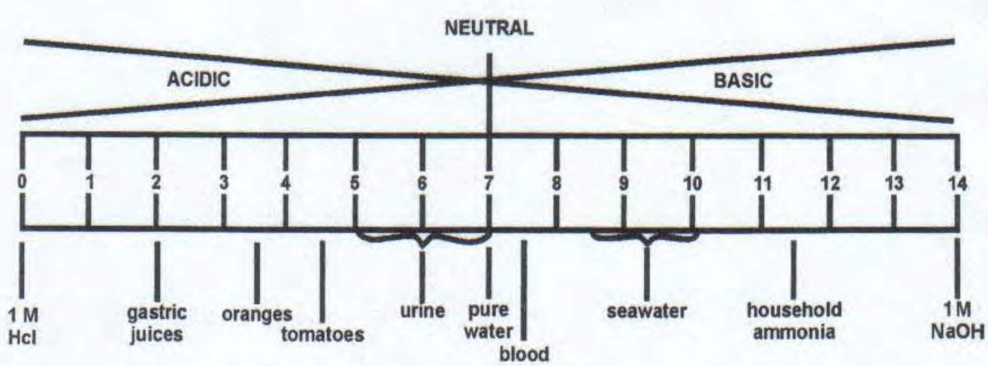
## *Analytical and equipment considerations*

pH can be analyzed in the field or in the lab. If it is analyzed in the lab, you must measure the pH within 2 hours of the sample collection. This is because the pH will change due to the carbon dioxide from the air dissolving in the water, which will bring the pH toward 7.

If your program requires a high degree of accuracy and precision in pH results, the pH should be measured with a laboratory quality pH meter and electrode. Meters of this quality range in cost from around $250 to $1,000. Color comparators and pH

**Figure 5.9**

**pH of selected liquids**



"pocket pals" are suitable for most other purposes. The cost of either of these is in the $50 range. The lower cost of the alternatives might be attractive if you are relying on several teams of volunteers sampling multiple sites at the same time.

#### pH Meters

A pH meter measures the electric potential (millivolts) across an electrode when immersed in water. This electric potential is a function of the hydrogen ion activity in the sample. Therefore, pH meters can display results in either millivolts (mV) or pH units.

A pH meter consists of a *potentiometer*, which measures electric current; *a glass electrode*, which senses the electric potential where it meets the water sample; a reference electrode, which provides a constant electric potential; and a *temperature compensating device*, which adjusts the readings according to the temperature of the sample (since pH varies with temperature). The reference and glass electrodes are frequently combined into a single probe called a *combination electrode*.

There is a wide variety of meters, but the most important part of the pH meter is the electrode. Buy a good, reliable electrode and follow the manufacturer's instructions for proper maintenance. Infrequently used or improperly maintained electrodes are subject to corrosion, which makes them highly inaccurate.

#### pH "Pocket Pals" and Color Comparators

pH "pocket pals" are electronic handheld "pens" that are dipped in the water and provide a digital readout of the pH. They can be calibrated to one pH buffer (lab meters, on the other hand, can be calibrated to two or more buffer solutions and thus are more accurate over a wide range of pH measurements).

Color comparators involve adding a reagent to the sample that colors the sample water. The intensity of the color is proportional to the pH of the sample. This color is then matched against a standard color chart. The color chart equates particular colors to associated pH values. The pH can be determined by matching the colors from the chart to the color of the sample.

## *How to collect and analyze samples*

The field procedures for collecting and analyzing samples for pH consist of the following tasks.

**TASK 1** **Prepare the sample containers**

Sample containers (and all glassware used in this procedure) must be cleaned and rinsed before the first run and after each sampling run by following the procedure described under Method A on page 128. Remember to wear latex gloves.

**TASK 2** **Prepare before leaving for the sampling site**

Refer to pages 19-21 for details on confirming sampling date and time, picking up and checking supplies, and checking weather and directions. In addition to the standard sampling equipment and apparel, when sampling for pH, include the following equipment:

- pH meter with combination temperature and reference electrode, or pH "pocket pal" or color comparator
- Wash bottle with deionized water to rinse pH meter electrode (if appropriate)
- Data sheet for pH to record results

Before you leave for the sampling site, be sure to calibrate the pH meter or "pocket pal." The pH meter and "pocket pal" should be calibrated prior to sample analysis and after every 25 samples according to the instructions that come with them.

If you are using a "pocket pal," use the buffer recommended by the manufacturer. If you are using a laboratory grade meter, use two pH standard buffer solutions: 4.01 and 7.0. (Buffers can be purchased from test kit supply companies, such as Hach or LaMotte.) Following are notes regarding buffers.

- The buffer solutions should be at room temperature when you calibrate the meter.
- Do not use a buffer after its expiration date.
- Always cap the buffers during storage to prevent contamination.
- Because buffer pH values change with temperature, the meter must have a built-in temperature sensor that automatically standardizes the pH when the meter is calibrated.
- Do not reuse buffer solutions!

**TASK 3** **Collect the sample**

Refer to page 128 for details on how to collect water samples using screw-cap bottles or Whirl-pak® bags.

**TASK 4** **Measure pH**

The procedure for measuring pH is the same whether it is conducted in the field or lab.

If you are using a "pocket pal" or color comparator, follow the manufacturer's instructions. Use the following steps to determine the pH of your sample if you are using a meter.

1. Rinse the electrode well with deionized water.
2. Place the pH meter or electrode into the sample. Depress the dispenser button once to dispense electrolyte. Read and record the temperature and pH in the appropriate column on the data sheet. Rinse the electrode well with deionized water.
3. Measure the pH of the 4.01 and 7.0 buffers periodically to ensure that the meter is not drifting off calibration. If it has drifted, recalibrate it.

**TASK 4** **Return the field data sheets and samples to the lab or drop-off point.**

Samples for pH must be analyzed within 2 hours of collection. If the samples cannot be analyzed in the field, keep the samples on ice and take them to the lab or drop-off point as soon as possible within the 2-hour limit.

## References

APHA. 1992. *Standard methods for the examination of water and wastewater.* 18th ed. American Public Health Association, Washington, DC.

River Watch Network. 1992. Total alkalinity and pH field and laboratory procedures (based on University of Massachusetts Acid Rain Monitoring Project). July 1.