EAR 419/619 – Aqueous Geochemistry

Lab #2: Alkalinity and pH

Alkalinity and pH

**Background**

Alkalinity is a measure of the capacity of an aqueous solution to neutralize acids. Alkaline compounds in the water, such as bicarbonate, carbonate, and hydroxide, combine with H+ to make new compounds, thereby removing H+ ions from solution and decreasing acidity (which means increasing pH). Without this acid-neutralizing capacity, any acid added to a stream would cause an immediate drop in stream pH, which could harm the ecosystem. Measuring alkalinity is important for determining a stream's ability to neutralize acidic pollution from rainfall or wastewater. It's one of the best measures of the sensitivity of the stream to acid inputs.

Alkalinity in streams is influenced by rocks and soils, salts, certain plant activities, and certain industrial wastewater discharges.

Total alkalinity is quantified as the amount of acid (e.g., sulfuric acid) that is needed to lower the pH of a water sample to 4.2. At this pH, all the alkaline compounds in the sample are "used up.” Alkalinity is often reported as milligrams per liter of calcium carbonate (mg/L CaCO3), by doing which other alkalinity-contributing species are converted to the equivalent amount of CaCO3.

***This lab consists of two parts. In the first part, you will need to use a web-based chemical reaction simulator, ChemReaX, to perform a virtual acid-base titration and to generate a titration curve. In the second part, you will learn how to use a portable meter to measure basic water quality parameters.***

**Objectives**

* Learn to record pH/conductivity/temperature using a water meter
* Generate a titration curve by monitoring changes in pH during acid titration
* Calculate alkalinity for a standard solution and a natural water sample

**Part I: Computer Lab**

**Titration:**

1. Go to the ChemReaX website: <https://www.sciencebysimulation.com/chemreax/AnalyzerAB.aspx>
2. Ensure that you are on the “Acid-Base Titrations” tab. Click “Clear All” to reset ChemReaX
3. Choose “H2CO3” as the titrand (a titrand refers to the compound being analyzed in the titration) and choose “NaOH” as the titrant (a titrant is the compound in the titration burette, mostly its concentration is exactly known).
4. Change the “Total Amount Added (L)” to 3 liters for the NaOH solution. Keep other parameters at default values.
5. After entering the above values, simulate the reaction by clicking “Run the Reaction”. Scroll down to see the simulated titration results and answer the following questions. Include your answers in the Lab 2 write-up.

**Questions to be answered and included in the Lab 2 write-up:**

1. Include the titration curve you derived from the above simulation.
2. In the same titration curve, mark the inflection points on the titration curve.
3. For the above titration curve, write a couple complete sentences explaining why there is variation in the rate of pH change per addition of base.

**Alkalinity Calculation:**

For this sub-part, you do not need to use the ChemReaX website. Instead, assuming the other titration in which the titrand is 40 mL of a solution containing 5.5 mM Na2CO3 + 34.5 mM NaHCO3 and the titrant is the strong acid (1.6 N H2SO4). The derived titration curve is shown below in which two inflection points are noted. Note: the x-axis refers to the number of click of the digital titrator. Each click will release 1/800 mL of acid.



With these, answer the following questions and include them in the Lab 2 write-up

**Questions to be answered and included in the Lab 2 write-up:**

1. Calculate alkalinity for the above titrand by following the equation below:

Alkalinity (mg/L CaCO3) = (B x N x 50,000)/V

B = the volume of acid (mL) to reach pH 4.2

N = the normality of the acid (*N* units are equal to mole equivalents per L);

V = volume of sample (mL)

50,000 = factor that converts eq/L of neutralized acid to mg/L CaCO3; each mole of CaCO3 can neutralize two H+ by converting CO32- to HCO3- then HCO3- to H2CO3. The molecular mass of CaCO3 is 100.09 g/mol.

1. Use the Henderson-Hasselbalch equation to determine the concentration of bicarbonate (HCO3-) at the final equivalent point of the titration of the above solution.
2. How would you determine whether your water samples are oversaturated or undersaturated with respect to carbonate minerals (e.g., calcite)?

**Part II: Chemistry Lab**

In this part, you will learn how to use the water meter to measure the basic water quality parameters. Following the instruction below and answer the relevant questions.

1. Calibrate the water meter (Instructor will demonstrate how to calibrate the water meter for EC and pH)
2. Measure pH, EC, TDS, and temperature of three different solutions: DI water, water from the drinking water fountain, and tap water

**Questions to be answered and included in the Lab 2 write-up:**

1. Finish the above measurements for all three aqueous solutions. Include your results in the following table and in your Lab 2 write-up

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Solution | pH | EC (ms/cm) | TDS (mg/L) | Temperature (°C) |
| DI water |  |  |  |  |
| Water fountain |  |  |  |  |
| Tap water |  |  |  |  |