Optional Salinity Titration Protocol

Purpose

To measure the salinity of the water using a salinity titration kit

Overview

Students will use a salinity titration kit to measure the salinity of the at a hydrology site.

Student Outcomes

Students will be able to measure salinity using a chemical kit, hypothesize about reasons for changes in salinity and provide parameters for interpretation of salinity data.

Science Concepts

Earth and Space Science

- Water is a solvent.
- Tides are caused by gravity.

Physical Science

- Water has characteristic properties, such as density and solubility.

Life Science

- Organisms can survive only in environments where their needs are met.

Scientific Inquiry Abilities

- Use a chemical kit to measure salinity.
- Identify answerable questions.
- Design and conduct scientific investigations.
- Use appropriate mathematics to analyze data.
- Develop descriptions and explanations using evidence.
- Recognize and analyze alternative explanations.
- Communicate procedures and explanations.

Time

10 minutes

Quality control – 10 minutes

Level

All

Frequency

Weekly

Quality control check every 6 months

Materials and Tools

- Salinity Titration Test Kit
- *Hydrology Investigation Data Sheet*
- *Quality Control Procedure Data Sheet*
- Latex gloves
- For quality control procedure
  - Salt (NaCl)
  - Distilled water
  - Balance
  - 500-mL clear graduated cylinder

Preparation

Suggested Learning Activities:

Practicing Your Protocols: Salinity

Water Detectives

Prerequisites

Instruction on reading a tide table

Optional Salinity Titration Protocol – Introduction

Although many different ions in ocean water contribute to salinity, six ions account for over 99% of the dissolved material. In the ocean, these six ions are very well mixed and are found in nearly constant proportions: chloride (Cl^-), 55.0%; sodium (Na^+), 30.6%; sulfate (SO_4^{-2}), 7.7%; magnesium (Mg^{+2}), 3.7%; calcium (Ca^{+2}), 1.2%; and potassium (K^+), 1.2%.

Because these ions are in nearly constant proportions, we can measure the concentration of one major constituent and then estimate the total salinity. Since chloride is the most abundant ion, it is the easiest to measure accurately. The chloride concentration, or *chlorinity,* is expressed in grams of chloride ion per kilogram of seawater. Salinity can be determined from chlorinity by the following formula:

Salinity (ppt) = Chlorinity (ppt) x 1.80655

Salinity Titration Procedure

Chlorinity is measured by titration in a fairly simple procedure. First an indicator, potassium chromate, is added to a carefully measured volume of sample. This reagent produces a yellow color. Then, a silver nitrate solution of a standard concentration is added as the titrant. The silver reacts with chloride in the sample to form a white precipitate, silver chloride. When all the chloride has been precipitated, the next portion of silver nitrate added forms red-colored silver chromate, producing the pinkish-orange endpoint.

Chloride concentration is calculated from the size of the sample and the concentration and amount of the silver nitrate used. Some test kits incorporate the conversion formula into their design so that salinity may be read directly. These kits will have "direct-read titrators". Because of the high levels of chloride in most samples, often the sample is diluted with distilled /deionized water to make the titration easier.

Some types of test kits (different indicators, different titrating solutions) may produce different color changes, but the principle is the same.

Teacher Support

Please look at the salinity protocol for the hydrometer method for discussions on salinity and tides.

Notes on Salinity Titration Kits

- Use a salinity titration test kit that meets the Globe Instruments Specifications in the Toolkit. The kits are based on the technique of adding a color indicator to the sample and then adding an acid titrant one drop at a time until color change is observed.
- As always when using chemicals and sample water, use gloves and googles.
- You will need to read and follow the instructions in the salinity titration kit. The chemical wastes from the salinity titration method are hazardous and need to be disposed of properly. Consult your school authorities for the required procedures you need to follow.

Helpful Hints

Which instrument should you use?

Hydrometer

Advantages
Easy and quick to use
No chromium by-products
Disadvantages
Breakable

Salinity titration

Advantages
Less math involved
Practice in chemistry
Disadvantages
Chromium by-products
Takes more time to take measurement

Frequently Asked Questions

1. How come the standard for the salinity titration methods measures 38.6 ppt while the standard for the hydrometer method measures 35 ppt? The standards are made exactly the same way.

The hydrometer measurement is based the actual density of the ocean water. In the titration measurement, you are only measuring chlorine. In seawater, there in a constant ratio between chlorine and other anions, which is taken into account in the values you get when you measure the salinity of ocean water. These other anions are not present in the standard. To calculate the seawater salinity from 17.5 g NaCl in 500 mL (35 ppt NaCl), you need to take into account the molecular composition of NaCl. The ratio of the molecular weight of Cl to NaCl is 0.61. So, 35 ppt x 0.61 = 21.35 ppt chlorinity of the sample. The kits have been designed to use the constant ratio of chlorine and other anions to convert the chlorinity value to a salinity value. To do this the ppt chlorinity value (here it is 21.35) is multiplied by a conversion constant of 1.80655. 21.35 ppt x 1.80655 = 38.6 ppt.

Quality Control Procedure for Salinity Optional Titration Protocol

Lab Guide

Task

Check your chemical titration skills.

What You Need

- ❑ Salinity Titration Test Kit (See *Toolkit*)
- ❑ *Quality Control Procedure Data Sheet*
- ❑ Latex gloves
- ❑ 1-liter plastic bottle
- ❑ Table salt
- ❑ Distilled water
- ❑ Masking tape
- ❑ 500-mL clear plastic graduated cylinder
- ❑ Balance

In the Lab

Mix the 38.6 ppt standard

1. Measure 17.5 g of table salt (NaCl) with the balance.
2. Pour the salt into the 500-mL cylinder.
3. Fill the cylinder to the 500-mL line with distilled water.
4. Gently mix the salt and water until all of the salt is dissolved. This is your 38.6 ppt standard. **Note:** This standard may be kept up to one year in a tightly closed bottle.

Check your Test Kit and Technique

1. Follow the directions in your Salinity Titration Test Kit, using the 38.6 ppt standard instead of sample water.
2. Record the value of the standards after testing on the *Quality Control Procedure Data Sheet*.
3. If salinity standards are off by more than 0.4 ppt, prepare new standards and repeat the measurement.

Salinity Protocol (Optional Titration)

Field Guide

Task

Measure the salinity of your water sample

What You Need

- ❑ Tide Table for your area
- ❑ *Hydrology Investigation Data Sheet*
- ❑ Salinity Titration Test Kit
- ❑ Latex gloves
- ❑ Pen or pencil

In the Field

1. Fill out the top portion of your *Hydrology Investigation Data Sheet.*
2. In the Salinity section of the *Data Sheet,* record the times of the high tide and low tide that occur before and after your salinity measurement is taken. Also record the place where the times from your Tide Table occur.
3. Put on gloves.
4. Follow the manufacturer's instructions on the kit. To titrate more saline water than 20 parts per thousand (ppt), you may need to refill the titrator with acid. Keep a record of the total amount of acid used (20 ppt + amount used in refilled titrator).
5. Record the salinity in ppt on the *Hydrology Investigation Data Work Sheet.*
6. Have two other students repeat Steps 3-6, recording their salinity measurements as Observers 2 and 3.
7. Calculate the average of the three measurements.
8. Each of the three measurements should be within 1 ppt of the average. If one or more of the observations is not within 1 ppt, do the measurement again and calculate a new average. If the measurements are still not within 1 ppt of the new average, talk to your teacher about possible problems.
9. Put all liquids in waste bottles and give to your teacher for proper disposal.