Salinity Testing

Introduction

When we use water to irrigate crops it is very important to take into account the salt ion concentrations because of the effects, both good and bad, that the ions have on plants. We can determine the salinity of water by the concentration of four major salts: sodium chloride, sodium bicarbonate, magnesium sulfate, and calcium sulfate. Of those four salts, the most common is sodium chloride. Too much sodium can prevent plants from taking up the water and too much chloride can be toxic. Therefore it is important for farmers to monitor the salt content of their irrigation water.

In developed countries like the United States, a farmer can send a sample of his or her water to a lab at relatively low cost to be analyzed by electrical conductivity measurements. In developing nations, such as many in Africa, water testing is much less available and can be prohibitively expensive for small-scale farmers. Therefore it would be useful to have a low-tech water test that allows farmers to detect and even quantify the presence of certain ions in their irrigation water.

Paper Analytical Devices (PAD)

A paper analytical device (PAD) is a low-cost, easy way of doing chemistry such as salinity testing in the field. The PAD can be made ahead of time and stored in a sealed package for later use. Once it is used, the user can read it immediately or take a picture with a cell phone camera and send it to a computer for analysis with imaging software.

In this assignment you will create and use a PAD to test for the presence of chloride ions in water.

Materials Needed

- Whatman no. 1 Filter paper
- oven, set to approximately 60°C
- 1 M silver nitrate
- 10, 25, 55, and 80 mM potassium chromate solutions
- micropipette or disposable dropper
- sample of salt water
- safety goggles
- gloves

SAFETY NOTE: Do NOT dispose chromate solutions down the sink. It is a hazardous chemical that contaminates drinking water. Please dispose of all chromate solutions and materials that have touched chromate solutions in the disposal containers provided by your teacher.

Pre-lab questions

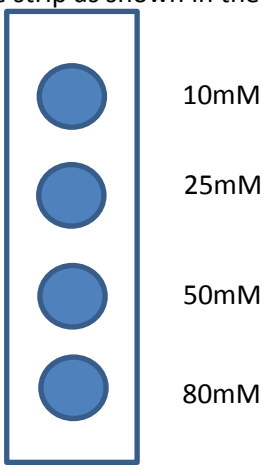
1. To create your PAD you will use silver nitrate and potassium chromate.
   a) Write the balanced reaction between silver nitrate and potassium chromate.

   b) What is the likely precipitate that will form on the paper?

2. Write the balanced reaction between silver chromate and sodium chloride.

Procedure for creating the PAD

1. Cut a 10 x 4 cm strip from the filter paper. Place the strip on top of 2-3 paper towels to protect the lab bench.
2. Using the dropper, completely saturate the strip with 1 M silver nitrate. Be careful not to get it on your skin
3. Put the strip into the oven to dry. Allow it to dry almost completely but don't let the edges brown.
4. Using your micropipette (or dropper), drop 7µL (or one small drop from a disposable dropper) of each chromate solution onto the strip as shown in the image below. A reddish precipitate should form.



5. Put the strip back in the oven and allow it to dry.
6. Once dry, use a wash bottle filled with distilled water to rinse away the excess silver nitrate for 2 minutes. Do this over a waste beaker or sink.
7. Place the strip back in the oven and allow it to dry completely.

Testing

1. Pour a sample of salt water into a beaker or glass dish.
2. Immerse the strip in the dish for about 15 seconds, then remove and place it on a paper towel.
3. Allow the strip to dry while you answer the questions in the Analysis section.

Analysis/Conclusions

3. Using what you know about solubility product, explain why the silver chromate color fades. What is most likely happening? Explain how you know.

4. Could you create a similar test for another anion (sulfate or bicarbonate)? If yes, propose a reaction and explain why you think it will work. If not, explain why not.

5. Research chromium in water and explain the downsides of using this reaction to test irrigation water.

The Next Step

What are the challenges/obstacles involved with this method? How would you improve them? Decide on an improved method, then perform an experiment to see if it works.