Technical Assistance
HYDROLOGY PROJECT

World Bank & Government of The Netherlands funded

Training module # WQ - 44

How to Measure Sodium

New Delhi, September 2000

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with
HALCROW, TAHAL, CES, ORG & JPS

Table of contents

1. Module context

This module deals with the significance of sodium to water quality and method for measuring sodium. Modules in which prior training is required to complete this module successfully an other available, related modules in this category are listed in the table below.

While designing a training course, the relationship between this module and the others, would be maintained by keeping them close together in the syllabus and place them in a logical sequence. The actual selection of the topics and the depth of training would, of course, depend on the training needs of the participants, i.e. their knowledge level and skills performance upon the start of the course.

No.	Module title	Code	Objectives
1.	Basic water quality concepts	**WQ - 01**	• Discuss the common water quality parameters • List important water quality issues
2.	How to prepare standard solutions	**WQ – 04**	• Select different types of glassware • Use an analytical balance and maintain it • Prepare standard solutions
3.	Major ions in water	**WQ - 28**	• Know the major ions in water and air sources • Understand the significance of major ion concentrations
5.	Emission Spectroscopy and Nephelometry	**WQ - 35**	• Understand the principles of emission spectroscopy and nephelometry • Explain how emission spectroscopy and nephelometry are used for specific laboratory analyses

2. Module profile

Title	:	How to Measure Sodium
Target group	:	HIS function(s): Q2, Q3, Q5, Q6
Duration	:	Theoretical session of 30 min, plus Practical Laboratory session of 120 min, plus Report writing session of 30 min.
Objectives	:	After the training the participants will • Understand the relevance of sodium to water quality • Know how to make analysis of sodium.
Key concepts	:	• Flame emission photometry method • Relation of Sodium concentration to different allowed water uses (e.g. irrigation, drinking water)
Training methods	:	Lecture, Laboratory Analytical Exercise, Report preparation
Training tools required	:	Board, flipchart, OHS, Complete Laboratory Facilities for Sodium Analysis
Handouts	:	As provided in this module, Including SAP for Analysis of Sodium
Further reading and references	:	• Chemistry for environmental engineers - C. N. Sawyer, P. L. McCarty & G. F. Parkin, McGraw - Hill, Inc., 1994 • Standard methods for the examination of water and wastewaters, AWWA, 19th edition, 1995

3. Session plan

No	Activities	Time	Tools
1	***Preparations*** • Prepare reagents according to SAP for Na determination • Prepare samples A, B and C using distilled water and sodium standard solution to give 60, 150 and 600 mg/L Na concentration and arbitrarily assign hardness values as 80, 120 and 100, as $CaCO_3$, respectively.		
2	***Introduction*** • Introduce the session • Ask the question, "Why do we need to measure sodium?' • Introduce the subject of sodium to the participants including occurance and standards • Discuss the sodium adsorption ration (SAR) – say why it is important and why Indian standards defer from world standards for this parameter	15 min	Flip chart, OHS
3	***Flame Emmission Photometry Method*** • Describe the basis of the photometric determination of sodium in terms of the theory of emmission photometry • Explain the overall aim of this sodium practical module • Describe the objectives of the analysis of the three water samples provided • Explain the three different water samples without saying which is which • Describe the content of the report and how it should be written	15 min	OHS
4	***Practical Session*** • Allow participants to conduct analysis according to SAP • Stress the need to write-up material as the analysis is proceeding. • Be available to guide participants and answer questions	120 min.	
5.	***Report Writing*** • Allow participants to complete their reports • Give the 'correct answers' to the sodium determinations • Ask participants to suggest reasons between differences in their results and the 'actual results'	30 min	

4. Overhead/flipchart master

OHS format guidelines

Type of text	Style	Setting
Headings:	OHS-Title	Arial 30-36, with bottom border line (not: underline)
Text:	OHS-lev1 OHS-lev2	Arial 24-26, maximum two levels
Case:		Sentence case. Avoid full text in UPPERCASE.
Italics:		Use occasionally and in a consistent way
Listings:	OHS-lev1 OHS-lev1-Numbered	Big bullets. Numbers for definite series of steps. Avoid roman numbers and letters.
Colours:		None, as these get lost in photocopying and some colours do not reproduce at all.
Formulas/ Equations	OHS-Equation	Use of a table will ease horizontal alignment over more lines (columns) Use equation editor for advanced formatting only

Measurement of Sodium

- All natural waters contain sodium as it is one of the earth's most abundant elements
- High sodium in inland waters is normally associated with industrial or sewage pollution or sea water intrusion
- WHO Guideline limit for sodium in drinking waters is 200 mg/L

Sodium Adsorption ratio

$$SAR = \frac{Na^{+}}{\sqrt{\left(Ca^{2+} + Mg^{2+}\right)/2}}$$ *(NB: in milliequivalents)*

- International SAR Standards:
  - *SAR < 3: suitable for irrigation*
  - *SAR 3 – 9: use may be restricted*
  - *SAR > 9 unsuitable for irrigation*
- Indian SAR Standard:
  - *SAR > 26 unsuitable for irrigation*

Flame Photometry Method

- Relies on the fact that the sodium ion emits light at a wavelength of 589 nm when excited in a gas flame
- Intensity of the light produced is proportional to the concentration of the element
- Sodium concentration is read from a calibration curve

Experiment

- Aim:
  - *To determine the concentration of sodium ion in a number of different samples by flame emission photometry*

Experiment (1)

- Method:

  a) *Collect a sample from each of the buckets A, B and C*

  b) *The three samples represent irrigation waters with different concentrations of sodium ion.*

  c) *Determine the sodium in each sample according to SAP.*

  d) *Use the values of the standard solutions to plot a standard curve of sodium versus emission*

Experiment (2)

e) Read the sodium concentration of the three samples from the standard curve.

f) You will be given the concentrations of calcium and magnesium in each sample. Using this information, calculate the SAR for each sample.

Experiment

- Write your report which should include:
  - *the aim of the investigation*
  - *the sodium content of each sample and what that means in terms of water quality*
  - *the SAR of each sample and what this means in terms of their usability for irrigation water in India.*

5. Evaluation sheets

6. Handout

Measurement of Sodium

- All natural waters contain sodium as it is one of the earth's most abundant elements
- High sodium in inland waters is normally associated with industrial or sewage pollution or sea water intrusion
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Flame Photometry Method

- Flame Emission Photometry Method:
  - *Relies on the fact that the sodium ion emits light at a wavelength of 589 nm when excited in a gas flame*
  - *Intensity of the light produced is proportional to the concentration of the element*
  - *Sodium concentration is read from a calibration curve*

Experiment

- **Aim:**
  - *To determine the concentration of sodium ion in a number of different samples by flame emission photometry*

- **Method:**
  a) *Collect a sample from each of the buckets A, B and C*
  b) *The three samples represent irrigation waters with different concentrations of sodium ion*
  c) *Determine the sodium in each sample according to SAP*
  d) *Use the valves of the standard solutions to plot a standard curve of sodium versus emission*
  e) *Read the sodium concentration of the three samples from the standard curve*
  f) *You will be given the concentrations of calcium and magnesium in each sample*

- **Write your report which should include**:
  - *the aim of the* investigation
  - the sodium content of *each sample and what that means in terms of water quality*
  - *the SAR of each sample and what this means in terms of their usability for irrigation water in India and internationally.*

Add copy of Main text in chapter 8, for all participants.

7. Additional handout

These handouts are distributed during delivery and contain test questions, answers to questions, special worksheets, optional information, and other matters you would not like to be seen in the regular handouts.

It is a good practice to pre-punch these additional handouts, so the participants can easily insert them in the main handout folder.

8. Main text

Contents

How to Measure Sodium

1. Introduction

All natural waters contain sodium ions (Na^+) as the element is one of the most abundant on the planet. High concentrations in inland waters, however, are normally associated with pollution from industrial discharges or sewage effluent or, in coastal areas, sea water intrusion. Normally, however, sodium concentrations are below 200 mg/L (this is also the World Health Organisation guideline limit for sodium in drinking water).

When water is to be used for irrigation purposes it is important to know the sodium concentration as sodium can have a negative effect on soil structure which can affect plant growth. To evaluate the suitability of water for irrigation the Sodium Adsorption Ration (SAR) is used as follows:

$$SAR = \frac{Na^+}{\sqrt{\left(Ca^{2+} + Mg^{2+}\right)/2}}$$

- where the concentrations of the ions in milliequivalents per litre are used.

From an international perspective, if the value of the SAR is less than 3 the water is suitable for irrigation use. Values from 3 to 9 represent some use restriction whilst SAR values in excess of 9 normally mean that water cannot be used for irrigation. In India, however, the SAR standard for irrigation water is set to 26 which reflects the fact that sodium does not build up in the soil and cause damage because every monsoon season the soil is thoroughly flushed and renewed.

2. Flame Emission Photometry Method

The flame emission photometry method for determining sodium relies on the fact that the sodium ion emits light at a wavelength of 589 nm when excited in a gas flame. The intensity of the light produced is approximately proportional to the concentration of the element. A calibration curve is used to determine sample sodium concentrations from the plotted emissions of a series of standard sodium solutions.

3. Experiment

Aim

a. To determine the concentration of sodium ion in a number of different samples by flame emission photometry.

Method

a. Collect a sample from each of the buckets marked A, B and C.
b. Read the SAP for sodium.

c. Determine the sodium in each sample according to the procedure

Observations & calculation

a. Fill in the following table as you proceed with the method:

Sample	Emission at 589 nm
1 mg/l Standard Solution	
5 mg/l Standard Solution	
10 mg/l Standard Solution	
20 mg/l Standard Solution	
30 mg/l Standard Solution	
40 mg/l Standard Solution	
50 mg/l Standard Solution	
100 mg/l Standard Solution	
A	
B	
C	

b. Use the values of the standard solutions in the table to plot a standard curve of sodium versus emission.

c. Read the sodium concentration of the three samples from the standard curve and enter them in the table above

d. You will be given the concentrations of calcium and magnesium in each sample. Using this information, calculate the SAR for each sample.

Report

When writing your report the following aspects should be addressed:

- the aim of the investigation
- the analytical results that you have produced
- the sodium content of each sample and what this means in terms of water quality
- the SAR of each sample and what that means in terms of its usability for irrigation use in India and internationally.