Technical Assistance
HYDROLOGY PROJECT

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Training module # WQ - 43

How to Measure Total Iron

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CSMRS Building, 4th Floor, Olof Palme Marg, Hauz Khas,
New Delhi – 11 00 16 India
Tel: 68 61 681 / 84 Fax: (+ 91 11) 68 61 685
E-Mail: dhvdelft@del2.vsnl.net.in

DHV Consultants BV & DELFT HYDRAULICS

with
HALCROW, TAHAL, CES, ORG & JPS

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1. Module context

This module deals with the significance of iron to water quality and method for measuring iron in water samples. Modules in which prior training is required to complete this module successfully and other available, related modules in this category.

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.	Basic chemistry concepts	**WQ - 02**	• Convert units from one to another • Discuss the basic concepts of quantitative chemistry • Report analytical results with the correct number of significant digits.
3.	The need for Good Laboratory Practice	**WQ – 03**	• Follow approved general laboratory procedures
4.	How to prepare standard solutions	**WQ – 04**	• Select different types of glassware • Use an analytical balance and maintain it • Prepare standard solutions
5.	Basic Aquatic Chemistry concept	**WQ – 24**	• Calculate ion concentrations from ionisation constants
6.	Major ions in water	**WQ - 28**	• Know the major ions in water and air sources • Understand the significance of major ion concentrations
7.	Absorption Spectroscopy	**WQ - 34**	• Understand the principle of absorption spectroscopy • Explain the use of absorption spectroscopy for chemical analyses

2. Module profile

Title	:	How to Measure Total Iron
Target group	:	HIS function(s): Q2, Q3, Q5, Q6
Duration	:	1 Theoretical session of 30 min, plus 1 Practical Laboratory session of 120 min, plus 1 Report writing session of 30 min.
Objectives	:	After the training the participants will be able to*:* • Understand the relevance of iron to water quality • Know how to make analysis of iron in water samples.
Key concepts	:	• Phenanthroline method
Training methods	:	Lecture, Laboratory Analytical Exercise, Report preparation
Training tools required	:	Board, flipchart, OHS, Complete Laboratory Facilities for Iron Analysis
Handouts	:	As provided in this module, Including SAP for analysis of Iron
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 iron measurement • Prepare samples A, B & C, containing approximate 0.1, 1.0 and 4 mg/L iron, respectively, using tap water and appropriate standard solution		
2	***Introduction*** • Introduce the session • Ask the question, 'Why do we need to measure iron'? • Introduce the subject of iron to the participants including occurrence, concentrations, problems and standards	10 min	OHS
3	***Phenanthroline Spectrophotometric Method – Background*** • Describe the method in terms of its chemistry and how iron is measured: **Refer to SAP for Iron** • Explain the overall aim of this module • Ask participants to read SAP for iron determination	20 min	OHS
4	***Practical Session*** • Allow participants to conduct analysis according to SAP: **Refer to SAP of Iron** • Stress the need to write-up results as the analysis proceeds • Be available to guide participants and answer questions	120 min	
5	***Report Writing:*** • Allow participants to complete their reports • Discuss 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 Iron

- Iron is abundant in earth's crust
- Concentrations are normally low (< 0.1 mg/L) in surface waters but can be higher in groundwaters (up to 10 mg/L or more)

Measurement of Iron

- Elevated concentrations of iron in drinking water can cause problems due to:
  - *staining of laundry*
  - *unpleasant appearance*
  - *unpleasant taste*
- India limits on iron are:
  - *0.3 mg/L for water to be used for drinking without treatment*
  - *50 mg/L for raw water to be used for drinking after conventional treatment*

Measurement of Iron

- Phenanthroline Spectrophotometric Method:
  - *Relies on the fact that iron ion forms a stable complex with phenanthroline*
  - *The absorbance of the red complex produced is measured in a spectrophotometer at wavelength of 510 nm*
  - *Iron concentration is read from a calibration curve*

Experiment

- To determine the concentration of total iron in a number of different samples by spectrophotometry

Experiment

Method:

- Collect a sample from each of the buckets A, B and C
- Determine total iron in each sample
- Samples containing more than 200 mg in 50 ml aliquot will need adequate dilution

Experiment

Report:

- The three samples represent potential drinking waters with different levels of iron. On the basis of your result state whether they are:
  - *Unsuitable for drinking water use*
  - *Suitable for drinking water use after conventional treatment*
  - *Suitable for drinking water use without treatment*

5. Evaluation sheets

6. Handout

Measurement of Iron

- Iron is abundant in the earth's crust
- Concentrations are normally low (<0.1 mg/L) in surface waters but can be higher in groundwaters (up to 10 mg/L or more)
- Elevated concentrations of iron in drinking water can cause problems due to:
  - *staining of laundry*
  - *unpleasant appearance*
  - *unpleasant taste*
- India limits on iron are:
  - *0.3 mg/L for water to be used for drinking without treatment*
  - *50 mg/L for raw water to be used for drinking after conventional treatment*
- Phenanthroline Spectrophotometric Method:
  - *Relies on the fact that iron ion forms a stable complex with phenanthroline*
  - *The absorbance of the red complex produced is measured in a spectrophotometer at a wave length of 510 nm*
  - *Iron concentration is read from a calibration curve*

Experiment:

- To determine the concentration of total iron in a number of different samples by spectrophotometry

Method:

- Collect a sample from each of the buckets A, B and C
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Report:

- The three samples represent potential drinking waters with different levels of iron. On the basis of your result state whether they are:
  - *Unsuitable for drinking water use*
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  - *Suitable for drinking water use without treatment*

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 Total Iron

1. Introduction

Iron is abundant element in the earth's crust but, assuming the pH of surface waters it is between 6 and 9, is normally present in low concentrations (< 1.0 mg/L). In groundwatees, however, particularly those in contact with iron bearing minerals, higher concentrations (up to 10 mg/L or more) are found.

Elevated concentrations of iron can be problematic in drinking water for three principal reasons:

- staining of laundry and other items can occur due to the precipitation of hydrated ferric oxide
- colloidal suspensions of the precipitate can also mean that the water looks unpleasant
- iron can also impart an unpleasant taste to the water which some people can detect at levels above 1.0 mg/L

In India, there is a limit on iron in water that is to be used for drinking without treatment of 0.3 mg/L and in raw water that is to be used for drinking after conventional treatment of 50 mg/L.

2. Phenanthroline Spectrophotometric Method

This method relies on the fact that iron, when converted to its ferrous state by reaction with acidified hydroxylamine, forms a colour-stable complex with phenanthroline. The red coloured complex formed can then be measured with a spectrophotometer at a wavelength of 510 nm.

3. Experiment

Aim

a. To determine the concentration of total iron in a number of different samples by spectrophotometry.

Method

a. Read the SAP for total iron determination
b. Collect a sample from each of the buckets marked A, B and C.
c. Determine the concentration of total iron in each sample according to the Standard Analytical Procedure for Iron.

Observations & calculation

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

Sample	Absorbance at 510 nm
0.1 mg/l Standard Solution	
0.2 mg/l Standard Solution	
0.3 mg/l Standard Solution	
0.5 mg/l Standard Solution	
1.0 mg/l Standard Solution	
2.0 mg/l Standard Solution	
3.0 mg/l Standard Solution	
4.0 mg/l Standard Solution	
A	
B	
C	

b. Use the values of the absorbance for the standard solutions in the table to plot a standard curve of iron versus absorbance.

c. Read the total iron concentrations of the three samples from the standard curve.

Report

The three samples all represent potential drinking waters each with different concentrations of iron. On the basis of your results state whether these waters are suitable for use as drinking water. Report as:

- Unsuitable for drinking water use
- Suitable for drinking water use after conventional treatment
- Suitable for drinking water use without treatment