Technical Assistance
HYDROLOGY PROJECT
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Training module # WQ - 09

How to measure electrical conductivity

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with
HALCROW, TAHAL, CES, ORG & JPS

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1. Module context

This module covers the procedure and a laboratory exercise for measuring electrical conductivity (EC). To complete this module successfully, the participant must have completed the modules on *understanding electrical conductivity* and *how to prepare standard solutions*. These and other available related modules 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	*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	*How to prepare standard solutions*	WQ -04	• Select different types of glassware • Use an analytical balance and maintain it. • Prepare standard solutions.
4	*Understanding electrical conductivity*	WQ -08	• Define electrical conductivity • Discuss the significance of EC measurement • Use correct EC unit

2. Module profile

Title	:	How to measure Electrical Conductivity
Target group	:	As per training needs
Duration	:	One session of 120 min
Objectives	:	After the training the participants will be able to*:* • Measure the electrical conductivity of water samples • Assess the effect of ion concentration and type on EC
Key concepts	:	• Calibration and operation of EC meter
Training methods	:	Explain, demonstrate, guided laboratory exercise
Training tools required	:	• Conductivity meter with conductivity cell and operation manual • Support of a basic chemical laboratory • Writing board or flip chart
Handouts	:	As provided in this module
Further reading and references	:	• Standard Methods: for the Examination of Water and Wastewater, APHA, AWWA, WEF/1995. APHA Publication • Chemistry for Environmental Engineering, C.N. Sawyer, P.L. McCarty and C.F. Parkin. McGraw-Hill, 1994

3. Session plan

No	Activities	Time	Tools
1	***Preparations*** • Use ToT-I checklist • Insert (adapted) instructions from user manual of EC meter in the handout • Prepare standard KCl, 0.01M • Prepare sample series A and B by diluting 50g/L stock solutions of NaCl and Na_2SO_4 respectively, at the rate of 10mL/L, 20mL/L, 30mL/L, and 40mL/L of distilled water.		
2	***Introduction***	15 min	Handout
3	***EC meter*** • Make inventory of components and salient features • Demonstrate how to calibrate the meter and read conductance/ resistance • Explain how to apply temperature correction and calculate cell constant	30 min	Conductivity meter, flipchart OHS
4	***Practice*** • Make groups in pairs • Describe the exercise • Ask each group to measure EC value of the eight samples and record results	45 min	
5	***Preparation of report*** • Ask participants to prepare report as suggested in the text • Collect data from each group and draw graph for combined data • Ask participants to copy • Discuss results	30 min	Board, flipchart, graph sheet

4. Overhead/flipchart masters

OHS format guidelines

Type of text	Style	Setting
Headings:	OHS-Title	Arial 30-36, Bold with bottom border line (not: underline)
Text:	OHS-lev1 OHS-lev2	Arial 26, Arial 24, with indent maximum two levels only
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 alignment over more lines (rows and columns) Use equation editor for advanced formatting only

How to measure electrical conductivity (EC)

1. Know the EC meter
2. Calibrate the EC meter
3. Measure conductance of samples
4. Calculate EC
5. Reporting EC

Know the EC meter

- Components
- Conductance or resistance?
- Built-in temperature compensation?

Calibrate EC meter: procedure

EC meter <u>with</u> built-in temperature compensation

1. Rinse conductivity cell with three portions of KCl, 0.01M
2. Immerse in the standard KCl solution
3. Adjust temperature compensation dial to 0.0191/ °C
4. Adjust meter to read 1412 μmho/cm

Calibrate EC meter: procedure

EC meter <u>without</u> built-in temperature compensation

1. Rinse conductivity cell with three portions of KCl
2. Note the temperature of fourth portion
3. Insert cell in the fourth portion & read resistance
4. Calculate cell constant

Calibrate EC meter: calculate cell constant

$$K_C = \frac{1412}{C_{KCl}} \times \left[0.0191\left(t - 25\right) + 1\right]$$

K_c = the cell constant, 1/cm

C_{KCl} = measured conductance, μmho

t = observed temperature of standard KCl solution, °C

3. Measure sample's conductivity: procedure

1. Rinse cell with one or more portions of sample
2. Adjust sample temperature about 25°
3. Immerse cell in sample: sample level above vent holes
4. Read & note conductivity of sample
5. Measure temperature of sample & record to nearest 0.1°C
6. Calculate EC at 25°C

Calculate EC

$$\text{Electrical Conductivity}\,(\mu\text{mho/cm}) = \frac{C_M \times K_C}{0.0191(t-25)+1}$$

Kc = the cell constant, 1/cm

C_M = measured conductance of the sample, μmho

t = observed temperature of sample, ^{0}C

Reporting EC

Sample	Salt	Conc. mg/L	Temp. °C	Conductance μS	EC at 25°C, μS/cm
Tap water					
A1					
A2					
A3					
A4					
B1					
B2					
B3					
B4					

Practice: Determine EC of selected samples

- Determine electrical conductivity of tap water
- Study effect of different types of dissolved salts
- Study effect of varied concentration of salts on EC of water
- Prepare report: relationship between EC and TDS

5. Evaluation

6. Handouts

How to measure electrical conductivity (EC)

1. Know the EC meter
2. Calibrate the EC meter
3. Measure conductance of samples
4. Calculate EC
5. Reporting EC

Know the EC meter

- Components
- Conductance or resistance?
- Built-in temperature compensation?

Calibrate EC meter: procedure

EC meter <u>with</u> built-in temperature compensation

1. Rinse conductivity cell with three portions of KCl, 0.01M
2. Immerse in the standard KCl solution
3. Adjust temperature compensation dial to 0.0191/ °C
4. Adjust meter to read 141μmho/cm

EC meter <u>without</u> built-in temperature compensation

1. Rinse conductivity cell with three portions of KCl
2. Note the temperature of fourth portion
3. Insert cell in the fourth portion & read resistance
4. Calculate cell constant

Calculate cell constant

$$K_C = \frac{1412}{C_{KCl}} \times \left[0.0191(t - 25) + 1\right]$$

K_c = the cell constant, 1/cm
C_{KCl} = measured conductance, μmho
t = observed temperature of standard KCl solution, °C

Measure sample's conductivity: procedure

1. Rinse cell with one of more portions of sample
2. Adjust sample temperature about 25°
3. Immerse cell in sample: sample level above vent holes
4. Read & note conductivity of sample
5. Measure temperature of sample & record to nearest 0.1°C
6. Calculate EC at 25°C

4. Calculate EC

$$\text{Electrical Conductivity}\,(\mu\text{mho/cm}) = \frac{C_M \times K_C}{0.0191(t-25)+1}$$

Kc = the cell constant, 1/cm
C_M = measured conductance of the sample, μmho
t = observed temperature of sample, ^{0}C

5. Reporting EC

Sample	Salt	Conc. mg/L	Temp. °C	Conductance μS	EC at 25°C, μS/cm
Tap water					
A1					
A2					
A3					
A4					
B1					
B2					
B3					
B4					

Practice: Determine EC of selected samples

- Determine electrical conductivity of tap water
- Study effect of different types of dissolved salts
- Study effect of varied concentration of salts on EC of water
- Prepare report: relationship between EC and TDS

7. Additional handouts

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

How to measure Electrical Conductivity

1. Aim

a. To determine electrical conductivity of tap water

b. To study the effect of different types of dissolved salts and their concentration on electrical conductivity of water

2. Method

a. Read SAP for measurement of EC. Familiarise yourself with the operation of the EC meter available in the laboratory. The instructor will demonstrate the operation first. Note if the instrument reads conductance or resistance and if it has built-in temperature compensation.

b. Measure the conductance/resistance of the standard KCl, 0.01M, solution and calculate the cell constant, according to SAP for EC.

c. Measure conductance/resistance of a sample of tap water and samples A1, A2, A3, A4, B1, B2, B3, B4 after adjusting their temperatures close to 25^{o}C. Record temperatures and calculate/read their EC values.

d. Find out from the instructor the salts and their concentrations dissolved in various samples.

Observations & calculations

A. Determination of cell constant:

Temperature of standard solution	=
EC of standard solution	=
Observed Conductance/resistance of standard solution	=
Conductance/resistance of standard solution at 25^{o}C	=
Cell constant	=

B. EC of samples

Sample	Salt	Conc, mg/L	Temp, °C	Conductance, μmho	EC,25°C, μmho/ cm
Tap water					
A1					
A2					
A3					
A4					
B1					
B2					
B3					
B4					

Report

Write your report in which the following aspects should be addressed:

Need for making EC measurements close to 25°C, temperature correction, frequent measurement of cell constant, relation between EC and TDS, effect of type of ions dissolved in water. Include a graph in your report showing relation between EC (X-axis) and TDS (Y-axis) for different compounds on the basis of analysis results for samples A and B.