Technical Assistance
HYDROLOGY PROJECT
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Training module # WQ - 10

How to measure dissolved, suspended & total solids

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with
HALCROW, TAHAL, CES, ORG & JPS

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1. Module context

This module describes a laboratory exercise for measurement of dissolved, suspended and total solids in water samples. Modules in which prior training is required to complete this module successfully and 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	*The need for good laboratory practice*	WQ- 03	• Apply the adopted standard practices in laboratory operations
3	*How to prepare standard solutions*	WQ- 04	• Select different types of glassware • Use an analytical balance and maintain it. • Prepare standard solutions
4	*How to measure colour, odour and temperature*	WQ- 05	• Measure natural colours in water samples • Distinguish different types of odours

2. Module profile

Title	:	How to measure dissolved, suspended and total solids
Target group	:	HIS function(s): Q1, Q2, Q3, Q5
Duration	:	One session of 180 min
Objectives	:	After the training the participants will be able to*:* • Determine various forms of solids in water samples • Select the right size of sample used for determination
Key concepts	:	• Gravimetric measurements • Sample size
Training methods	:	Explanation, laboratory exercise
Training tools required	:	• Board • Support of a basic chemical laboratory
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*** • Collect necessary glassware for the laboratory exercise according to the three SAPs for the determination of dissolved, suspended and total solids. Ensure that the required oven and water bath is at the required temperature. • Prepare filter paper and evaporating dishes for the use of the class by washing, drying and cooling as described in the SAPs. • Prepare sample for analysis in the exercise by adding 1 g $CaCO_3$ in one 1L tap water		
2	***Introduction***: • Ask participants to describe different types of solids in water. • Add / supplement to the information	5 min	Board OHS
3	***Demonstration*** • Allow participants time to read the 3 SAPs. • Clarify doubts, if any. • Ensure that each participant knows operation of the analytical balance. • Demonstrate the procedure to measure dissolved suspended & total solids.	15 min	Filtration assembly
4	***Practice*** • Describe the exercise. • Form working groups of two persons each. • Inform the class that the first step of washing drying and cooling of filter papers and evaporating dishes was carried out before hand. • Ask participants to write their report	140 min	
5	***Conclusion*** • Discuss results and discrepancies.	20 min	Board

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 determine concentration of solids

1. Measurement of total dissolved solids:

   50 ml aliquot

2. Measurement of total suspended solids:

   50 & 10 ml aliquots

3. Measurement of total solids:

   50 ml aliquot

1. Measurement of total dissolved solids: procedure

1. Wash filter paper
2. Dry evaporating dish & weigh
3. Stir sample
4. Pipette 50 ml while stirring
5. Filter and wash three times
6. Transfer filtrate to evaporating dish & dry
7. Cool & weigh
8. Calculate in mg/ L

Calculating total dissolved solids concentration:

$$\text{mg Dissolved Solids/L} = \frac{(A - B) \times 1000}{\text{mL sample}}$$

where:

A = weight of dried residue + dish, mg

B = weight of dish, mg.

2. Measurement of total suspended solids: procedure

1. Wash filter paper & dry
2. Cool & weigh filter paper
3. Assemble filtration apparatus
4. Wet filter paper with distilled water
5. Stir sample
6. Pipette 50ml while stirring
7. Filter and wash three times
8. Transfer filter to evaporating dish & dry
9. Cool & weigh
10. Calculate in mg/ L
11. Repeat steps 1 to 10 using 10 ml aliquot

Calculating total suspended solids concentration:

$$\text{mg Suspended Solids / L} = \frac{(A - B) \times 1000}{\text{mL sample}}$$

where:

A = weight of filter + dried residue, mg

B = weight of filter, mg

3. Measurement of total solids: procedure

1. Weigh evaporating dish
2. Stir sample
3. Pipette 50ml into evaporating dish & dry
4. Cool & weigh evaporating dish
5. Calculate in mg/ L

Calculating total solids concentration:

$$\text{mg Total Solids /L} = \frac{(A - B) \times 1000}{\text{mL sample}}$$

where:

A = weight of dish + residue, mg

B = weight of dish, mg

Exercise:

- Work in pairs
- Filter paper & evaporating dishes already washed, dried & cooled
- Measure in sample
  1. Total dissolved solid concentration
  2. Total suspended solid concentration
  3. Total solid concentration
- Record findings
- Calculate
- Report

Exercise: record findings

Determine	Sample volume, mL (V)	Final weight, g (A)	Initial weight g (B)	Concentration mg/L
TSS	50			
	10			
TDS	50			
TS	50			

Exercise: calculate

1. Add total suspended & total dissolved fractions to make mass balance for total solids.
2. Compare with the total solids determined experimentally.
3. Calculate percent error.
4. Calculate twice; with results of suspended solids

   - using 50 mL aliquot

   - using 10 mL aliquot

Exercise: Report

- Reasons for different results
- Effect of sample size

.

5. Evaluation

6. Handouts

How to determine concentration of solids

1. Measurement of total dissolved solids: 50 ml aliquot
2. Measurement of total suspended solids: 50 & 10 ml aliquots
3. Measurement of total solids: 50 ml aliquot

1. Measurement of total dissolved solids (TDS): procedure

1. Wash filter paper
2. Dry evaporating dish & weigh
3. Stir sample
4. Pipette 50ml into filter while stirring
5. Filter and wash three times
6. Transfer filtrate to evaporating dish & dry
7. Cool & weigh
8. Calculate in mg/ L

Calculating total dissolved solids (TDS) concentration:

$$\text{mg Dissolved Solids/L} = \frac{(A - B) \times 1000}{\text{mL sample}}$$

where:

A = weight of dried residue + dish, mg
B = weight of dish, mg.

2. Measurement of total suspended solids (TSS): procedure

1. Wash filter paper & dry
2. Cool & weigh filter paper
3. Assemble filtration apparatus
4. Wet filter paper with distilled water
5. Stir sample
6. Pipette 50ml into filter while stirring
7. Filter and wash three times
8. Transfer filtrate to evaporating dish & dry
9. Cool & weigh
10. Calculate in mg/ L
11. Repeat steps 1 to 10 using 10 ml aliquot

Calculating total suspended solids (TSS) concentration:

$$\text{mg Suspended Solids / L} = \frac{(A - B) \times 1000}{\text{mL sample}}$$

where:

A = weight of filter + dried residue, mg
B = weight of filter, mg

3. Measurement of total solids (TS): procedure

1. Weigh evaporating dish
2. Stir sample
3. Pipette 50ml into evaporating dish & dry
4. Cool & weigh evaporating dish
5. Calculate in mg/ L

Calculating total solids (TS) concentration:

$$\textbf{mg Total Solids /L} = \frac{\textbf{(A} - \textbf{B)} \times \textbf{1000}}{\textbf{mL sample}}$$

where:

A = weight of dish + residue, mg
B = weight of dish, mg

Exercise:

- Work in pairs
- Filter paper & evaporating dishes already washed, dried & cooled
- Measure in sample
  1. Total dissolved solid content
  2. Total suspended solid content
  3. Total solid content
- Record findings
- Calculate
- Report

Record findings

Determine	Sample volume, mL (V)	Final weight, g (A)	Initial weight g (B)	Concentration mg/L
TSS	50			
	10			
TDS	50			
TS	50			

Calculate

- Add total suspended & total dissolved fractions to make mass balance for total solids.
- Compare with the total solids determined experimentally.
- Calculate percent error.
- Calculate twice; with results of suspended solids
  - using 50 mL aliquot
  - using 10 mL aliquot

Report

- Reasons for different results
- Effect of sample size

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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

Contents

How to measure total dissolved, total suspended and total solids

1. Aim

a. To characterise a water sample with respect to its solids content.
b. To evaluate the effect of sample size on the result.

2. Method

a. Read the three SAPs for dissolved, suspended and total solids. Identify the instruments and glassware that you would be using in this experiment.
b. Following the procedures described in the three SAPs and using a 50 mL sample aliquot volume for each of the three determinations determine the solids concentrations.
c. Repeat the determination for suspended solids following identical steps but using only 10 mL sample aliquot volume.

3. Observations & calculations

a. Record your observations for the four determinations in the following table and calculate the results as described in SAPs.

Determination	Sample volume, mL (V)	Final weight, g (A)	Initial weight, g (B)	Concentration, mg/L
TSS	50			
	10			
TDS	50			
TDS	50			

b. Make a mass balance for total solids by adding suspended and dissolved fractions and compare it with the total solids determined experimentally. Calculate percent error. There will be two sets of calculations, one in which the result for SS based on 50 mL aliquot will be used and the other in which result for SS based on 10 mL aliquot will be used.

4. Report

Write your report in which you should give possible reasons for imbalance among results and effect of sample size.