Technical Assistance
HYDROLOGY PROJECT

World Bank & Government of The Netherlands funded

Training module # WQ - 19

How to measure chemical oxygen demand

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DHV Consultants BV & DELFT HYDRAULICS

with
HALCROW, TAHAL, CES, ORG & JPS

Table of contents

1. Module context

This module concerns laboratory determination of COD of water samples. Modules in which prior training is needed to complete this module successfully and other related modules are listed 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 chemistry concepts*[a]	**WQ - 02**	• Convert units from one to another • Understand the basic concepts of quantitative chemistry • Report analytical results with the correct number of significant digits
2	*How to prepare standard solutions*[a]	**WQ - 04**	• Recognise different types of glassware • Use an analytical balance and maintain it. • Prepare standard solutions
3	*Understanding the chemistry of dissolved oxygen measurement*	**WQ - 11**	• Appreciate significance of DO measurement • Understand the chemistry of DO measurement by Winkler method
4	*Understanding biochemical oxygen demand test*	**WQ - 15**	• Understand the significance and theory of BOD test
5	*Understanding chemical oxygen demand test*[a]	**WQ - 18**	• Appreciate significance of COD measurement • Understand the chemistry of COD measurement

a – prerequisite

2. Module profile

Title	:	How to measure chemical oxygen demand
Target group	:	HIS function(s): Q2, Q3, Q5
Duration	:	Two sessions, one of 180 min followed by another of 60 min
Objectives	:	After the training the participants will be able to*:* • Measure COD of water and wastewater samples
Key concepts	:	• Open reflux method • Procedure evaluation
Training methods	:	Lecture, laboratory exercises
Training tools required	:	Board, flipchart, OHS Support of a chemistry 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*** • Prepare reagents as listed in the SAP for COD measurement. • Arrange glassware for refluxing • Collect/prepare samples as below: – sample A, raw sewage – sample B, river or pond water – sample C, groundwater – sample D, potassium hydrogen phthalate, 425 mg/L		
2	***Introduction*** • Recapitulate significance of COD test • Chemistry of the test	15 min	OHS
3	***Source of samples and expected COD values*** • Describe the sources of samples and ask the participants to estimate the COD value of each sample • Explain significance of the sample aliquot volume to be used	15 min	OHS
4	***Exercise*** *Session I* • Ask participants to read the exercise handout and SAP for COD measurement • Assist in making selection of sample volumes and preparation of reaction mixtures • Start refluxing of the mixtures. Explain that the refluxing would be done for one hour instead of two hours as done in standard test to save time • While the samples are refluxing, demonstrate the FAS titration *Session II-* • Ask participants to complete the test and report result	30 min 30 min 90 min 30 min	
5	***Wrap up*** • Ask participants to write report • 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

Recapitulate COD

1. Oxygen demand of aggregate organic matter

2. Steps
   - *sample + excess oxidant*
   - *determine remaining oxidant*
   - *oxidant consumed = COD of sample*

3. Complete oxidation

Evaluation of technique

- Theoretical oxygen demand
  - *425 mg/L KHP has a COD = 500 mg/L*

Sample volume

- Oxidant quantity should be in excess of sample COD

- Example
  - *0.25 N, 10mL pot dichromate oxygen equivalence = 2.5 meq or 20 mg O_2*
  - *for 20 mL sample, COD< 20mg/20mL*
  - *or <1000 mg/L*

Samples for analysis

Sample	Source	Predicted COD	Reason
A	Sewage		
B	River		
C	Well		
D	Standard		

5. Evaluation sheets

6. Handout

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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 chemical oxygen demand

1. Aim

a. To determine the chemical oxygen demand of various samples of water.
b. To evaluate the COD measurement technique using a standard sample.

2. Method

a. Read the SAP for COD measurement.
b. Prepare the COD reflux mixtures for the four samples in accordance with the procedure.
c. Standardise the ferrous ammonium sulphate (FAS) solution.
d. You will be told the source of the four samples which you have begun to analyse. Based on this information and your knowledge of water quality and the COD test, fill in a table similar to the one below to predict the COD results which you expect and the reason for your prediction:

Sample	Source	Predicted COD	Reason for your COD prediction
A			
B			
C			
D			

e. Following the reflux, cooling and dilution of the digested mixture, titrate the resulting solution with standardised FAS.

3. Observations & calculations

Calculate the COD of each sample in accordance with the Standard Analytical Procedure for the COD test.

4. Report

When writing your report the following aspects should be addressed:

- the aim of the investigation
- the results that you have produced
- your original predictions
- whether the results were as you originally predicted and, if they were not, the reasons why they deviated
- whether your COD measurement technique was satisfactory
- the environmental condition of the samples in terms of their pollution potential