

Training module # WQ - 17

***How to measure biochemical
oxygen demand***

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with
HALCROW, TAHAL, CES, ORG & JPS

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1. Module context

This module concerns laboratory determination of BOD of water samples. Modules in which prior training is necessary 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	<i>How to prepare standard solutions^a</i>	WQ - 04	<ul style="list-style-type: none"> Recognise different types of glassware Use an analytical balance and maintain it. Prepare standard solutions
2	<i>Understanding the chemistry of dissolved oxygen measurement^a</i>	WQ - 11	<ul style="list-style-type: none"> Appreciate significance of DO measurement Understand the chemistry of DO measurement by Winkler method
3	<i>How to measure dissolved oxygen (DO)^a</i>	WQ - 12	<ul style="list-style-type: none"> Measure dissolved oxygen in water samples
4	<i>Understanding biochemical oxygen demand test^a</i>	WQ - 15	<ul style="list-style-type: none"> Understand the significance and theory of BOD test
5	<i>Understanding dilution and seeding procedures in BOD test^a</i>	WQ - 16	<ul style="list-style-type: none"> Understand the need and procedure for dilution and seeding in BOD measurement
6	<i>Understanding chemical oxygen demand test</i>	WQ - 18	<ul style="list-style-type: none"> Appreciate significance of COD measurement Understand the chemistry of COD measurement

a – prerequisite

2. Module profile

Title	:	How to measure biochemical oxygen demand
Target group	:	HIS function(s): Q1, Q2, Q3, Q5
Duration	:	Two session, one of 150 min followed by another of 60 min after 3 days
Objectives	:	After the training the participants will be able to: <ul style="list-style-type: none">• Prepare required dilution• Measure BOD of water and wastewater samples.• Understand need for seeding
Key concepts	:	<ul style="list-style-type: none">• Estimating required dilution• Seeding• Method/quality control/reporting
Training methods	:	Demonstration and laboratory exercises
Training tools required	:	<ul style="list-style-type: none">• Chemicals and glassware required to conduct DO analysis as per SAP• Support of a chemistry laboratory
Handouts	:	As provided in this module
Further reading and references	:	<ul style="list-style-type: none">• Chemistry for Environmental Engineering, C.N. Sawyer, P.L. McCarty and C.F. Parkin. McGraw-Hill, 1994• Standard Methods: for the Examination of Water and Wastewater, APHA, AWWA, WEF/1995. APHA Publication

3. Session plan

No	Activities	Time	Tools
1	<p>Preparations</p> <ul style="list-style-type: none"> • Prepare reagents as listed in the SAP for DO and BOD determinations • Prepare samples as follows: <ul style="list-style-type: none"> – sample A, raw sewage – sample B, raw sewage, boiled for 10 min – sample C, unpolluted pond or river water – sample D, glucose-glutamic acid sample, 150 mg/L each, alternatively, 300 mg/L glucose solution • Prepare enough dilution water for the dilutions of each sample, as required, taking into account the number of participants 		
2	<p>Introduction</p> <ul style="list-style-type: none"> • Recapitulate the need for dilution and seeding of samples • Describe preparation of dilution water • Glucose-glutamic acid solution for standardisation of procedure 	5 min 5 min	OHS
3	<p>Sources of samples</p> <ul style="list-style-type: none"> • Describe the sources of samples and ask the participants to estimate the BOD of each sample • Explain that samples B and D would need seeding. However, ask the participants not to seed sample B to highlight the need for seeding. Use sample A as source of seed 	5 min 5 min	OHS
4	<p>Laboratory exercise</p> <ul style="list-style-type: none"> • Ask the participants to read the exercise handout and the SAP for determination of BOD and DO • Divide the participants in groups of two persons each • Ask the participants to suggest the dilution for each sample and calculate the requirement for dilution water. Check individually the calculation of each group • Demonstrate the use of siphon in filling a BOD bottle • Ask the participants to start the exercise; prepare dilutions, fill bottles, find initial DO for each dilution and incubate the samples 	10 min 20 min 100 min	Handout and OHS
5	<p>Conclusion</p> <ul style="list-style-type: none"> • Ask the group to find the final DO after 3 day incubation period and write report • Discuss results 	60 min	Board

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

BOD measurement procedure

- Dilution
- Seeding
- Standard sample to check procedure

Characteristics of samples

Sample	Source	Estimated BOD, mg/L	Seed	Dilution
A	Raw sewage	100 – 200	Present	2 %
B	Raw sewage, boiled	100 – 200	Absent	2 %
C	River water	2 – 5	Present	not required
D	Glucose std	200 ± 37	Absent	1.5%

Dilution & seeding

- Dilution water is saturated with DO at 27⁰C
- Dilution water contains inorganic salts
- Prepare 1000 mL of diluted samples A, B & D
- Use A as source of seed for D, 3 mL/1000 mL
- Use siphon to fill three bottles for each sample
- Ensure that sample C has sufficient DO

Determine DO & BOD

- Initially, 1 bottle each sample
- After incubation, 2 bottles each sample
- Calculate BOD

Report

- Compare BOD of raw & boiled sewage
- Comment on quality of river water
- Was your technique acceptable

5. Evaluation sheets

6. Handout

BOD measurement procedure

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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
1.	Aim	1
2.	Method	1
3.	Observations & calculations	1
4.	Report	1
	SAP for BOD	2
	SAP for DO	5

How to measure biochemical oxygen demand

1. Aim

- To determine the biochemical oxygen demand (BOD) of various samples of water
- To understand the need for seeding in the BOD test
- To check the procedure by determining the BOD value of a standard glucose-glutamic acid sample

2. Method

- Collect samples marked A, B, C and D. The instructor will tell you the volume of each sample you require.
- Prepare the BOD bottles for analysis in accordance with the Standard Analytical Procedure for BOD. Prepare only ONE dilution as explained by the instructor for each sample.
- Using standardised sodium thiosulphate titrant, determine the DO in one bottle of each sample according to the Standard Analytical Procedure for DO measurement. Incubate the other two bottles at 27°C and determine the DO after 3 days.
- You will be told the origin of the samples that you have begun to analyse. Based on this information and your knowledge of water quality and the BOD test, fill in a table similar to the one below to predict the BOD results which you expect and the reason for your prediction:

Sample	Source of Sample	Predicted BOD ₃	Reason for your BOD ₃ prediction
A			
B			
C			
D			

3. Observations & calculations

NOTE: In order to calculate values for the table below you will need to refer to the Standard Analytical Procedures for both DO and BOD.

Sample	DO, mg/L before incubation	DO, mg/L after incubation	BOD, mg/L of sample
A			
B			
C			
D			

4. Report

When writing your report the following aspects should be addressed:

- the aim of the investigation
- the results that you have produced, acceptability of your technique
- whether the results were as you originally predicted and, if they were not, the reasons why they deviated
- river water quality

