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AUTHOR Bonte, John L.; Davidson, Arnold C.
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ABSTRACT

This document is an instructional module package prepared in objective form for use by an instructor familiar with the threshold odor determination. Included are objectives, an instructor guide, student handouts, and transparency masters. A video tape is also available from the author. This module considers sample preparation, panel selection, determination and calculation of the threshold odor number, and interpretation of results. (Author/RH)

THRESHOLD ODOR

Training Module 5.255.2.77

Prepared for the

Iowa Department of Environmental Quality
Wallace State Office Building
Des Moines, Iowa 50319

by

John E. Bonte
Developer
Arnold C. Davidson
Project Director
Clinton Community College
1000 Lincoln Boulevard
Clinton, Iowa 52732

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September, 1977

Module No:	Module Title: Threshold Odor
	Submodule Title:
Approx. Time: 3.0 hours	Topic: Summary

Instructional Objective:

Upon completion of this module the participant should be able to:

1. Prepare water samples and properly diluted samples for panel testing.
2. Set up a panel for threshold odor determination.
3. Direct the work of the panel, tabulate panel responses, and calculate threshold odor numbers.

Instructional Aids:

1.Transparency Od1- Od4

2.Color/odor videotape

Instructional Approach:

Lecture, demonstration, discussion, videotape viewing, practical.

References:

"Standard Methods for the Examination of Water and Wastewater," 14th edition

Class Assignments:

Module No:	Module Title: Threshold Odor
	Submodule Title:
Approx. Time: 0.25 hours	Topic: Origins of Odor

Instructional Objective:

Upon completion of this module the participant should be able to:

1. List three sources of odor in water.
2. Name 2 ways in which odor affects water quality.
3. Relate odor to taste.
4. Explain why odor cannot be determined by a simple chemical or physical test.

Instructional Aids:

Instructional Approach:

Lecture-discussion

References:

Standard Methods, p. 75, 76.

Class Assignments:

None

Module No: Od	Topic: Origins of Odor
Instructor Notes:	Instructor Outline:

1. Sources of Odor:
   a. organic and inorganic chemicals
   b. municipal and industrial waste discharge
   c. natural sources (decomposition of vegetable matter)
   d. microbial activity

2. Effects on water quality:
   a. acceptability of drinking water
   b. tainting of fish and other aquatic organisms
   c. aesthetics of recreational waters

3. Taste and odors:
   a. both are chemical senses
   b. many tastes are actually odors

4. Human nose as the ultimate odor testing device:
   a. the compounds responsible for odor are very complex
   b. the concentration of the complex compounds is too low to permit detection by instruments

Module No:	Module Title: Threshold Odor
	Submodule Title:
Approx. Time: 0.5 hours	Topic: Sample Preparation

Instructional Objective:

Upon completion of this module, the participant should be able to:

1. Collect in a proper container a water sample for odor analysis.
2. Properly dechlorinate a water sample for odor analysis.
3. Determine proper temperatures for odor analysis.

Instructional Aids:

Transparency Odl - Dechlorination of water.

Instructional Approach:

Lecture/discussion

References:

Standard Methods p. 76, 77.

Class Assignments:

None

Module No: Od	Topic: Sample Preparation

Instructor Notes:	Instructor Outline:
	1. Sample collection and storage: a. glass bottle, glass or teflon stopper b. analyze as soon as possible c. if storage necessary, refrigerate
Transparency Od-1 Dechlorination of water Na_2SO_3 solution: Dissolve 0.9g Na_2SO_3 in 1 l. H_2O	2. Dechlorination a. determine odor before and after chlorination b. prepare sodium sulfite dechlorinating agent; add 1 ml to remove 1 mg/l Cl_2 in 500 ml sample
	3. Temperature a. 60° C b. 40° C for fleeting odors c. always report temperature

Module No:	Module Title: Threshold Odor
	Submodule Title:
Approx. Time: 0.25 hours	Topic: Panel Selection

Instructional Objective:

Upon completion of this module the participant should be able to:

1. List 4 characteristics which should be avoided in the selection of odor panel members.
2. Describe the environment for panel testing.
3. Determine the proper size of a panel.

Instructional Aids:

Instructional Approach:

Lecture/discussion

References:

Standard Methods, p.79

Class Assignments:

None

Module No: Od	Topic: Panel Selection
Instructor Notes:	Instructor Outline:

1. Persons to be avoided for the panel:
   a. insensitive persons
   b. lack of interest
   c. persons who have smoked or eaten just prior to the test
   d. wearers of perfume scented soaps or shaving lotion
   e. persons with colds or allergies

2. Room environment:
   a. free from drafts, distractions, and other odors
   b. constant temperature and humidity

3. Size of panel:
   a. five or more testers are needed for precise work
   b. the panel should not prepare samples or know dilutions

Module No:	Module Title: Threshold Odor
	Submodule Title:
Approx. Time: 0.5 hours	Topic: Preparation of Odor-Free Water

Instructional Objective:

Upon completion of this module the participant should be able to:

1. Identify suitable sources of water for the preparation of odor-free water.
2. Describe a odor-free water generator.
3. Describe the operation of an odor-free water generator.
4. Determine when the carbon in the filter is no longer working properly.

Instructional Aids:

Transparency Od2 - Diagram of odor-free water generator

Instructional Approach:

Lecture/demonstration

References:

Standard Methods pp. 77-79.

Class Assignments:

None

Module No: Od	Topic: Preparation of odor-free water

Instructor Notes:	Instructor Outline:*
	1. Suitable sources for the preparation of odor-free water a. most tap water with low chlorine, salt, and neutral pH b. distilled water is the best
Transparency Od-2 Odor-free water generator	2. Odor-free water generator a. end fittings. b. pyrex 3 inch pipe c. filled with activated carbon
	3. Operation a. water at 0.1 l/min b. check water quality daily
	4. Replace carbon filter when odor is detected in "odor-free" water.

Module No:

Module Title:
Threshold Odor

Submodule Title:

Approx. Time:
0.5 hours

Topic:
Determination of Threshold

Instructional Objective:

Upon completion of this module the participant should be able to:

1. Explain how to determine the approximate range of threshold number.
2. Explain how the correct threshold number is finally arrived at.
3. Explain how samples should be presented to panel members.
4. Explain how the point of threshold is determined from panel responses.

Instructional Aids:

Color/odor videotape.

Transparencies - Od3, Od4: threshold odor num[illegible] dilutions of various odor intensities.

Instructional Approach:

Lecture/discussion, videotape viewing

References:

Standard Methods, p. 79, 80, 81.

Class Assignments:

None

Module No: Od	Topic: Determination of Threshold
Instructor Notes:	Instructor Outline:
Color/odor video tape	1. Show color/odor video tape (second half); answer questions concerning the tape.
	2. Approximate range: 200 ml, 50, 12, 2.8 ml samples diluted to 200 ml with odor-free water
Transparencies Od-3, Od-4 Threshold odor numbers, dilutions of various odor intensities	3. Determine sample at which odor first detected, prepare new series of dilutions according to table. Test again. T.O.N. is sample at which odor first detected.
	4. Presentation of sample: a. most dilute samples first b. blanks near expected threshold
	5. Final threshold is the geometric mean of the thresholds for all panel members.

Module No:	Module Title: Threshold Odor
	Submodule Title:
Approx. Time: 0.25 hours	Topic: Sample Dilution

Instructional Objective:

Upon completion of this module the participant should be able to:

1. Prepare samples diluted to give threshold numbers of 1, 4, 17, 70.
2. Prepare samples with any other threshold number.
3. Prepare samples from an intermediate dilution and calculate threshold number.

Instructional Aids:

Transparencies - Od3, Od4.

Instructional Approach:

Laboratory Practice

References:

Standard Methods p. 79-81

Class Assignments:

None

Module No: Od	Topic: Sample dilution
Instructor Notes:	Instructor Outline:
Transparencies Od-3, Od-4 from before	1. Have students make dilutions 1, 4, 17, 70 from table; dilute to 200 ml with odor-free water.
	2. Have Groups of students prepare series of dilutions from each of the groups.
	3. Label each sample with a code number and record the threshold number and code number on a data log.

Module No:	Module Title: Threshold Odor
	Submodule Title:
Approx. Time: 0.5 hours	Topic: Determination and Calculation of T.O.N.

Instructional Objective:

Upon completion of this module the participant should be able to:

1. Participate on a threshold panel.
2. Prepare samples for a threshold panel.
3. Collect data from a threshold panel.
4. Interpret threshold data to obtain a T.O.N.

Instructional Aids:

Instructional Approach:

Laboratory practice

References:

Standard Methods p. 80, 81.

Class Assignments:

None

Module No: Od	Topic: Determination and Calculation
Instructor Notes:	Instructor Outline:
An odor-free room will be required for the panel. Generally, chemistry laboratories are not odor-free.	1. Arrange it so that half the class participates as panel members and - 2. The other half prepares the samples and - 3. Collects data. Roles should be reversed for the second half of the period. 4. Students may combine results to make final calculation.

Module No:	Module Title: Threshold Odor
	Submodule Title:
Approx. Time: 0.25 hours	Topic: Interpretations of Results

Instructional Objective:

Upon completion of this module the participant should be able to:

1. Determine the most probable average T.O.N. from panel data.
2. List precautions which should be taken in the interpretation of panel results.

Instructional Aids:

Instructional Approach:

Lecture/discussion

References:

Standard Methods, p.81.

Class Assignments:

Module No: Od	Topic: Interpretation of Results
Instructor Notes:	Instructor Outline:

1. Express the threshold of the group as the geometric mean of results. Use student data for calculation.

2. Precautions:
   a. T.O.N. is not a precise number
   b. for a single observer it represents a judgment
   c. unless test conditions are standardized, it is dangerous to compare results from time to time and from place to place.

Exam Questions

Threshold Odor
Origins of Odor

1. Which of the following is not a source of odor in water?
   a. organic chemicals
   b. sodium chloride
   c. microbial activity
   d. industrial waste discharge

2. Odor affects water quality by tainting the flavor of fish and by _____.

3. Name the two chemical senses.

4. What is the ultimate odor testing device?

Sample Preparation

5. Of what material should a proper odor sampling bottle be made?

6. What should be done to a superchlorinated water sample prior to odor testing?

7. What is the proper temperature for odor testing of most samples?

Panel Selection

8. Name four characteristics of a poor odor panel member.

9. Would a chemistry laboratory be a good panel testing room?

10. For precise work is one odor tester sufficient?

Preparation of Odor Free Water

11. Would heavily chlorinated water be a good source for the preparation of odor-free water?

12. What medium removes odor from water in an odor-free water generator?

13. How often should the quality of odor-free water be checked?

14. How will you know if the carbon in the odor-free water generator is no longer working?

Determination of Threshold

15. Preliminary odor testing is accomplished by presenting the panel with a broad/narrow(choose one) range of dilution.

16. Final determination of threshold odor number is accomplished by presenting the panel with a broad/narrow(choose one) range of dilution.

17. Should the panel members be able to see the samples they are testing?

18. The dilution level at which odor is just detectable is called the _____.

Sample Dilution

19. A sample dilution is prepared by diluting a 50 ml water sample to 200 ml. If this were the dilution at which odor was just detectable, what would the threshold odor number (T.O.N.) of the sample be?

20. If in preliminary testing the T.O.N. was found to be 4, which of the following sets of volumes diluted to 200 ml should be used for final testing?
    a. 200, 140, 100, 70, 50, 35, 25
    b. 50, 35, 25, 17, 12, 8.3, 5.7, 4.0
    c. 12, 8.3, 5.7, 4.0, 2.8

21. Where should blanks be inserted in the above sequence?

Determination and Calculation of T.O.N.

22. Should a threshold panel member be interested in the work of the panel?

23. Should the most dilute or least dilute sample be presented to the panel members first?

24. If anomolies occur (positive for high dilution; negative for low dilution), at what point should the threshold be taken?

25. True or False: The T.O.N. is calculated from the sample just before odor is detected.

Interpretation of Results

26. For most purposes the most probable average threshold from a panel can be taken as the:
    a. arithmetic mean
    b. geometric mean
    c. root mean square
    d. square root

27. Is the threshold odor a precise number?

THRESHOLD ODOR

EQUIPMENT AND SUPPLIES LIST

1. odor free water or odor free water generator
2. 100, 25, 10, 5 ml graduated cylinders
3. 9 glass-stoppered, amber, 500 ml erlynmeyer flasks
4. hot plate

Threshold Odor

Laboratory Procedure

I. Equipment, Supplies, Samples and personel.

A. Obtain the equipment and supplies needed as listed on the "equipment list."

B. Have available about 10 liters of odor-free water obtained from an odor-free water generator.

C. Samples should be tested as soon as possible after collection. Or refrigerate such that no extraneous odors reach the sample.

D. Select five persons to participate on the odor panel.

II. Sample preparation.

A. For preliminary testing, using graduated cylinders measure 200, 50, 12, and 2.8 ml of sample to be tested into 500 ml erlynmeyer flasks labled C, A, B, D respectively. Add 0, 150, 188, 197.2 ml odor free water to these flasks respectively, and mix. Heat each of these five flasks on the hot plate to 60°C. Present to panel as described in section III.

B. Final testing. Determine from the preliminary test the most dilute sample in which odor could be detected by the panel. Using the table below, choose a series of dilutions corresponding to the most dilute odiferous sample.

	MOST DILUTE ODIFEROUS SAMPLE			
	200	50	12	2.8
	Volumes to be diluted to 200 ml			
F	200	50	12	Dilute 1:10
B	140	35	8.3	then 12
A	100	25	5.7	then 8.3
C	70	17	4.0	then 5.7
E	50	12	2.8	then 4.0
D	35	8.3	2	then 2.8
G	25	5.7	1.4	then 2
H	17	4.0	1.0	then 1.4

Measure the appropriate amount of sample into each of 7-500 ml glass stoppered flasks. Add 200ml minus the amount of sample for a volume of odor free water. Mix. Heat on the hot plate to 60°. Present to panel.

III. Presentation of samples.

A. Present the most dilute of the preliminary samples to each of the panel members by shaking the flask, uncorking and presenting the sample for sniffing. Ask whether odor was noted. Record the response of each member. Repeat the procedure with more and more concentrated samples until all panel members have noted odor. Record responses.

B. From the responses in A., prepare a series of dilutions for more precise odor detection. Present the flasks as in A. (most dilute sample first) and record responses.

IV. Analysis of results

A. Determine for each panel member the dilution at which he or she first detected odor. The ml sample used should be called "A". Calculate the T.O.N. for each person on the panel by dividing "A" into 200. For the column with intermediate dilution, multiply the T.O.N. by 10.

B. Multiply all the T.O.N.'s determined together (panel 1xpanel 2xpanel 3 xpanel 4xpanel 5). Take the fifth root of this product. This number is the approximate most probable T.O.N. of the sample.

C. Comment on sample collection, disposition and environment of the panel, and other possible sources of error.

Threshold Odor

Data sheet

Sample number_____

Preliminary test

sample	ml dil to200	Response of panel member I	II	III	IV	V	x where all detect odor	T.O.N.
C	200							1
A	50							4
B	12							17
D	2.8							70

Final Test

sample	column used (X) ml diluted to 200 ml				Response I	II	III	IV	V
F	200	50	12	20					
B	140	35	8.3	20 then 12					
A	100	25	5.7	20 then 8.3					
C	70	17	4	20 then 5.7					
E	50	12	2.8	20 then 4					
D	35	8.3	2	20 then 2.8					
G	25	5.7	1.4	20 then 2					
H	17	4	1	20 then 1.4					
	A	A	A	A intermediate					

Panel member	I	II	III	IV	V
T.O.N.detected					

T.O.N. 200/A = ____; (200/A)x10 for intermediate dilution.

Most probable T.O.N. = $(IxIIxIIIxIVxV)^{0.2}$ = _____

Comments:

Analyst_____ Date_____

TRANSPARENCY ODI

Dechlorination of Water

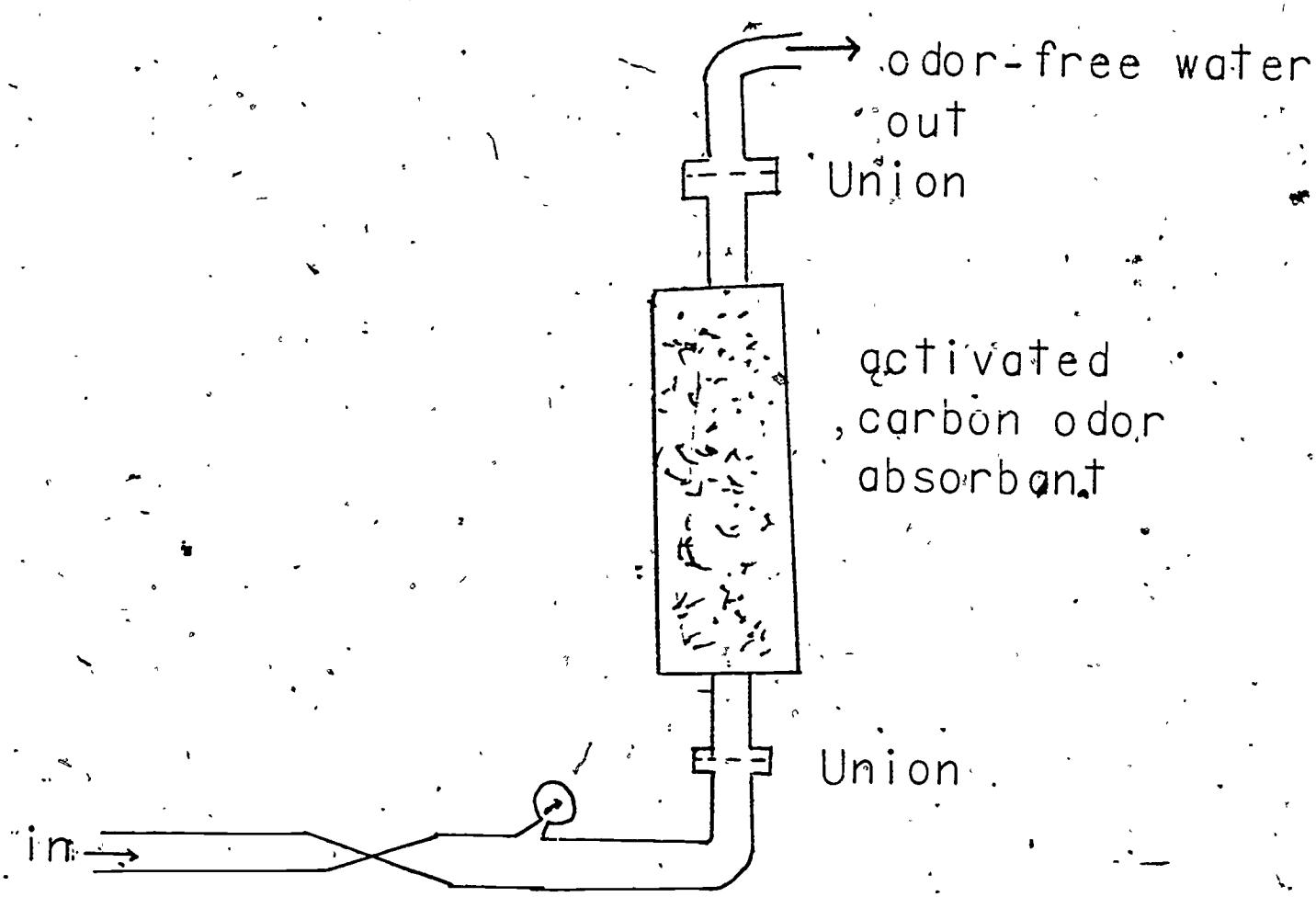
Reagent: 0.9g Na_2SO_3 dissolved in 1 liter water solution.

Add 1 ml reagent for 1 mg/l residual chlorine in 500 ml sample.

For example: If a water sample contains 20 mg/l chlorine, 20 ml of reagent would be added to 500 ml sample to produce a chlorine-free sample.

The odor test should be performed before and after dechlorination.

TRANSPARENCY OD2



Odor-free
Water generator

TRANSPARENCY OD3

Threshold Odor Numbers

Sample volume diluted to 200 ml.	T.O.N.	Sample volume diluted to 200 ml	T.O.N.
200	1	12	17
140	1.4	8.3	24
100	2	5.7	35
70	3	4	50
50	4	2.8	70
35	6	2	100
25	8	1.4	140
17	12	1	200

TRANSPARENCY OD4

Dilutions for Various Odor Intensities

Volume of sample to be Diluted to 200 ml.	Sample Volume in Which odor First Detected			
	200 ml	50 ml	12 ml	2.8 ml*
	200	50	12	12
	140	35	8.3	8.3
	100	25	5.7	5.7
	70	17	4.0	4.0
	50	12	2.8	2.8

*Dilution volume of 1:10 intermediate dilution