Wisconsin Department of Natural Resources
Municipal Waterworks Operator Certification

Volatile Organic Compound Removal Study Guide

January 1998 Edition

Subclass V

Wisconsin Department of Natural Resources
Bureau of Science Services
Operator Certification Program
P.O. Box 7921, Madison, WI 53707

http://dnr.wi.gov

Preface

This operator's study guide represents the results of an ambitious program. Operators of water supply facilities, regulators, educators and local officials, jointly prepared the objectives and exam questions for this subclass.

How to Use This Study Guide with References

In preparation for the exam you should:

1. Read all the objectives and write down the answers to the objectives that readily come to mind.

2. Use the resources at the end of the study guide to look up those answers you are not sure of.

3. Write down the answers found in the resources to those objectives you could not answer from memory.

4. Review all answered objectives until you can answer each from memory.

It is advisable that the operator take classroom or online training in this process before attempting the certification exam.

Choosing a Test Date

Before you choose a test date, consider the training opportunities available in your area. A listing of training opportunities and exam dates is available on the internet at http://dnr.wi.gov, keyword search "operator certification". It can also be found in the annual DNR "Certified Operator" or by contacting your DNR regional operator certification coordinator.

Table of Contents

Chapter 1 - Principle, Structure, and Function

Section 1.1 - Principle of Volatile Organic Compound (VOC) Removal

1.1.1 Describe an organic chemical compound.

1.1.2 Describe synthetic organic compounds (SOC's).

1.1.3 Describe volatile organic compounds (VOC's).

1.1.4 List the common EPA regulated VOC compounds.

1.1.5 Discuss the most common sources of water contamination by VOC's.

1.1.6 Identify the major human health problems that can be caused by VOC's in a water supply and the utilities' responsibility when detected.

1.1.7 Discuss why VOC contamination is more a problem in a groundwater supply than in a surface water supply.

Section 1.2 - Structure and Function

1.2.1 Define the following treatment technologies most commonly used to remove VOC's from a water supply.

A. Air stripping (packed tower aeration)
B. Granular activated carbon

1.2.2 Describe the flow of water through an air stripping tower.

1.2.3 Explain what is meant by counter-current air stripping.

1.2.4 Describe the functions of the following components of an air stripping tower:
A. Liquid distributor
B. Packing media
C. Liquid redistributor
D. Packing support
E. Mist eliminator (Chevron baffle)
F. Blower
G. Blower screen (intake)
H. Air volume meter
I. Differential pressure gauges

1.2.5 Discuss the difference between a forced-draft aeration system and an induced-draft aeration system.

1.2.6 State what materials are used as packing media.

1.2.7 Describe contaminant adsorption and capacity of a granular activated carbon (GAC) unit.

Chapter 2 - Operation and Maintenance

Section 2.1 - Operation

2.1.1 Discuss what is meant by the term, "best available technology", (BAT).

2.1.2 List some types of impurities that may be added and must be removed when using the air stripping process.

2.1.3 Explain why some VOC's are more easily removed by air stripping than some other process.

2.1.4 Describe how the air-to-water ratio affects contaminant removal efficiency.

2.1.5 State the removal efficiency of the air stripping process.

2.1.6 Discuss activated carbon (AC) and why it is useful when dealing with VOC's.

2.1.7 Describe the proper chemical additions for the following:

A. Packed column aeration
B. Granular activated column

2.1.8 Discuss potential undesirable impacts of installing GAC.

2.1.9 Discuss what special operating procedures should be observed for VOC removal during cold weather.

2.1.10 Describe what benefit the increasing of the raw water temperature has on the removal efficiencies of hard-to-strip VOC compounds.

2.1.11 Explain why water should be disinfected before treatment.

2.1.12 Discuss the problems iron and manganese pose to an air stripping system.

2.1.13 Describe how water stability may be affected by aeration.

2.1.14 Discuss the concern and elimination of the off-gas from an air stripping unit.

2.1.15 List the steps involved in backwashing a typical granulated activated carbon unit.

2.1.16 Discuss budget considerations that should be anticipated with the operation and maintenance of a VOC removal system.

Section 2.2 - Maintenance

2.2.1 List the operational and maintenance records that should be kept by a VOC removal system.

2.2.2 Develop a sample calendar of operation and maintenance, laboratory, and recordkeeping events an operator must do on a daily, weekly, monthly, quarterly, and yearly basis.

2.2.3 Describe what types of routine maintenance should be performed on the following pieces of air supply tower equipment:

A. Blowers
B. Packing media
C. Screens (air filter)
D. Tower exterior
E. Gauges and controls

2.2.4 Explain the techniques used to clean the following items:

A. Packing media
B. Tower interior
C. Mist eliminator
D. Effluent storage basins or piping

Chapter 3 - Monitoring and Troubleshooting

Section 3.1 - Monitoring

3.1.1 Explain the level of concentration of VOC's and how they are regulated.

3.1.2 Discuss how and where contaminant levels are established.

3.1.3 Discuss the concerns that should be addressed in selecting a laboratory to test for VOC's.

3.1.4 Specify the types of laboratory tests that should be run at a VOC removal facility.

3.1.5 Explain the VOC sampling container requirements.

3.1.6 Discuss VOC sampling points and techniques.

Section 3.2 - Troubleshooting

3.2.1 Describe the causes for the following air stripping situations:

A. Tower overflow
B. Excessive precipitation or ice formation on the tower
C. Scaling in the tower effluent system
D. Influent VOC concentration is increasing
E. Effluent VOC concentration is increasing with no change to the influent concentration

3.2.2 Discuss the solution to the following common granular activated carbon unit operation and maintenance problems:

A. Excessive headloss
B. Reduction in removal efficiency
C. Carbon media loss
D. Physical exterior deterioration
E. Freezing

Chapter 4 - Safety and Calculations

Section 4.1 - Safety

4.1.1 List safety concerns that should be anticipated with a VOC removal system.

4.1.2 Describe the correct safety procedures or techniques used in the following:

A. Confined space entry
B. General equipment safety concerns
C. Chemical handling safety

Section 4.2 - Calculations

4.2.1 Given data, calculate the VOC removal efficiency percentage.

References and Resources

1. SMALL WATER SYSTEM OPERATION AND MAINTENANCE.

1st Edition (1990). Kenneth D. Kerri. California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.

http://www.owp.csus.edu/

2. STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER.

17th Edition (1989), 18th Edition (1992). Joint Publication of: American Public Health Association, American Water Works Association, and Water Environment Federation (Old WPCF). Publication Office: American Public Health Association,1015 Fifteenth Street NW, Washington, DC 20005.

http://www.standardmethods.org/

3. WATER TREATMENT PLANT OPERATION.

2nd Edition (1989). Volumes 1 and 2. Kenneth D. Kerri. California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.

http://www.owp.csus.edu/

4. WISCONSIN ADMINISTRATIVE CODE NR 809 SAFE DRINKING WATER.

Wisconsin Legislative Reference Bureau, One E Main St, Suite 200, Madison, WI 53701-2037 Reference Desk: 608-266-0341

http://docs.legis.wisconsin.gov/code/admin_code/nr/800/809

5. WISCONSIN ADMINISTRATIVE CODE NR 811 REQUIREMENT FOR THE OPERATION AND DESIGN OF COMMUNITY WATER SYSTEMS.

Wisconsin Legislative Reference Bureau, One E Main St, Suite 200, Madison, WI 53701-2037 Reference Desk: 608-266-0341

http://docs.legis.wisconsin.gov/code/admin_code/nr/800/811

6. AIR STRIPPING FOR VOLATILE ORGANIC CONTAMINANT REMOVAL.

AWWA No. 20035 (1989). American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone (303) 794-7711

www.awwa.org

7. OCCURANCE AND REMOVAL OF VOLITILE ORGANIC CHEMICALS FROM DRINKING WATER.

AWWA 1983 Research Foundation. American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone (303) 794-7711

www.awwa.org

8. SAFE DRINKING WATER ACT SERIES:

SURFACE WATER TREATMENT RULE. AWWA No. 70055 (1990).
PUBLIC NOTIFICATION. AWWA No. 70056 (1990).
TOTAL COLIFORM RULE. AWWA No. 70057 (1990).
VOC'S AND UNREGULATED CONTAMINANTS. AWWA No. 70058 (1990).
LEAD AND COPPER. AWWA No. 70073 (1991).
PHASE II: VOC'S, IOC'S, AND SOC'S. AWWA No. 70074 (1991).
American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone (303) 794-7711

www.awwa.org

9. WATER QUALITY AND TREATMENT-FOURTH EDITION.

AWWA No. 10053 (1990). American Water Works Association, Member Service Department. 6666 W. Quincy Avenue, Denver, CO 80235. Phone (303) 794-7711

www.awwa.org