Wisconsin Department of Natural Resources
Wastewater Operator Certification

Advanced Stabilization Ponds and Aerated Lagoons Study Guide

November 1998 Edition

Subclass D

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 wastewater 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 exams you should:

1. Read all of the key knowledges for each objective.

2. Use the resources listed at the end of the study guide for additional information.

3. Review all key knowledges until you fully understand them and know them by 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.

Acknowledgements

Special appreciation is extended to the many individuals who contributed to this effort.

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Chapter 1 - Principle, Structure, and Function

Section 1.1 - Principle of Ponds

1.1.1 Describe how the stabilization of organic waste material occurs in nature and in a wastewater treatment plant.

Stabilization of organic waste is accomplished by bacterial degradation of organic waste material aerobically, anaerobically, or a combination of the two. The aerobic organisms are provided oxygen from photosynthesis by algae.

1.1.2 Explain photosynthesis.

Photosynthesis is the creation of plant cell mass using carbon dioxide, water, and nutrients, with sunlight as the energy source and chlorophyll as a catalyst. During this process, free oxygen is given-off.

1.1.3 Explain respiration.

Respiration is the process by which an organism (plant or animal) assimilates oxygen and releases carbon dioxide.

1.1.4 Relate photosynthesis and respiration to BOD removal.

The oxygen produced by photosynthesis can be used by bacteria in their life processes (respiration), this includes degrading organic material, which reduces BOD.

1.1.5 Relate pH, carbon dioxide, and dissolved oxygen concentrations to photosynthesis and respiration.

During photosynthesis, green plants use carbon dioxide and produce oxygen. This causes an increase in dissolved oxygen and pH (the pH increase is due to the loss of dissolved carbon dioxide which would normally form a weak carbonic acid).

During respiration, plants or animals use dissolved oxygen to assimilate organic material and give off carbon dioxide. This causes a reduction in the dissolved oxygen and pH (the pH drop is caused by the increase in carbon dioxide, causing a weak carbonic acid).

1.1.6 Explain why a pond may violate pH permit limits during periods of intense photosynthesis.

Intense sunlight speeds-up algae photosynthesis. Algae use up carbon dioxide which raises pH to very high levels (11 + Specific Units).

1.1.7 Discuss some innovative uses of Aerated Lagoon Systems.

Rearing minnows or other food fish. Minnows that forage on planktonic material are a food source for larger fish. This process will work providing there is enough dissolved oxygen. A concern would be possible ammonia toxicity.

Section 1.2 - Structure and Function

1.2.1 Identify the valve action necessary to bypass a Pond cell.

Close the inlet and outlet valves on the unit to be bypassed. Open the valve on the bypass line.

1.2.2 Discuss different flow patterns that are used in Multiple Pond treatment systems.

There are various ways to route the hydraulic flow through multiple pond systems. With proper valving, ponds can be operated in either series or parallel modes. In most cases, multiple cell treatment is designed and operated in series. In a three pond system, series operations will minimize algae in the final cell. If high organic loading to the primary cell is occurring, especially during winter months and ice cover, it may be desirable to operate the cells in parallel to reduce the affect of this over-loading. This should be considered a short term solution, and if continuous overloading occurs action needs to be taken to reduce the overload or system re-design should be evaluated.

1.2.3 Discuss the advantage of Helical Diffusers over Floating Mechanical Aerators.

Helical diffusers are much less affected by ice build-up during winter weather.

Chapter 2 - Operation and Maintenance

Section 2.1 - Operation

2.1.1 Explain the theory of isolation of a Pond cell which is experiencing an algae bloom in a Series Pond System.

Isolation of a pond cell which is experiencing an algae bloom gives the cell a chance to "rest" and recover.

2.1.2 Discuss the use of chemicals to control weeds.

If chemicals are used for pond weed control, they must be approved for that specific use and label directions must be followed precisely. It may be necessary to provide additional monitoring for toxics. Many times, the use of a surfactant is recommended to improve the "wetting" ability of the mixture so it adheres better to the treated plants.

2.1.3 Describe how Pond depth and bubble size affect aeration efficiency.

The deeper the pond, the longer the contact time before the bubbles reach the surface. The smaller the bubbles, the more contact surface between the air and water, which increases the transfer rate.

2.1.4 Explain how to balance aerators within and between Ponds.

Balancing of aeration within and between ponds is accomplished by using the valves on the manifold to get an even agitation pattern.

2.1.5 Discuss when Floating Aerators are used for temporary additional aeration capacity.

Floating aerators are used for additional aeration capacity to handle larger than expected organic loads during the summer months.

2.1.6 List the important issues to consider in developing a public relations program for a Pond system.

A. Post a notice explaining the principles of operation of a pond system.
B. Develop an educational program for local elected officials.

C. Explain to the public how unauthorized entrance and use can jeopardize a ponds affectiveness.
D. Explain why children should not be allowed in the area of the pond's "rapid depth".
E. Explain why you should stay off the ice of a pond at all times.
F. All public information and education programs could be done with public notice.

2.1.7 Explain why alternate discharges to seepage cells should be practiced in a Multiple Seepage Cell system.

The alternate loading/resting of seepage cells is done for a number of reasons. One reason is to allow the operator to physically work-up (disk, rototill, or drag) and clean the cell bottom. It also allows the operator to control vegetation within the cell. Finally, with the new ground water rules, it allows spreading the load over a larger area to prevent ground water exceedances. The new ground water standards will change seepage cell operations to meet these standards. This may mean more cells (larger area) or even possible discontinuance of seepage cells.

2.1.8 List the considerations a Pond operator would have to make when considering accepting septic tank waste.

A. BOD concentration of haulers load
B. Solids loading of the load
C. D.O. Capacity
D. Grit
E. Hydraulic loading

Normally, ponds and aerated lagoons are not designed with holding tanks to accept septage.

Section 2.2 - Maintenance

2.2.1 Identify the items to be included in a Preventive Maintenance plan for a Pond system.

Monitor all equipment: blowers, check valves, air diffuser orifices, dikes, all pumps, control manholes, and shear gates. Maintain seepage cells. A planned maintenance program will prevent problems and will identify potential concerns before they actually become problems. Maintenance at a pond system involves simple housekeeping items which are critical to good treatment.

Good housekeeping items are:

a. Remove any scum which impedes oxygen transfer and causes odors.
b. Mow dikes to the water line to keep weeds down, discourage burrowing muskrats, and promote wind mixing.
c. Maintain dikes by restoring any erosion and/or fill muskrat dens.
d. Skim floating duckweed regularly.
e. Control cattails regularly.
f. Perform preventive maintenance on all mechanical equipment as instructed in the O&M manual and the equipment manufacturers' manuals.
g. Exercise valves in the system on a regular basis.

2.2.2 List the maintenance items on Aeration Equipment.

A. Piping: check all air piping, including valves and diffusers to ensure that there are no blockages.
B. Centrifugal blowers: check oil levels, air filters, relief valves, and drive motors.
C. Positive displacement blowers: maintain oil levels, air relief valves, v-belts, air filters, and drive motors.
D. Floating aerators: maintain floats, electric lines, check oil levels, anchors, drive motors. Make sure impellers are not clogged.

2.2.3 Explain how to clean clogged Air Diffusers.

Cleaning of air diffusers in pond systems can be done in several ways. If the plugging is minor, the air flow can be increased by shutting down some sections to increase the air to the remaining sections or by increasing blower output (if possible). Another cleaning method would be to introduce hydrogen chloride or oxygen /ozone gas through the air lines. In some instances, divers have been used to mechanically clean the diffusers (rolling tubing through a flex tool or other methods). If none of these procedures work, the last option would be to draw the pond down to repair/replace diffusers.

2.2.4 Describe the function and maintenance of the Blower Inlet Filter.

The inlet air filter removes particulates from the air before the compression stage so debris does not get into the air line and plug diffuser orifices. It is also essential to protect the compressor from any damage, especially from gritty materials. The main maintenance requirement is to keep the filter clean. Usually, this is done by removing the filter and blowing it out with compressed air. The frequency of cleaning is dependent on filter size and ambient air quality. Other maintenance activities should be specified by the manufacturer or as listed in the O&M manual. Failure to adequately clean filters can cause reduced blower air output, an overheated blower, possible diffuser clogging, and possible damage to blower and drive motor.

2.2.5 Explain methods of controlling dike erosion.

The main methods for preventing dike erosion are proper dike vegetation and the use of rip rap around the normal operating pond levels to prevent erosion from wave action.

2.2.6 Discuss how to prevent ice damage to floating aeration equipment.

Ice damage occurs most often to floating aerators when they tip over. The motors and power cables can be damaged or broken during tipping. The best method is to stabilize them with adequate guy cables. Since oxygen requirements are lower in the winter, it is possible to protect equipment by removing some of the aerators.

Chapter 3 - Monitoring and Troubleshooting

Section 3.1 - Monitoring

3.1.1 Set-up a sampling schedule for a Fill and Draw Pond system

Sampling locations should be about eight feet from each corner and below the surface of the pond. Samples should be collected about a week prior to proposed discharge. During the entire duration of discharge, check the pond level daily. Sample at the control manhole on the frequency specified in the discharge permit.

Prior to drawing down a pond, the operator should sample the pond contents for pH, BOD, and suspended solids. It is also necessary to determine the volume needed to hold flows until the next draw-down (usually 180 days).

3.1.2 Describe two ways to determine Dissolved Oxygen levels in a Pond.

A. Use a dissolved oxygen meter.
B. Perform a winkler dissolved oxygen test.

3.1.3 Discuss the requirements for groundwater monitoring.

Changes in state law have established requirements for ground water (NR 140). This is important for wastewater systems, especially land disposal seepage facilities and lagoons that may be leaking. Normally, up-gradient and down-gradient wells will be located to determine if a system is affecting ground water. Concern at municipal type treatment plants would be total dissolved solids, chlorides, and nitrogen series (and more specifically, nitrates). These parameters will be the potential areas that pond systems might expect exceedances of the ground water standards which will require operational changes, discharge location changes, or future reconstruction.

Section 3.2 - Troubleshooting

3.2.1 Describe how to determine if a drop in Pond water levels is caused by seepage or evaporation.

A. Calibrate the flow meter to determine if the totalizer is working properly.
B. Check the results of groundwater samples to see if down-grade wells show significant changes in water quality.

Calibrate the flow meter to determine if you have accurate influent flow data. Set-up a staff gauge to accurately measure pond elevation. By filling a 55-gallon drum, or similar holding device with water, this can be used to determine the affects of precipitation and evaporation. Collecting this data over a period of time can be used to determine the rate of pond seepage.

3.2.2 List the chemical and non-chemical controls for the following Pond conditions:

A. Algae.
B. Rooted Weeds.
C. Duckweed.
D. Organic Overload.

A. Algae: Chemical = copper sulfate, Non-Chemical = filtration
B. Rooted weeds: Chemical = herbicides, Non-Chemical = cutting, pulling, or vary pond levels
C. Duckweed: Chemical = herbicide, Non-Chemical = wind and rake
D. Organic overload: Chemical = sodium nitrate, Non-Chemical = reduce load and use aeration
Note: For cattail control, herbicides are usually most effective during development. Cutting

cattails below the water line in fall is also an effective control method.

3.2.3 State the action to take if a polishing Pond produces worse suspended solids effluent than its influent.

This situation is normally a problem associated with an algae bloom. The alternatives to correct this problem would be to by-pass the polishing pond, or to attempt to withdraw effluent from a different elevation.

3.2.4 List the conditions that might lead to solids build-up on the bottom of a Pond.

A. High influent TSS.
B. Excessive weed growth.
C. Overloading.
D. Poor treatment.
E. High influent BOD.
F. Inorganic solids.

3.2.5 List some possible consequences of exceeding the design organic loading rate of a Pond system.

A. Poor treatment.
B. High effluent BOD.
C. Increase of sludge solids.
D. Potential for objectionable odors.
E. Excessive algae (blue-green filamentous mats).

3.2.6 Discuss the significance of long-term domination of a Pond by blue-green algae.

Blue-green algae dominance of a pond system is an indication of incomplete or poor treatment. The problem with blue-green algae happens when the algae dies-off and foul odors occur. If operational changes cannot be made to eliminate the blue-green algae, then considerations need to be given to plant re-design.

3.2.7 Explain why a Pond receiving a white dairy waste might turn red.

High protein waste is causing red algae to bloom

3.2.8 Describe when and how to use copper sulfate to achieve maximum control of algae.

Use copper sulfate when algae becomes excessive. Use label directions for mixing and applying this chemical. Additional monitoring for toxics may be required. A concern that needs watching when treating the entire pond is that dissolved oxygen levels can decrease due to the die-off and decomposition of algae.

3.2.9 List some alternatives to using copper sulfate for algae control.

A. Introduction of fish.
B. Spray the ponds with another approved algicide.
C. Change operational mode (if possible).
D. Discharge effluent from a different pond level.
E. Apply for an algae variance.

3.2.10 Describe short circuiting and possible causes and problems it creates.

Short circuiting is a hydraulic condition which may occur in parts of a pond when the flow passes through more quickly than the theoretical detention. This type of flow pattern reduces detention time as compared with even uniform flow through the pond.

Short circuiting can be caused by poor design and/or construction of inlet and outlet structures, uneven pond bottoms, shape of the cells, prevailing winds, and excessive growth of rooted weeds.

Problems associated with short circuiting include: dead spots, uneven oxygen levels, sludge build-up, odor problems, and a reduction in treatment efficiency.

Chapter 4 - Safety and Calculations

Section 4.1 - Safety

4.1.1 List the characteristics of an affective safety program.

A. Red cross first aid training.
B. CPR Training.
C. Proper equipment operation near ponds (mowing, snow removal from dikes, etc.).
D. Wearing proper apparel when entering control structures.
E. Confined entry training.
F. Water safety course training.
G. Understanding usage of chemicals.

4.1.2 List some Pond security measures.

A. Fencing to prevent any unauthorized entry.
B. Erecting signs with proper message.
C. Passing an ordinance to regulate use of the area and penalize violators.

Section 4.2 - Calculations

4.2.1 Given data, calculate pounds BOD per acre per day.

Given:
Pond surface = 6.2 acres
Average daily flow = 50,000 GPD
Influent BOD5 = 220 mg/L

Formula:
Surface loading rate = pounds of BOD per day/pond surface area

Pounds of BOD/day = concentration(mg/L) x flow(MGD) x 8.34 lbs/MG/mg/L
= 220 mg/L x 0.05 MGD x 8.34 lbs/MG/mg/L
= 91.7 pounds bod/day

surface loading rate = 91.7 lbs/day ÷ 6.2 acres

= 14.8 pounds BOD/acre/day

4.2.2 Given data, calculate the cost of a chemical ($/Pound) needed to control duckweed.

Given:
Pond surface area = 12.5 acres
Application rate = 2.1 per acre
Chemical cost = $8.75 per acre

Formula:
cost ($)= area (acres) x application rate x cost

= 12.5 x 2.1 x 8.75
= $230

4.2.3 Given data, calculate the theoretical detention time of a pond.

Given:
Volume = 5.2 MG
Flow = 0.05 MGD

Formula:
detention time = volume (MG) / flow rate (MGD)
detention time = 5.2 MG/0.05 MGD
dentention time = 104 days
(For pond systems, detention time is usually expressed in days)

4.2.4 Given data, calculate a discharge flow rate to achieve a given Pond draw-down.

Given:
Pond dimensions (at mid-point of drawdown)= 200 feet x 400 feet
Drawdown desired = 4 feet
Duration of drawdown = 100 hours
(one cubic foot = 7.5 gallons)

Formula:
Flow rate = volume to be discharged / duration of draw-down

= (200 ft. X 400 ft. X 4 ft. X 7.5 gal/ft cubed) ÷ (100 hours x 60 min/hr)
= 400 gallons per minute

4.2.5 Given data for a Fill and Draw Pond system, calculate the amount of draw-down required and the time required to achieve draw-down.

Given:
Amount of draw-down req. =
Volume req. for desired storage time/Volume per foot of depth

Time req. for draw-down =
Volume of draw-down needed/Maximum draw-down rate

(1 cubic foot = 7.5 gallons)

A pond is being operated fill and draw with the operator drawing-down a pond to meet a desired detention time of 180 days. The pond dimensions are 400 feet by 600 feet at average depth. The measured water depth is 6 feet, with the maximum operating depth of 6 feet, and the maximum draw-down rate of 0.5 feet per day. The influent flow to the system is 30,000 GPD. What is the minimum number of days that it will take to draw the pond down?

4.2.6 Given data, calculate the volume of water in a groundwater monitoring well casing.

Given:
Inside well casing diameter = 2 inches
Depth of water = 15 feet

Formula:
volume(gallons) = 3.14 x r^2 x depth x 7.5 gal/ft cubed
(1 cubic foot = 7.5 gallons)
(1 cubic foot = 1728 cubic inches)

Volume = (3.14 x 1" x 1" x 15 ft x 12 in x 7.5 gal/ft cubed) / 1728 in cubed/ft

Volume = 2.45 gallons

References and Resources

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