

IDEM Wastewater Operator Examination

Study Guide

Municipal Class 3 and Class 4 Exams

April 2025

As you prepare for the Municipal Class 3 and Class 4 exams, you will need to focus your study on Books 1, 2, 3, 10 and 14 as listed on the IDEM Wastewater Operator Certification Exam Book List web page. These references have been used in developing the examination questions which you will need to be able to answer. Books 1, 2 and 3 are manuals prepared by and available through California State University, Sacramento College of Engineering and Computer Science, Office of Water Programs (Referred to hereafter as the Sacramento manuals), which can be purchased at: <https://www.owp.csus.edu/courses/wastewater.php>

Book 10 is IDEM's Wastewater Operator Certification Manual which can be found at: https://www.in.gov/idem/cleanwater/files/wastewater_cert_booklist_10_manual.pdf

Book 14 is EPA's Introduction to the National Pretreatment Program, which is available online at: https://www3.epa.gov/npdes/pubs/pretreatment_program_intro_2011.pdf

This document is designed to guide you to the subject matter that you will need to be familiar with in order to pass the test. While this covers a wide range of material, you should keep in mind that the exam consists of only 100 multiple choice questions, you do not need to study every chapter of these books, and since you have been working at a wastewater treatment plant for some time, much of this will already be familiar to you. You can do this! The breakdown of the distribution of those questions is described below.

The approximate percentage of the examination questions comprised from all categories are listed below:

Activated Sludge	15%
Advanced Treatment	5%
Clarifiers	4%
Disinfection	6%
Fixed Film	1%
Laboratory	11%
Maintenance	4%
Math	10%
Preliminary treatment	5%
Pretreatment	5%
Rules/Regulations/Reports	21%
Safety	3%
Solids Handling	10%

Book 1: Operation of Wastewater Treatment Plants – Volume I

Chapter 1 Introduction to Wastewater Treatment

Chapter 2 Safety

Chapter 3 Preliminary Treatment

Chapter 4 Primary Treatment

Chapter 5 Activated Sludge Systems

Chapter 6 Fixed Film Processes

Chapter 7 Disinfection

Chapter 9 Laboratory Procedures

Appendix A Introduction to Basic Math for Operators

Book 2: Operation of Wastewater Treatment Plants – Volume II

Chapter 1 Introduction to Wastewater Treatment

Chapter 2 Nutrient Removal

Chapter 3 Solids Removal from Effluent

Chapter 4 Residual Solids Management

Chapter 5 Plant Maintenance

Appendix A Introduction to Basic Math for Operators

Book 3: Advanced Waste Treatment

Chapter 1 Odor Control

Chapter 2 Activated Sludge

Chapter 3 Residual Solids Management

Chapter 4 Solids Removal from Secondary Effluents

Chapter 5 Phosphorus Removal

Chapter 6 Nitrogen Removal

Mathematics:

Mathematics problems given on the examination will have a corresponding formula listed on the Formula Sheet furnished with the exam on your test day. It is recommended that you look over the formula sheets and work the problems in the Appendices in Volumes 1 and 2 of the Sacramento manuals. Solving these problems involves plugging the numbers given in the problem into the correct formula and calculating the answer. Formulas for calculating areas and volumes of common shapes will not be provided and must be memorized.

There are a few basic rules that apply to solving formulas:

1. Work from left to right
2. Do all of the multiplication and division above the line (in the numerator) and below the line (in the denominator); then do the addition and subtraction above and below the line.
3. Perform the division (divide the numerator by the denominator).
4. Parentheses () are used in formulas to identify separate parts of a problem.
Work the arithmetic within the parentheses before working outside the parentheses.
Use the same order stated in rules 1, 2, and 3 above when working inside of parentheses.

Website for the Formula Sheet:

https://www.in.gov/idem/cleanwater/files/wastewater_cert_study_guide_formula_sheet.pdf

Pretreatment:

Questions concerning the regulatory pretreatment program are derived from the Introduction to the National Pretreatment Program (Book 14).

Rules/Statutes/Completing Reports

The remainder of the examination questions will cover the applicable rules and completion of monthly reports. Practice questions on Rules are covered extensively in Chapter III, Section One, of the Wastewater Operator Certification Manual.

There will also be questions related to the completion of the Discharge Monitoring Report (DMR) and the Monthly Report of Operation (MRO). A worksheet and necessary additional documents are incorporated into the Certification Manual as Appendices A, B, C, and D to help prepare you for the exam.

Subject Matter Topics

The following is subject matter that an operator should be familiar with. You should be able to answer questions on the points presented below. Of course, not all of this will appear on any given test, but some of it will appear on all tests.

Activated Sludge

Define first stage and second stage BOD relative to nitrification (carbonaceous versus nitrogenous BOD removals).

Describe where the activated sludge process fits in the wastewater treatment flow pathway.

Define the activated sludge process.

Describe the secondary treatment process of activated sludge systems.

Identify common microorganisms the activated sludge process including filamentous.

Define the role and affects microorganisms have in the activated sludge process.

Identify and explain the meaning of the following terms:

- MLSS
- SVI
- WAS
- RAS

List the important conditions necessary for optimum bacterial growth in an aeration basin of activated sludge systems.

Draw a diagram of the secondary activated sludge process and name the components.

Describe the relationship among D.O., BOD loadings, floc settleability, filamentous bacteria and pinpoint floc.

Why is sludge wasting important in an activated sludge system?

List the main controls an operator has over the activated sludge processes.

Describe the layout of the common type of extended aeration tanks.

What is the definition of sludge age and what is the expected sludge age in an extended aeration process?

Describe the differences among and advantages/disadvantages of conventional activated sludge, extended aeration, contact stabilization and complete mix systems. For example, which of the four processes has the longest detention time? What are the advantages of the longer detention time?

What is the function of cathodic protection for a metal-built package plant?

Which two methods of aeration are commonly used in the activated sludge process? Describe the mechanism of aeration.

What are the advantages and disadvantages of fine bubble air systems?

What can happen if not enough air is supplied to an activated sludge system?

Define Oxidation-Reduction Potential

In the activated sludge systems, foam can appear on the surface of the aeration tank. How could the color of foam indicate the condition of the aerator?

Explain sludge wasting:

How to dispose of excess sludge

What is the consequence of NOT wasting sludge?

Describe nitrification and its importance.

Know the chemical reaction that occur during nitrification

Know common chemical treatment for Phosphorus removal.

Describe the normal operation of an activated sludge plant.

Describe the abnormal operation of an activated sludge system.

Describe troubleshooting of activated sludge systems.

Describe the settling test for activated sludge and explain how the results of the test should be used to control the plant operation.

Describe the flow path and major components of oxidation ditches.

Explain why the oxidation ditch process is less affected by cold weather than the conventional activated sludge processes?

What is the result of wasting sludge from an oxidation ditch system?

How is the dissolved oxygen level in oxidation ditches controlled?

To build up MLSS in an oxidation ditch in order for foam reduction, what control should be manipulated?

What is the most essential component of an oxidation ditch and why?

Discuss essential design features of package plants.

Explain the term "endogenous respiration".

What types of laboratory data are needed to be recorded for proper operation of an activated sludge process?

Define the term "organic loading". Compare the organic loadings of different activated sludge processes.

Describe the different types of air diffusers in activated sludge systems. What are their advantages and disadvantages?

What level of D.O. should be maintained in an aeration tank of an activated sludge system?

Where should this level be maintained?

Describe what will happen when the return sludge rate is too low in an activated sludge system.

Describe what would happen if the mixed liquor suspended solids are allowed to increase beyond the optimum range in an activated sludge system.

Describe the term "sludge bulking".

Explain why sludge may turn septic in an activated sludge system.

Describe rising sludge in an activated sludge system.

What causes rising sludge?

Which is the 'main worker' among the various organisms found in activated sludge?

Clarifiers/Sedimentation

Describe the purpose of sedimentation.

Differentiate between primary and secondary (or final) clarifiers.

Describe the essential components of a rectangular clarifier.

Describe the essential components of a circular clarifier.

What is the purpose of the effluent weir in a circular clarifier?

Black and odorous septic wastewater is leaving the primary clarifier of your wastewater plant.

What could be the causes and their solutions?

You found that sludge was hard to pump from the hopper of the secondary clarifiers. What could be the causes and their solutions?

Excessive corrosion is observed on the clarifier of your package extended aeration unit.

What could be the causes and their solutions?

At what location would you collect samples in order to determine the efficiency of a clarifier?

What water quality parameter should be measured to determine the efficiency of a clarifier?

Describe the factors affecting clarifier efficiencies.

Describe the method to determine the proper intervals for removal of sludge from a clarifier.

Describe the proper maintenance program for a clarifier.

Define specific gravity.

Describe the temperature effect on sedimentation of a particle in a clarifier. Describe short-circuiting in a clarifier.

Discuss secondary clarifiers.

What are the common causes of short-circuiting in a clarifier and their remedial measures?

Describe the relationship between the detention time and particle settling rates in a clarifier.

Define weir overflow rates in a clarifier.

Define surface loading rates in a clarifier.

Explain the "hydrostatic" sludge removal system.

Describe the layout of an activated sludge plant and the location of secondary clarifiers.

What will happen if sludge is allowed to stay in a secondary clarifier too long? What is the solution?

Disinfection

What are pathogenic organisms?

Describe the difference between the terms "disinfection" and "sterilization".

Describe the reaction of chlorine in wastewater. What is "chlorine demand"?

Describe the reaction of chlorine with ammonia.

Describe factors affecting disinfection of wastewater by chlorine.

Discuss the hazards in handling chlorine gas.

Describe the type of breathing apparatus necessary when entering a room with a chlorine leak.

Discuss the handling of chlorine cylinders and importance of fusible plug.

Know different options of liquid chlorination.

Know parts of a Chlorinator

Discuss the need for dechlorination.

What methods are available for dechlorination?

Discuss the properties of sulfur dioxide and importance of not overdosing.

Discuss the typical application point of sulfur dioxide for dechlorination.

Be able to troubleshoot a sulfonator.

Understand how UV disinfection works.

Understand what kind of light is used in UV disinfection.

Laboratory, Sampling and Monitoring

Describe the following terms used in laboratory analyses.

- buffer & buffer capacity
- meniscus

List the chemical formulas of the following compounds:

- sodium hydroxide
- sulfuric acid
- ferric chloride
- nitric acid
- hydrochloric acid

Describe the functions of the following lab equipment:

- beakers
- graduated cylinders
- volumetric pipet
- burette

State the function of a desiccator.

Define spectrophotometer and what it directly measures.

Explain the different uses of flasks and volumetric flasks.

Explain the proper method of use of three types of pipets.

Describe laboratory work (bench) sheets.

Discuss laboratory safety at a wastewater treatment plant laboratory.

Define ambient temperature.

Define specific gravity.

Discuss the safe storage of laboratory chemicals as it relates to proper location and the compatibility of various types of chemicals.

Discuss the accuracy expected from the use of analytical balances and graduated cylinders.

Define standards and their importance in analytical testing.

Describe proper laboratory techniques in handling acids

Explain why it is important to collect samples correctly.

Discuss the importance of composite samples and their use in the laboratory tests.

Explain grab samples and composite samples

Describe the proper sample preservation methods and the maximum recommended holding time for the following tests:

- ammonia
- BOD
- pH
- chlorine
- Total Suspended Solids (TSS)
- Oil and grease
- metals

Specify temperature requirements in degrees C (Celsius) for each of the following:

- BOD incubator
- TSS drying oven
- refrigerator
- composite sampler
- muffle furnace

Describe settleability tests, and how the results can be used in plant process control.

Explain the difference between the settleable solids test and the settleability test, the method and the use of information.

Understand total suspended solids, total dissolved solids, volatile solids and Total solids.

Discuss the measurement of the sludge volume index and its application in the activated sludge processes.

Discuss the determination of "sludge age".

Why are we concerned about the concentration of coliform group bacteria?

Why is it important to maintain residual chlorine in a chlorine contact tank?

Describe the precautions necessary in the use of a D.O. probe for BOD tests.

Explain the meaning of BOD.

Describe the procedure for BOD measurement including seed preparation.

What are the requirements of the minimum depletion and the minimum residual D.O. in BOD tests?

Explain the relationship between temperature and percent saturation with regard to dissolved oxygen.

Describe precautions required in the BOD tests.

"Blank tests" in BOD measurement are a requirement. What is the purpose?

What does the term "pH" represent? What is the range of pH? What is the neutral pH?

What are the precautions one should take in the pH measurement?

Discuss the importance of temperature measurement.

How is a thermometer calibrated?

Define reduction in a chemical reaction

Safety and Maintenance

What precautions should be taken against the risk of infection by operators at a wastewater treatment plant?

Discuss safety in operation of the floating cover of an anaerobic digester.

Describe the toxic and harmful chemicals encountered at a wastewater treatment plant.

Describe the dangerous and explosive gases encountered in sewer and at a wastewater treatment plant.

Discuss the hazard of electrical shock while working at a wastewater treatment plant.

Discuss the safety precautions necessary for operation of a biological-mechanical wastewater treatment plant.

Discuss water supplies for a wastewater treatment plant.

Discuss a Material Safety Data Sheet (MSDS).

What precautions should be taken when working with blowers?

Can you clean air filters while a blower is in operation?

Discuss the dangerous gases and their health effects encountered in sewers and wastewater treatment plants.

Describe how one can locate chlorine leaks in a chlorination system.

Describe the collection of wastewater. Discuss the shutdown of surface aerators.

Describe the function of leaking water in a packing gland for a pump.

Compare mechanical seals and packings in a pumping system.

Describe reason for backflow preventer for water supply at a WWTP.

Explain the concern for cross-connection in a pumping system.

Describe the possible causes when a pump will not start.

How would you determine the schedule of lubrication for a pump? What could cause a pump shaft and motor to spin backward?

Compare positive displacement pumps with centrifugal pumps. Where are positive displacement pumps used and what is the most important thing to remember in their operation?

Know the functions and components of centrifugal pumps.

Compare two types of blowers.

Why are fine bubble diffusers easily clogged?

Describe two types of diffusers in the aeration system.

Pretreatment

Describe the objectives of the National Pretreatment Program and its origin.

Define a Significant Industrial User (SIU).

Define categorical pretreatment standards.

Know who general pretreatment regulations apply to.

Define Control Authorities and when they are required to inspect SIUs.

A POTW's requirement to develop and implement a pretreatment program is a condition of what?

Know what a Sewer Use Ordinance is and what it does.

What must a Wastewater Discharge Pretreatment Permit include.

Describe local limits and why they are implemented.

Know the specific prohibitions of 40 CFR 403.5.

Define non-contact water

Know the function of a chain of custody

Know what guidance an Enforcement Response Guide (ERG) provides

Know what significant noncompliance (SNC) is and what qualifies as SNC

Define slug discharge and notification requirements and handling

Define TOMP

Preliminary Treatment

Identify the different types of preliminary treatment and describe the purpose of each.

Define "grit" and "detritus".

Describe methods for the ultimate disposal of sludge.

Describe the purpose of comminutors.

Describe the composition of grit.

Methods of measuring the liquid level

Describe flume-type flow measurement channel.

Describe weir-type flow measurement. What is their application in a wastewater treatment plant?

What are the purposes of flow measurement at a wastewater treatment plant?

Describe the purpose of grit channels and proportional weirs.

Describe aerated grit chambers. What are the side benefits of aerated grit chambers?

What are the benefits of pre-aeration?

If screens or comminutors are overloaded or bypassed, what problems can one expect?

Solids Treatment & Handling

Explain the sludge digestion process.

Purpose of sludge thickening

Describe the anaerobic sludge digestion process and its purpose.

Types of bacteria present in all 3 temperature ranges of anaerobic digestion

Purpose of a pilot flame in an anaerobic digester

Function of a water seal on the gas dome of an anaerobic digester

Uses of digester gas

Discuss the factors affecting gravity thickeners

Describe the operation of gravity thickeners

Describe centrifuge thickener and what factors affect its performance

Purpose of mixing anaerobic digester

Discuss operational strategy of anaerobic system.

Know the two basic types of bacteria present in an anaerobic digester

Understand the role volatile acids play in anaerobic digesters

Describe the aerobic sludge digestion process.

Compare the aerobic and anaerobic digestion processes.

Describe the relationship between aerobic digestion and endogenous respiration.

Describe the operational procedures of aerobic digesters.

Describe construction materials of sludge drying beds.

Discuss troubleshooting of the aerobic digestion process

Describe the operation of a sludge drying bed.

Describe the types of mechanical dewatering methods available.

Describe five methods of final disposal of sludge.

Describe a belt filter press and know troubleshooting of problems

Describe factors affecting sand drying beds

Influences of primary sludge production
Common processes used for sludge stabilization
Characteristics of well stabilized sludge
Define coning
Describe chemical conditioning of sludge
Describe the operation of vacuum filters for sludge dewatering

Fixed Film

Define zoogeal film
Describe function of filter media
Define rotating biological contactor
Know major parts of Rotating Biological Contactor (RBC)
Know why RBCs are covered
Know common problems with RBCs
Describe conditions needed to maintain maximum efficiency when operating a trickling filter
Know common problems and solutions associated with trickling filters
Define ponding and know causes in a trickling filter.
Definition of recirculation and the purpose of it in a trickling filter
What conditions cause foul odors in a trickling filter
Definition of sloughing
Describe how you control the speed of non-mechanical distribution arm on trickling filter
Know solutions to cold weather issues for trickling filters

Advanced Treatment (Book 3)

Discuss Ammonia remove by breakpoint chlorination and ion exchange
Discuss nitrification and know factors that affect it
Discuss denitrification
Know minimum dissolved oxygen recommended for nitrification
Know necessary elements for suspended growth reactors to accomplish nitrification
Know techniques that can be used to adjust return activated sludge

Know optimal time to measure sludge blanket depth in the clarifier

Define Mean Cell Residence Time

Define residual dissolved oxygen

Know conditions necessary for nitrification (pH range, DO range)

Know which microorganisms cause poor settling

Know how temperature affects biological activity

Define facultative bacteria

Discuss examples of modifications for the conventional activate sludge process

Know the three major nutrients required by microorganisms and the ratio needed

Why use a surge or storage tank

What nutrients cause algae to grow in water?

What are the two best means to monitor day-to-day operations for nitrification?

What gas produces rotten egg smell?

Two types of bacteria necessary for the conversion of ammonia to nitrate

Know how to troubleshoot limited nitrification

Describe how coagulant aides are used to assist in settling and what are some examples

Know how to determine coagulant dosing

Discuss the need to remove solids from secondary effluent.

Describe the use of microscreens.

Describe the use of ultraviolet lights for a microscreen.

Discuss the operational strategy of the microscreening process.

Describe a rapid sand filter system and its purpose.

Know all gravity filter systems components

What are indications of disturbed or damaged underdrain in a rapid sand filter system.

Describe the method for filling an empty rapid sand filter system.

Explain the backwashing process of a rapid sand filter.

Discuss surface straining and depth filtration in a rapid sand filtration process.

Discuss the section of filter media in a rapid sand filter system.

Troubleshoot problems with a rapid sand filter system?

Be familiar with the gravity sand filter operational strategies

Know purpose of a surface wash system in a gravity filter system

Describe the term scouring in regard to filter media in a rapid sand filter system.

Discuss head loss in a rapid sand filter system

What causes problems in a pressure filter

What gases cause odor in wastewater treatment and know how to address them?

Discuss ozonation in regard to odor control

Discuss absorption in regard to odor control

Describe how Hydrogen Peroxide controls odor

How does pH affect the release of hydrogen sulfide gas?

Discuss the types of phosphorus removal systems.

Why remove Phosphorus?

Describe the process of luxury uptake.

Describe a phosphorus stripping tank.

Discuss safety in the luxury uptake phosphorus removal system

Discuss phosphorus as a nutrient.

What is classification of polymers based on?

Mathematics

Calculations for the area of a rectangle and circle and the volume of a rectangular tank and a cylinder tank will not be provided, you must know this information.

You must memorize the value of π .

You must know how to calculate an average (mean).

You must know that r = radius and that r = diameter/2.

Given the volume of a sedimentation tank and the flow rate, calculate the detention time of the sedimentation tank.

Given a flow rate in gpm, convert it into MGD.

Given the distance and time of travel of a stick in a grit channel, calculate the velocity of travel.

Given the influent and effluent TSS, calculate the TSS removal efficiency in percent.

Given the concentration of MLSS and the volume of an oxidation ditch, calculate the pounds of solids under aeration.

Given the influent BOD and the required percent removal, calculate the required maximum effluent BOD.

Given the dimensions of an aeration tank (circular), calculate the volume of the tank.

Given the 30 minute settleable solids (%) and MLSS, calculate the sludge volume index.

Given the flow totalizer readings at the beginning and end of a month (30 days), calculate an average flow rate for the month.

Given the effluent BOD in mg/l and an effluent flow rate, calculate the BOD loading to a receiving stream in pounds per day.

Given the influent and effluent TSS of a wastewater plant, calculate the overall TSS removal efficiency.

Given the TSS of a primary effluent, the daily flow and the total solids (pounds) in an aeration tank, calculate the sludge age.

Given the estimated BOD of a sample, calculate the ml of sample to be added to a BOD bottle (300 ml).

Given the sample volume of a BOD test, the initial D.O. and the final D.O., calculate the sample BOD.

Given six BOD values in mg/l, calculate the mean BOD in mg/L.

Given the flow rate and the desired dosage of chlorine, calculate the chlorine feed rate in pounds per hour.

Given test results on the TSS determination using a Gooch crucible (sample volume, crucible weight w/ and w/o residue), calculate the TSS in mg/l.

Given the required chlorine feed rate and the strength of HTH (high test hypochlorite), calculate the pounds/day of HTH required.

Given the volume of water in liters, calculate its weight in grams.

Given a stock solution's normality, calculate the volume in mLs needed for diluted normality.

We at IDEM wish you success and hope to see you out there working to protect Indiana's waters and the infrastructure investments in wastewater facilities. Now, go pass that test!