Effective Study Habits for OpCert Exams

October 7, 2014

Why are we here?

A brief history of lab exam results

How to best prep for an exam?

Why should we care?

Rick Mealy

George Bowman

WI DNR Lab Certification

Troubled Knowledges

The following slides reflect those knowledges in existing exams with historically poor passing performance (< 50-60%)

Intro Activated Sludge

- **1.2.4 Describe the types of protozoa and organisms commonly found in activated sludge and observable under a microscope.**

Pass rate: 48.3%

INTRO to Disinfection

- **1.3.1 Explain the relationship between chlorine dosage, chlorine demand and chlorine residual. Pass rate: 34.4%**
- **3.2.1 Describe the laboratory test method most commonly used to measure fecal coliforms in wastewater treatment plants. Pass rate: 58.6%**
- **5.1.6 Given fecal coliform test results, calculate the fecal coliform geometric mean. Pass rate: 36.3%**

WISCONSIN DEPT. OF NATURAL RESOURCES

INTRO to Tertiary Filtration

- **1.2.6 Discuss the common auxiliary cleaning aids that may be used during backwashing to aid in cleaning the media. Pass rate: 53.6%**
- **2.1.9 Discuss backwash rates for filter medias. Pass rate: 27.3%**
- **3.1.5 Explain how to use the results from BOD and suspended solids test to determine filter effectiveness. Pass rate: 53.4%**

Advanced Tertiary Filtration

WISCONSIN DEPT. OF NATURAL RESOURCES

- 1.2.2 Discuss types of media, effective media size, specific gravity, and where solids should be caught in the following types of filters. **Pass rate: 32.3% & 52.2%**

WISCONSIN DEPT. OF NATURAL RESOURCES

INTRO to Ponds, Lagoons, and Natural Systems

- 1.2.6 Discuss the relationship between bacteria and algae in a pond system. Pass rate: 50% & 46.2%
- 2.2.10 Describe how to check for efficient aeration of a lagoon. Pass rate: 46.2%
- 2.3.3 Describe the meaning of blower air pressure gauge readings. Pass rate: 50%
- 3.3.7 Discuss the effects of pumping sewage to a distant pond or lagoon site. Pass rate: 50%

Advanced Stabilization Ponds and Aerated Lagoons

- **1.2.1 Identify the valve action necessary to bypass a Pond cell. Pass rate: 22.4%**
- **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.**
- **Pass rate: 59.7%**
- **3.2.5 List some possible consequences of exceeding the design organic loading rate of a Pond system. Pass rate: 56.7%**

INTRO Phosphorus Removal

- **3.2.10 Discuss in-line monitoring of the biological phosphorus process using oxidation reduction potential (ORP) and dissolved oxygen (DO) meters. Pass rate: 47.8%**
- **6.4.1 Describe the effect of wastewater characteristics on phosphorus removal. Pass rate: 49.7%**
- **8.2.3 Describe the difference between total phosphorus and reactive phosphorus (orthophosphate). Pass rate: 58.5%**

Advanced Phosphorus Removal

- **3.1.1 Describe the significance of phosphorus content in the sludge as related to biological phosphorus efficiency and effluent phosphorus. Pass rate: 53.3%**
- **3.1.2 Discuss how much phosphorus is released in the anaerobic selector of an optimized municipal EBPR plant. Pass rate: 54.3%**
- **3.3.1 Discuss corrective actions that can be taken when problems removing phosphorus biologically occur. Pass rate: 59.5%**
- **5.2.5 Discuss the effects of influent wastewater with high sulfides on phosphorus removal using iron salts. Pass rate: 40%**
- **7.2.1 Discuss the effect the addition of acidic metal salts can have on wastewater alkalinity and pH. Pass rates: 57.6%, 53.8% and 42.9%**

Intro General Wastewater

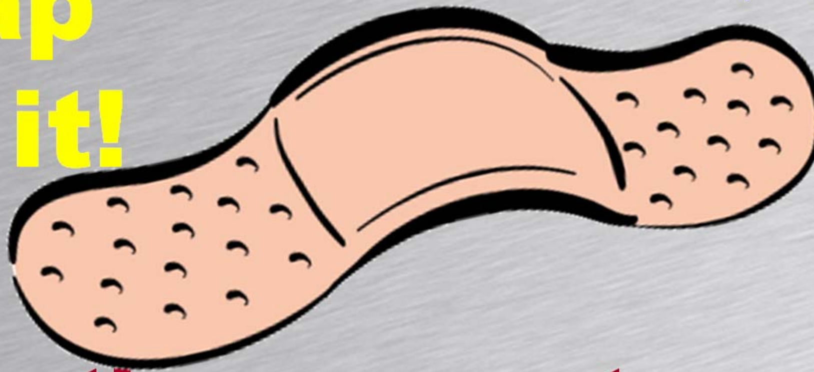
- **2.5.2 Discuss the difference between a time proportional and flow proportional composite sample. Pass rate: 51.4%**
- **3.3.2 Discuss Suspended Growth Systems (Activated Sludge). Pass rate: 52.2%**

ADV General Wastewater

- 1.3.5 Definitions: Anoxic Pass Rate: 55.2%
- 2.3.6 Describe the types of materials prohibited from discharge into sewer systems, and the reasons they should not be discharged. Pass Rate: 59%
- 3.1.3 Discuss how a vortex-type (Pista®) grit chamber works. Pass Rate: 54.3%
- 3.2.1 Describe common equipment used in primary treatment. Pass Rates: 40.1%, 38.8%
- 3.3.1 Describe common equipment used in suspended growth secondary (biological) treatment. Pass Rate 47.3%
- 7.5.1 Given data, calculate detention time for multiple clarifiers operating in parallel. Pass Rate: 59.9%

WISCONSIN DEPT. OF NATURAL RESOURCES

Don't just slap a bandaid on it!



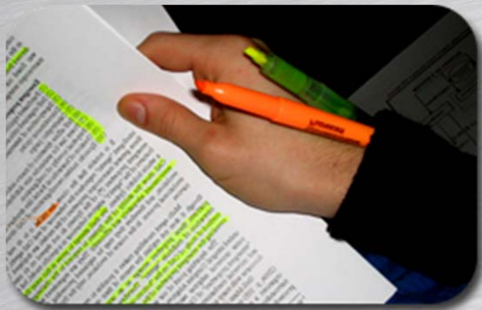
- **DO NOT go study only the concepts just presented!**
- Remember: Exams are generated randomly from a bank of questions.
  - There are up to 120 questions in each exam bank. Less than 2/3 have appeared so far.
- There are questions that have yet to appear tied to OTHER knowledges that operators lack.
- READ the Study Guide.
- …and did we mention...**READ the Study Guide!**

WISCONSIN
DEPT. OF NATURAL RESOURCES

How to effectively study/prepare for an exam:

Reading for Comprehension

Reading for Comprehension



- Highlight important ideas.
- Circle or bracket **key terms**.
- Identify the **main point(s)** of the info.
- Can you eliminate "extraneous" information?
- Look for "telling" words: "always, must, require"
- What question(s) would YOU create?

Reading for Comprehension isolating critical info

5.1.04 Define super-saturation.

- Supersaturation means that the water contains more DO than it SHOULD contain according to physical tables.
- According to tables, the saturation point of oxygen in water at 20° and 760 mm pressure -which is standard temperature and pressure at sea level- is 9.06 mg/L. So, yes, at sea level and 20°C, anything over 9.06 mg/L represents supersaturation.
- The method kind of "defines" super-saturation as anything above 9.0 mg/L. However, in reality saturation will vary with temperature and pressure. Consult a DO saturation table.

Multiple Choice Test Taking Tips

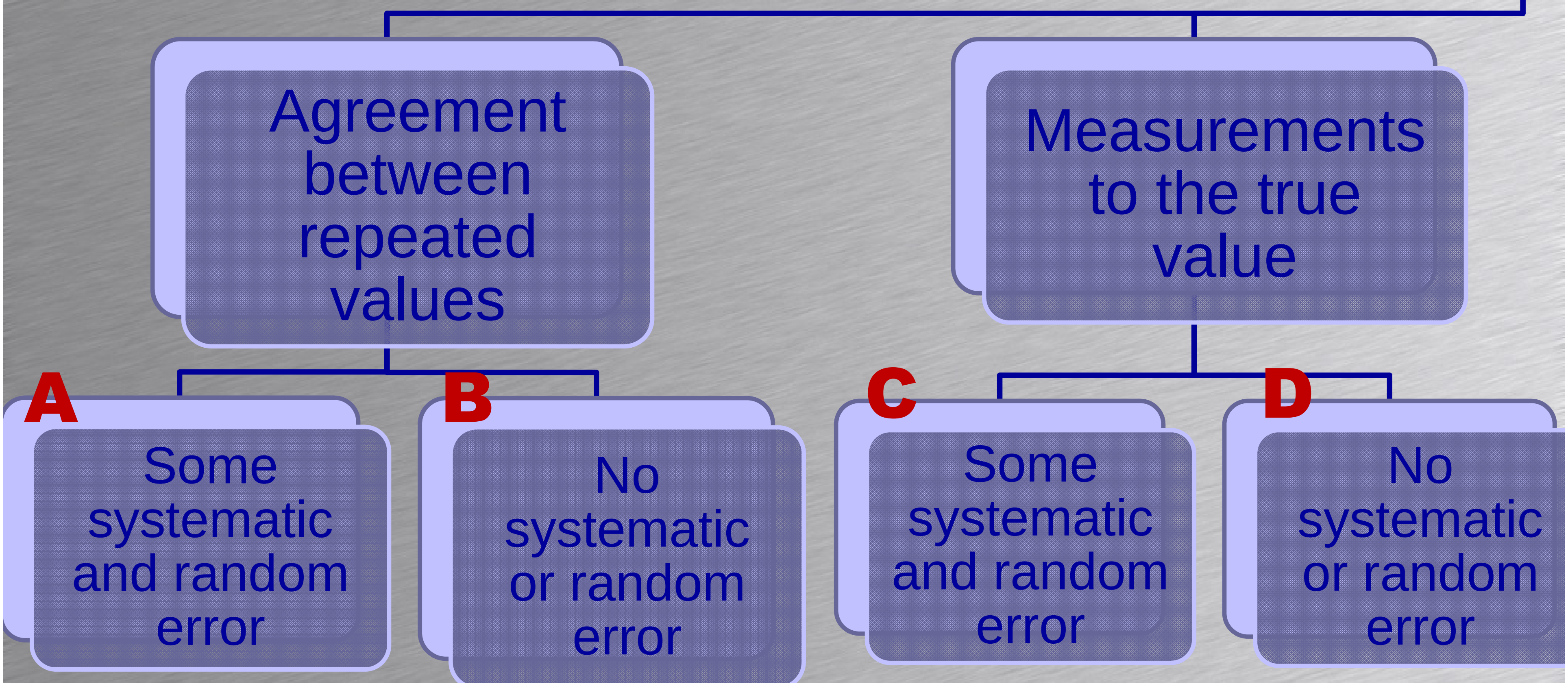
- Read the question before you look at the answer.
- Come up with the answer in your head before looking at the possible answers, this way the choices given on the test won't throw you off or trick you.
- Eliminate answers you know aren't right or are just way out of line.
- Read all the choices before choosing your answer.
- Don't keep on changing your answer, usually your first choice is the right one, unless you misread the question.

Many multiple choice answers have a dichotomy, or branching, to them. It's almost like a fork in the road and at the end of each fork are two doors.


1
2
1
2
RIGHT Way
WRONG Rd

Good precision can be defined as closeness of....

- A. Agreement between repeated measurements; some systematic/ random error
- B. Agreement between repeated measurements; no systematic/ random error
- C. Measurement to the true value; some systematic/ random error
- D. Measurement to the true value; no systematic/ random error



ABC Practice Exams

Filamentous bulking of activated sludge may be controlled temporarily by

- ○ A. Adding sodium chloride to the aeration tank
- ○ B. Spraying water on the aeration tank surface
- ○ C. Carefully chlorinating the return sludge or mixed liquor
- ○ D. Aerating the final settling tank

In the activated sludge process, some of the activated sludge must be wasted to

- ○ A. Prevent excessive solids buildup
- ○ B. Prevent clogging of the sludge return line
- ○ C. Prevent overloading of sludge return pumps
- ○ D. Increase digester gas production

ABC Practice Exams

In a healthy activated sludge process which of the following organisms will most likely be found in the greatest numbers?

- A. Stalked Ciliates
- B. Amoebas
- C. Free Swimming Ciliates
- D. Nymphs

Since reaction rates are lower during the winter, the operator of an activated sludge plant will usually

- A. Increase dissolved oxygen levels
- B. Decrease MCRT
- C. Decrease wasting
- D. Increase MCRT

Which of the following tests would give the fastest indication of toxicity in an activated sludge process?

- A. Oxygen Uptake Rate (OUR)
- B. Settleometer
- C. MLSS
- D. Microscopic Observation

Creating Flashcards

- Summarize the CRITICAL information from the study guide and copy to index cards.
- Use THESE to study

Writing your own questions

- If you were quizzing someone on the topic, what questions would you ask?
- Writing the question and correct answer is the easy part.
- Coming up with 3 “wrong” answers without using all/none of the above and not being too tricky is a challenge!

WISCONSIN DEPT. OF NATURAL RESOURCES

What questions would YOU write for this?

Explain the relationship between chlorine dosage, chlorine demand and chlorine residual.

Dosage: The amount of chlorine fed to achieve disinfection. This is normally reported as a concentration in milligrams per liter (mg/L) or pounds per day (lbs/day).

Demand: The amount of chlorine used to disinfect wastewater after a given contact time.

Residual: The amount of chlorine remaining after a given contact time.

A general expression of this relationship is:

Chlorine **Residual = ** Chlorine **Dosage -** Chlorine **Demand**

How about these….

The amount of chlorine fed to achieve disinfection is: **Dosage**

The amount of chlorine used to disinfect wastewater is: **Demand**

The amount of chlorine remaining (after a given contact time) is: **Residual**

Study Guide Review

Identify “buzz” words:

shall, must, require, only always, every, **however**

Take note of any numbers/values (criteria)

Ignore extraneous words

Find the point(s) being made.

Definitions are often “need to know”: “is”, “are”

Cause & effect: “causes”, “results in”, “leads to”

Try to separate informative but non-critical info

Create flashcards

Write your own questions

It's time to take a look at the Study Guides

INTRO General Wastewater

2.5.2 Discuss the difference between a time proportional and flow proportional composite sample. Pass rate: 51.4%

A time proportional composite sample is a collection of samples over time, usually after so many minutes. A flow proportional composite sample are samples collected per unit of flow, after so many gallons. Flow-proportional samples are collected directly proportional to the flow, with more samples taken when flows are higher and less samples when flows are lower. Automatic flow proportional composite samplers are required for almost all wastewater treatment plants, as it is the most representative way of collecting samples from continuous flowing treatment systems, especially for BOD and TSS.

Intro General Wastewater

3.3.2 Discuss Suspended Growth Systems (Activated Sludge). Pass rate: 52.2%

Activated sludge is a suspension of sewage and microorganisms in an aeration basin. The mixture of wastewater and microorganisms is referred to as mixed liquor suspended solids (MLSS). Aeration equipment provides dissolved oxygen to promote the growth of microorganisms that substantially remove organic material. Some common types of suspended growth processes are

- conventional and extended aeration activated sludge plants,
- oxidation ditches, and
- sequencing batch reactors (SBRs).

The reader is referred to the Activated Sludge Operator Study Guide for more detailed information about suspended growth processes.

ADV General Wastewater

3.3.1 Describe common equipment used in suspended growth secondary (biological) treatment. Pass Rate 47.3%

The purpose of secondary biological treatment is to remove dissolved and suspended organic material from wastewater to produce an environmentally-safe treated effluent and biosolids/sludge. A secondary treatment system can achieve overall BOD and suspended solids removal in the 85-95% range.

Common equipment used in suspended growth secondary biological treatment are aeration tanks, blowers, diffusers, final clarifiers, and sludge pumps.

A. Aeration Tanks

Aeration tanks are usually square, rectangular, or circular. They contain aeration equipment for providing oxygen to the microorganisms that live and grow in the tanks. Aeration equipment also provides mixing in the tank. The mixed suspension of sewage, solids, and microorganisms in the aeration tank is commonly referred to as activated sludge. The activated sludge is measured as mixed liquor suspended solids in milligrams per liter (mg/L).

ADV General Wastewater

3.3.1 Describe common equipment used in suspended growth secondary (biological) treatment. Pass Rate 47.3%

B. Blowers

Mechanical blowers provide the air to the aeration tanks.

C. Diffusers

Diffusers disperse the air into the aeration tank, providing oxygen and mixing in the tank.

D. Final Clarifiers

Final clarifiers follow the aeration basins and **settle the mixed liquor suspended solids**. Clear effluent is discharged over and through weirs in the clarifier.

E. Sludge Pumps

The settled solids in the clarifier can be returned back to the aeration tank or wasted from the treatment system by a pump(s). The pump(s) are known as the return activated sludge (RAS) or waste activated sludge (WAS) pump(s).

ADV General Wastewater

1.3.5 Definitions: Anoxic Pass Rate 55.2%

A condition in which oxygen is only available in a combined form such as…

nitrate (NO_3^-),

nitrite (NO_2^-), or

sulfate (SO_4^{-2})

…in an aqueous environment.

ADV General Wastewater

2.3.6 Describe the types of materials prohibited from discharge into sewer systems, and the reasons they should not be discharged. **Rate 59%**

- **The materials with the characteristics listed below are generally prohibited from discharge to the sewer system**. These prohibitions are included in **local sewer use ordinances**.
- Generally, materials that can interfere with wastewater treatment; or pass through the treatment system and cause a water quality violation; or accumulate in sludges making the sludges toxic or hazardous, are prohibited. Many of the industrial materials can be handled with proper pretreatment or segregation of waste streams that cannot be pretreated.
- A. **Volatile organics**, such as gasoline or solvents that can cause an explosive atmosphere in the sewer system or at the treatment plant.
- B. **Heavy metals**, such as chromium, zinc, copper, nickel, and cadmium are very toxic and can cause a treatment plant upset, pass through the plant or accumulate in the sludge.

2.3.6 Describe the types of materials prohibited from discharge into sewer systems, and the reasons they should not be discharged. **Rate 59%**

- C. **Acidic and alkaline wastes** that can damage the sewer system or upset the treatment plant. Generally, pH's lower than 5.0 or greater than 10.0 should be neutralized prior to discharge to the sewer system.
- D. **Fats, Oils, and Grease (FOG)** must be controlled at industrial and commercial sources with oil separators and grease traps to prevent maintenance problems in wet wells and at the treatment plant.
- E. **High strength loadings of BOD or suspended** soils that could organically overload the treatment plant. This would especially be a problem with "batch" dumping that would cause large slug loads. **Any "batch" type operation should be handled by flow equalization to prevent plant upsets**.
- F. **High temperature wastewaters** that could affect biological activity..

ADV General Wastewater

2.3.6 Describe the types of materials prohibited from discharge into sewer systems, and the reasons they should not be discharged. **Rate 59%**

- G. Any **solid or viscous materials** that could cause sewer blockages.
- H. Any **debris such as rags or other materials** that could cause sewer blockages or pump clogging.
- I. **Any other toxic materials** that impair or interfere with the treatment process.

ADV General Wastewater

3.2.1 Describe common equipment used in primary treatment. **Pass Rate 39, 40%%**

- The purpose of primary treatment is to settle wastewater solids and capture floatable substances (such as oil & grease). Well designed and operated primary facilities can expect removal efficiencies of 60-75% for TSS and 20-35% for BOD.
- **Common primary treatment units are**
  - rectangular clarifiers,
  - circular clarifiers, and
  - dissolved air flotation.

Figure 3.2.1.1

RETANGULAR CLARIFIER

The flow enters one end of the tank, where a baffle directs it downward. The flow exits the other end of the tank over the effluent weir. Two chains run along the edges for the length of the tank. Flights (wooden or fiberglass boards) are attached between the chains, half submerged. A motor slowly moves the chains, and the flights push the scum to the end of the tank, where it is skimmed off. The chains then travel to the bottom of the tank where the flights push settled sludge to the other end of the tank, where the sludge is removed. The (relatively) clear liquid overflows to secondary treatment.

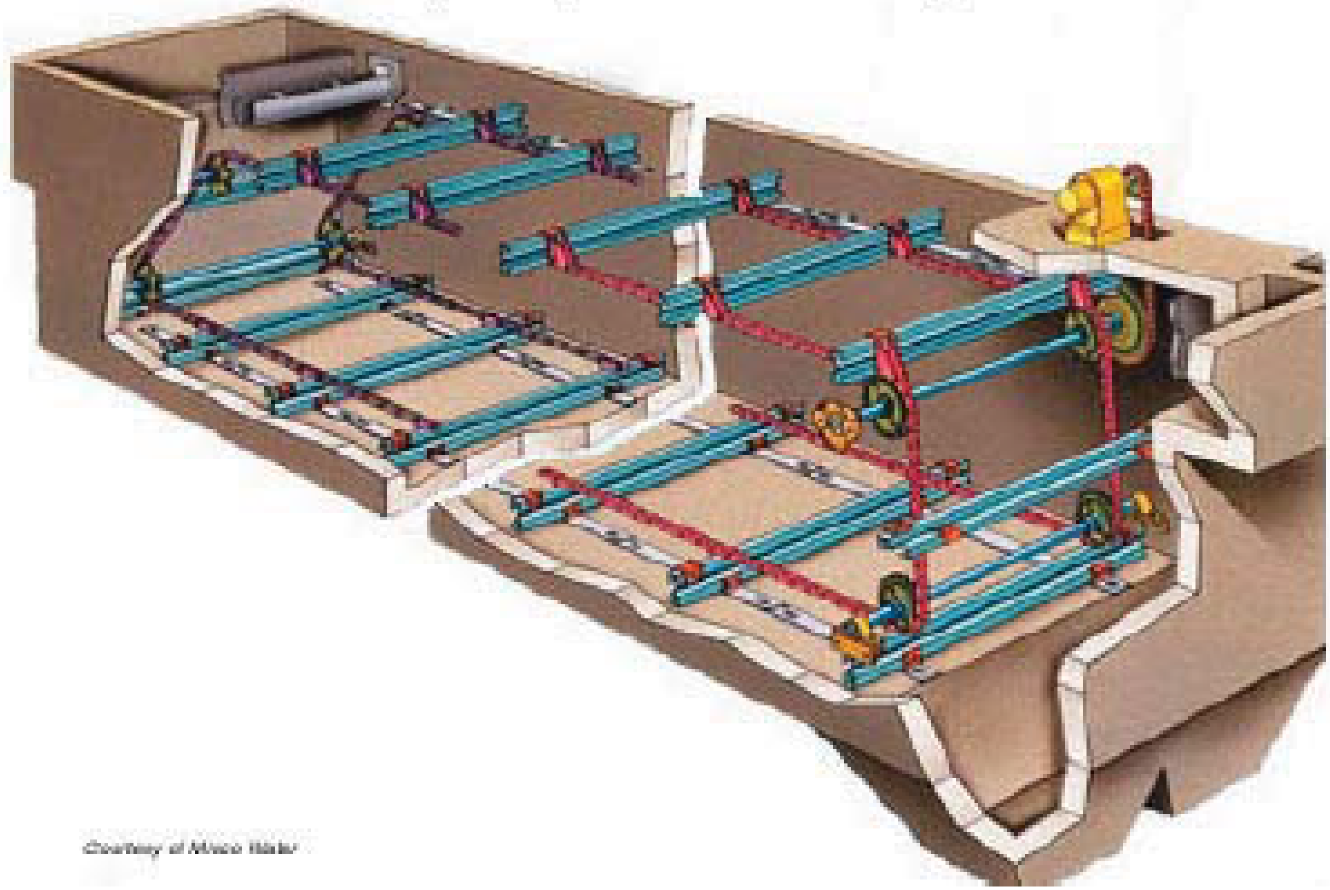


Figure 3.2.1.2

CIRCULAR CLARIFIER

The flow enters the center of the tank and is directed downward by a cylindrical baffle. The wastewater moves outward from the baffle to the overflow weir around the tank perimeter. A central drive unit moves the skimmer arm around the surface to a scum hopper, where scum is removed. The drive unit also moves a scraper arm around the bottom of the tank, pushing settled sludge to a sludge hopper, where sludge is removed. The (relatively) clear liquid overflows to secondary treatment.

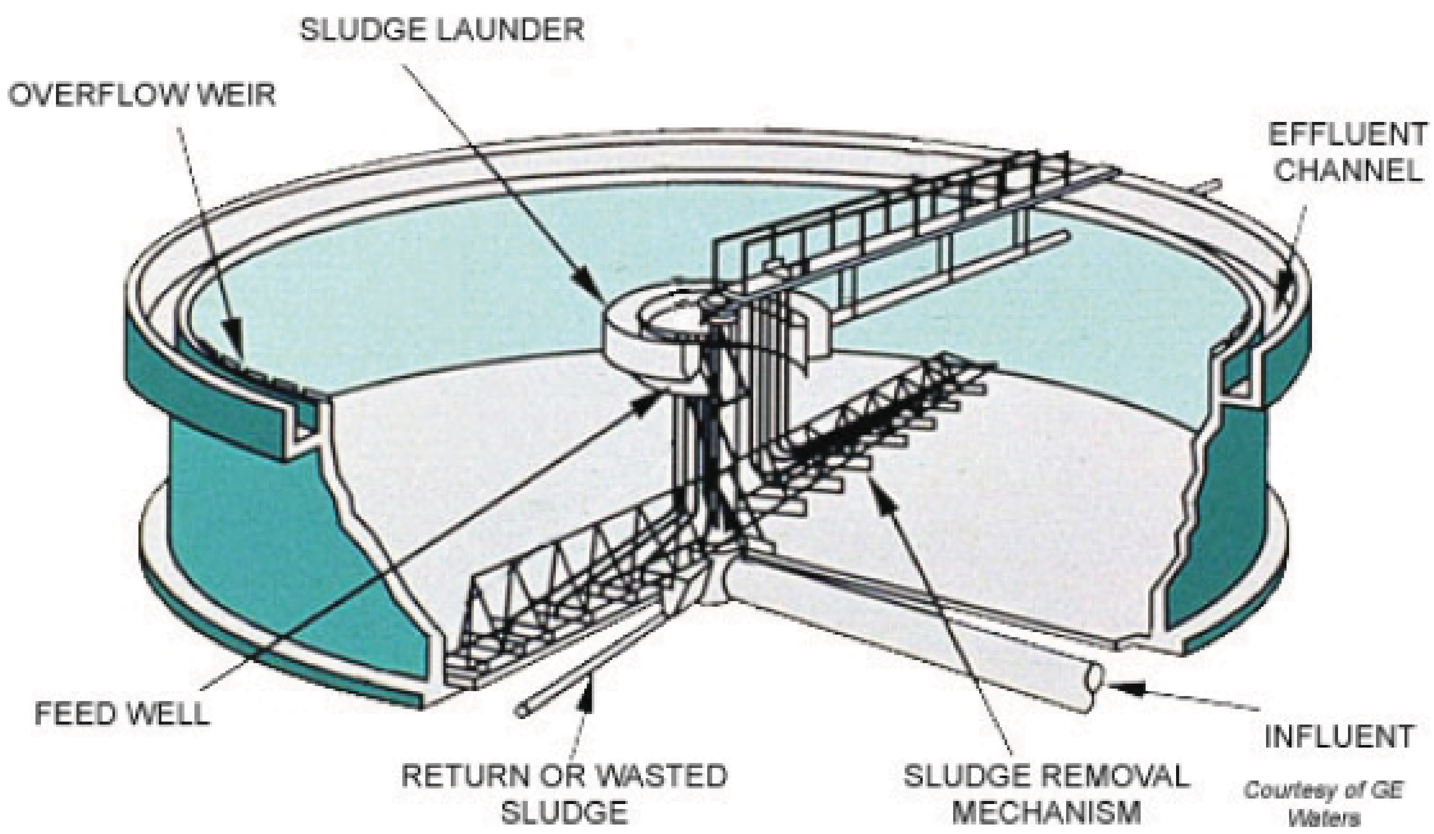
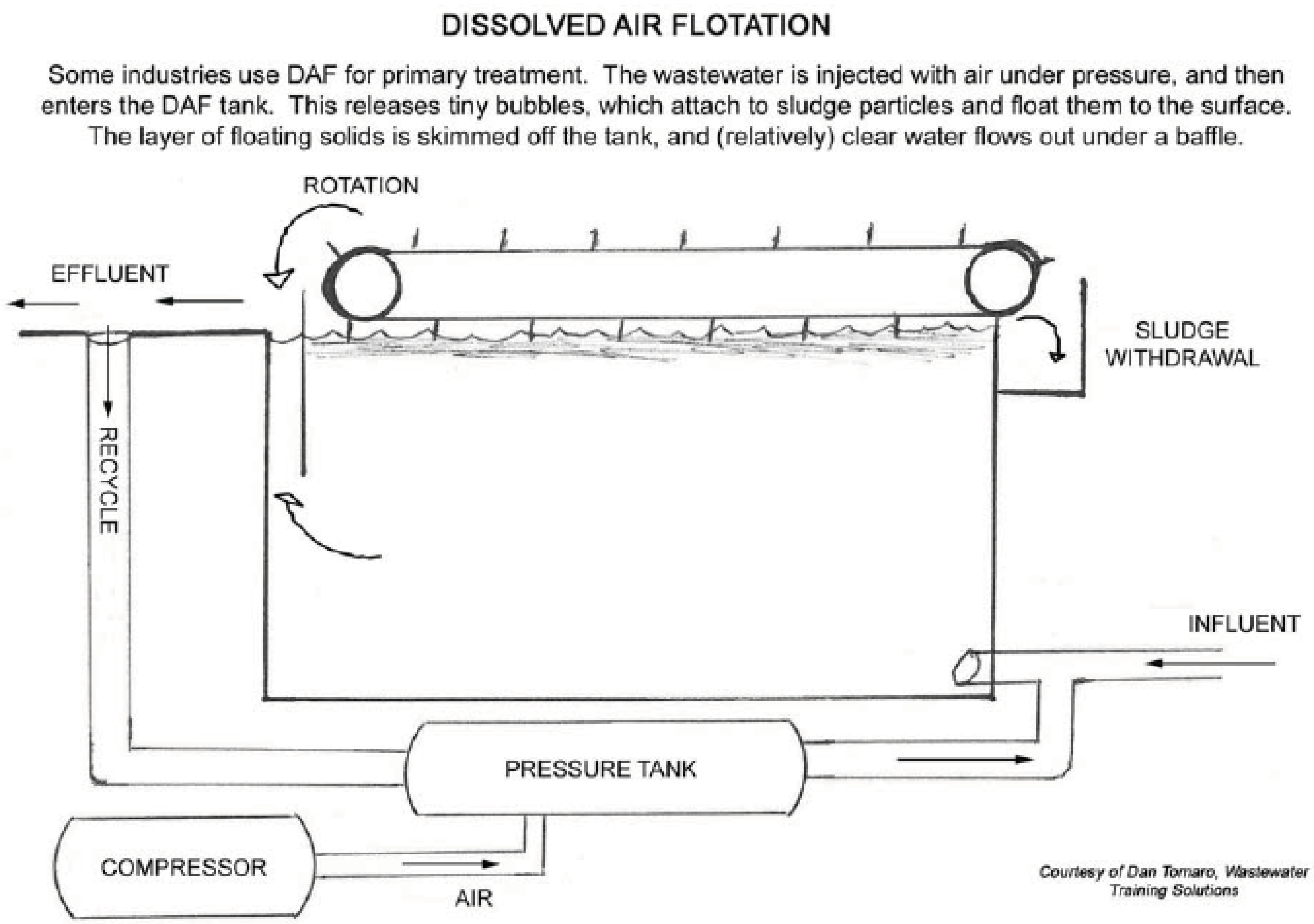


Figure 3.2.1.3


DISSOLVED AIR FLOTATION
Some industries use DAF for primary treatment. The wastewater is injected with air under pressure, and then enters the DAF tank. This releases tiny bubbles, which attach to sludge particles and float them to the surface. The layer of floating solids is skimmed off the tank, and (relatively) clear water flows out under a baffle.
ROTATION
EFFLUENT
SLUDGE WITHDRAWAL
RECYCLE
INFLUENT
PRESSURE TANK
COMPRESSOR
AIR
Courtesy of Dan Tomaro, Wastewater Training Solutions

7.5.1 Given data, calculate detention time for multiple clarifiers operating in parallel. Pass Rate: 59.9%

GIVEN:

Primary clarifiers = 2

Clarifier diameter = 80 feet

Clarifier depth = 12 feet

GIVEN:

Average daily flow = 7.2 MGD

1 cubic foot = 7.48 gallons

Note: both clarifiers receive equal flows

FORMULA & SOLUTIONS:

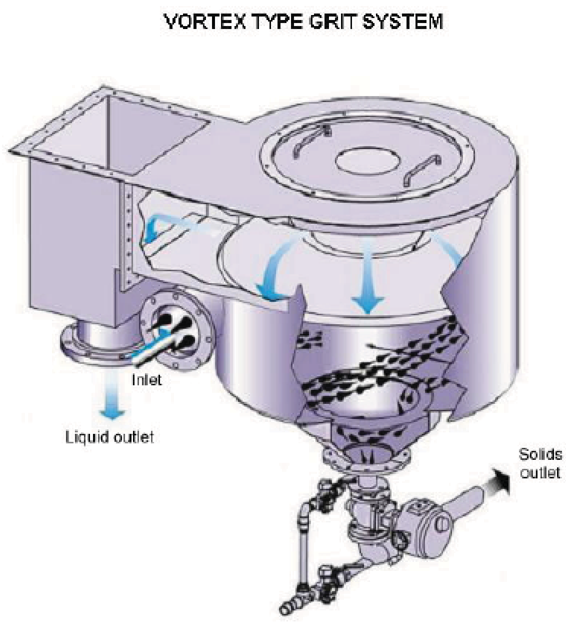
- Volume (gal) = # of clarifiers × (3.14 × [radius squared (ft)] × height (ft) × 7.48 gal/cu.ft)
- Detention time = tank volume (gal) ÷ flow rate (gal/hour)
- Volume (gal) = 2 clarifiers × (3.14 × [40 ft × 40 ft] × 12 ft) × 7.48 gal/cu.ft = 901,908 gallons
- Detention time = 901,908 gallons ÷ [7,200,000 gpd ÷ 24 hours/day]
- = 901,908 gallons ÷ 300,000 gal/hour
- = 3 hours

Note: *this can also be calculated by using the volume of 1 clarifier and dividing the flow by 2.*

3.1.3 Discuss how a vortex-type (Pista®) grit chamber works.

Pass Rate 54.3%

- Raw wastewater is introduced along the side of a cylindrical tank designed for vortex flow.
- The water and grit combination rotates slowly around the vertical access of the tank. The flow spirals gradually down the tank perimeter, allowing the heavier solids to settle to the tank bottom where they are then removed.



INTRO Phosphorus Removal

3.2.10 Discuss in-line monitoring of the biological phosphorus process using oxidation reduction potential (ORP) and dissolved oxygen (DO) meters.. **Pass rate: 47.8%**

While dissolved oxygen is often used to monitor anaerobic, anoxic, and aerobic processes, it is limited in its accuracy in measuring very low levels to zero oxygen in solution, thus true and actual anaerobic or anoxic conditions cannot be measured with a dissolved oxygen meter.

In wastewater, the oxidation-reduction potential is the tendency of the solution to either gain or lose electrons. Oxidizing agents take on electrons while reducing agents give up electrons. Raw wastewater typically contains more reducing agents than oxidizing agents and in the biological treatment of wastewater bacteria, in the presence of oxygen, oxidizes these reducing agents.

INTRO Phosphorus Removal

3.2.10 Discuss in-line monitoring of the biological phosphorus process using oxidation reduction potential (ORP) and dissolved oxygen (DO) meters.. **Pass rate: 47.8%**

ORP measures the movement of electrons in wastewater solution. It is a measurement of the ratio of oxidizing and reducing agents in solution. ORP is measured in millivolts (mV). It is an excellent and preferred method for measuring **anaerobic** (a highly reducing environment), **anoxic** (a reducing environment), and **aerobic** (an oxidizing environment) , all necessary and very important conditions needed in the successful biological removal of phosphorus from wastewater.

The range of ORP readings for such environments can be found in Figure 3.2.10.1 below.
Graphic courtesy of Gronsky, et al., 1992.

INTRO Phosphorus Removal

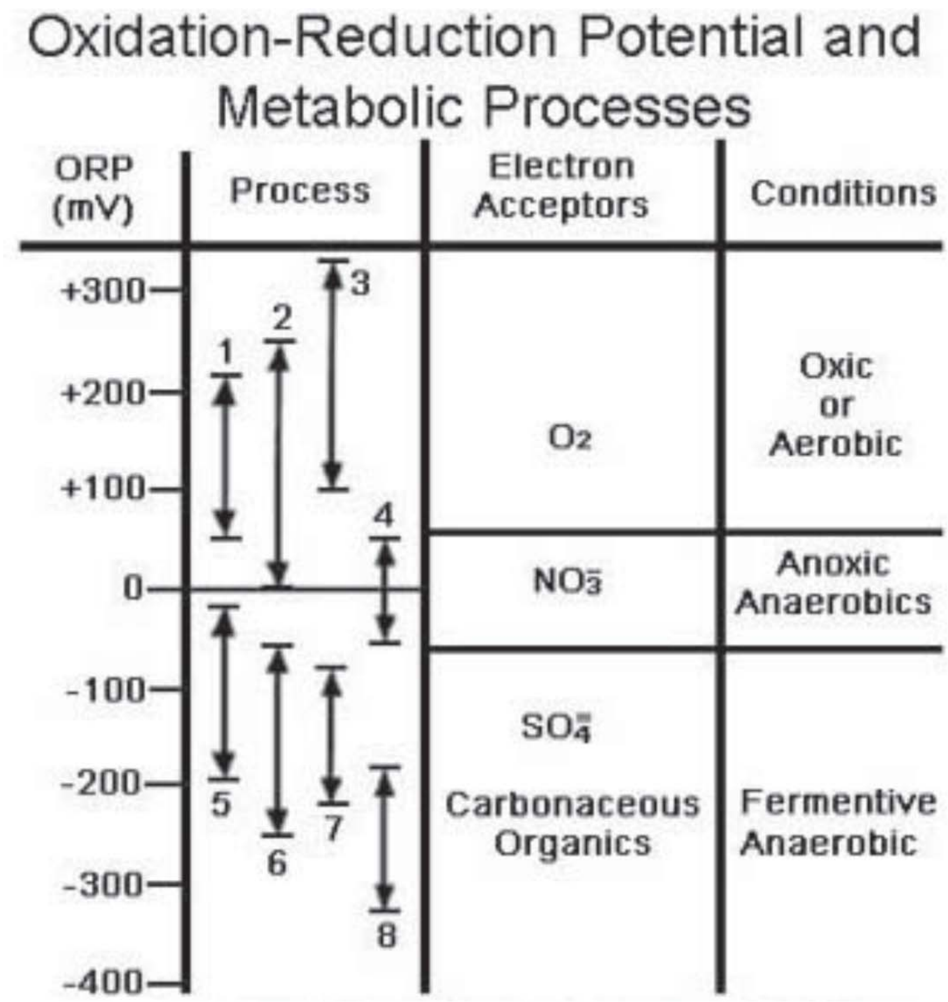
3.2.10 Discuss in-line monitoring of the biological phosphorus process using oxidation reduction potential (ORP) and dissolved oxygen (DO) meters.. **Pass rate: 47.8%**

Key to Figure: Figure 3.2.10.1	
1. Organic Carbon Oxidation	5. Polyphosphate Breakdown
2. Polyphosphate Development	6. Sulfide Formation
3. Nitrification	7. Acid Formation
4. Denitrification	8. Methane Formation

INTRO Phosphorus Removal

3.2.10 Discuss in-line monitoring of the biological phosphorus process using oxidation reduction potential (ORP) and dissolved oxygen (DO) meters.. **Pass rate: 47.8%**

Figure 3.2.10.1



INTRO Phosphorus Removal

6.4.1 Describe the effect of wastewater characteristics on phosphorus removal. **Pass rate: 49.7%**

Actual chemical usage depends on the competing reactions and wastewater characteristics such as pH, alkalinity and very fine particulate materials (colloids). Wastewater characteristics and competing chemical reactions in the wastewater between the metal salt and phosphorus will result in the need for increased metal salt addition above what was calculated. Biological removal of phosphorus in upstream processes could result in a decreased amount of metal salt addition than calculated. Sampling phosphorus concentrations just upstream of the chemical dose point will help in fine-tuning chemical feed rates.

INTRO Phosphorus Removal

8.2.3 Describe the difference between total phosphorus and reactive phosphorus (orthophosphate). **Pass rate: 58.5%**

Total phosphorus is the analytical result following a rigorous acid digestion of a wastewater sample. This typically includes phosphorus associated with suspended solids and organically bound forms, as well as more soluble and reactive forms.

Phosphorus occurs mostly as phosphates in wastewater. Phosphates that respond to colorimetric tests without digestion of the sample are termed "reactive phosphorus", which is largely measured as orthophosphate (H2PO4, HPO4, PO4).
Orthophosphate can be thought of as the form of phosphorus that is dissolved, reactive, and most readily available to microrganisms and aquatic life.

ADV Phosphorus Removal

5.2.5 Discuss the effects of influent wastewater with high sulfides on phosphorus removal using iron salts.

Pass rate: 40%

Sulfide will react with iron forming a black precipitate. High sulfide wastewater will require higher dosages of iron salts.

Sources of sulfides include

- hauled and certain industrial wastes, and
- collection systems with long detention times.

ADV Phosphorus Removal

7.2.1 Discuss the effect the addition of acidic metal salts can have on wastewater alkalinity and pH.

Pass rate: : 57.6%, 53.8% and 42.9%

Both alum and iron metals salts are acidic and will reduce alkalinity and pH.

In low alkalinity wastewaters the addition of metal salts could impair biological treatment, particularly nitrification, by consuming alkalinity.

Care should be taken not to overdose metal salts. Adding metal salts before the final clarifiers rather than ahead of the biological reactor may mitigate the impact on the biological treatment.

ADV Phosphorus Removal

3.1.1 Describe the significance of phosphorus content in the sludge as related to biological phosphorus efficiency and effluent phosphorus. Pass rate: 53.3%, 85.2%

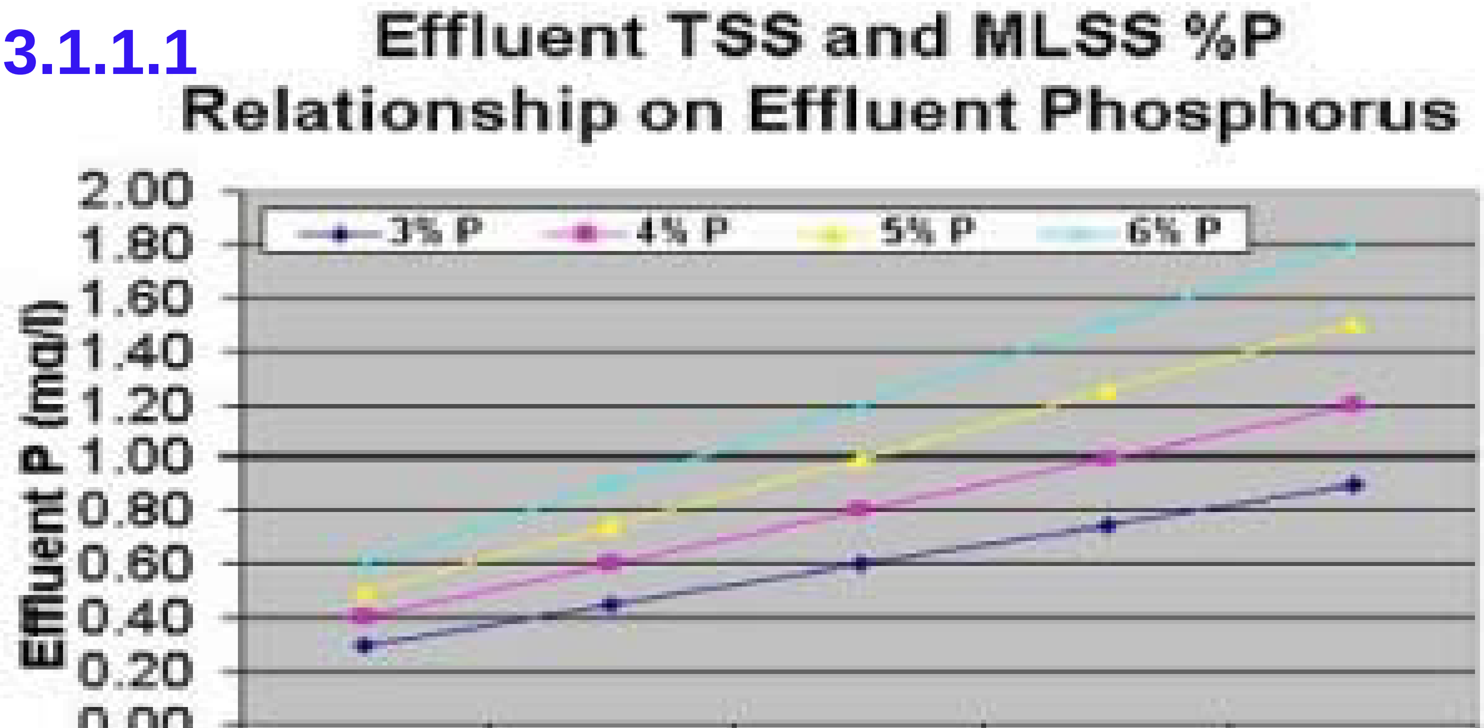
Sludge phosphorus content is defined as the percentage of phosphorus in cell mass and is expressed as P/VSS (%). In a conventional activated sludge treatment process, the sludge phosphorus content is approximately 1.5 - 2.5%. In an enhanced biological phosphorus removal (EBPR) system, the sludge phosphorus content is 3.0 - 6.0 % or higher. The more efficient the biological phosphorus removal system is, the higher the sludge phosphorus content will be. Phosphorus is removed from the treatment system by wasting sludge! Because the activated sludge phosphorus content is high in an EBPR plant, effluent total suspended solids (TSS) should be kept low. A small amount of TSS with high phosphorus content could contribute to a high total phosphorus (TP) concentration in the effluent.

Phosphorus is in the TSS, so keep effluent TSS low!

ADV Phosphorus Removal

3.1.1 Describe the significance of phosphorus content in the sludge as related to biological phosphorus efficiency and effluent phosphorus. Pass rate: 53.3%

Figure 3.1.1.1



	10 mg/l	15 mg/l	20 mg/l	25 mg/l	30 mg/l
3% P	0.30	0.45	0.60	0.75	0.90
4% P	0.40	0.60	0.80	1.00	1.20
5% P	0.50	0.75	1.00	1.25	1.50
6% P	0.60	0.90	1.20	1.50	1.80

ADV Phosphorus Removal

3.1.2 Discuss how much phosphorus is released in the anaerobic selector of an optimized municipal EBPR plant.

Pass rate: 54.3%

The amount of phosphorus released in the anearobic selector varies from plant to plant. Generally phosphorus released is 4 times the total phosphorus in the influent. EBPR plants have been successful at a release of 2.5 times the influent concentration (Bernard, J.L and M.T Steichen, WEF, 2007). Monitoring the influent phosphorus and the phosphorus level in the effluent of the anaerobic selector is a good process control practice for assessing the phophorus release in this reactor.

ADV Phosphorus Removal

3.3.1 Discuss corrective actions that can be taken when problems removing phosphorus biologically occur.

Pass rate: 59.5%

OBSERVATION: BOD/TP RATIO HAS CHANGED

Possible **Cause**: High P in side stream recycles from sludge handling

Monitor or Check: BOD, soluble BOD, TP and orthophosphate in influent to anaerobic zone

Possible **Solution**: Control volume of side stream P recycles or provide side stream P removal.

Possible **Cause** : Increased in P in raw influent from industrial or commercial discharges

Monitor or Check: : High TP in raw influent.

Possible **Solution** : Control industrial or commercial P discharge to sanitary sewer system.

ADV Phosphorus Removal

3.3.1 Discuss corrective actions that can be taken when problems removing phosphorus biologically occur.

Pass rate: 59.5%

OBSERVATION: P release is poor or not occuring in anaerobic zone

Possible **Cause** : Insufficiant VFAs.

Monitor or Check: VFAs/soluble BOD entering anaerobic zone and orthophosphate at end of anaerobic zone.

Possible **Solution:**

a) Supplement VFA by chemical addition

b) Increase HRT of anaerobic zone if possible to ferment BOD.

ADV Phosphorus Removal

3.3.1 Discuss corrective actions that can be taken when problems removing phosphorus biologically occur.

Pass rate: 59.5%

OBSERVATION: ANAEROBIC ZONE NOT TRULY ANAEROBIC

Possible **Cause** : Excess DO from recycle flows.
Monitor or Check: ORP above -100 mv in anaerobic zone - DO in recycle
Possible **Solution:**
a) Reduce DO in aeration basin
b) Reduce RAS or internal mixed liquor recycle to anaerobic zone.

Possible **Cause** : Excess NO3 from recycle flows
Monitor or Check: ORP above -100 mv in anaerobic zone - Nitrate in recycles.
Possible **Solution:**
a) Reduced RAS or internal mixed liquor recycle to anaerobic zone
b) Increase anoxic zone HRT if possible to promote denitrification

ADV Phosphorus Removal

3.3.1 Discuss corrective actions that can be taken when problems removing phosphorus biologically occur.

Pass rate: 59.5%

OBSERVATION: ANAEROBIC ZONE NOT TRULY ANAEROBIC

Possible **Cause**: Air entrainment from excessive turbulence in anaerobic zone or upstream processes, such as aerated grit tanks.

Monitor or Check: : ORP above -100 mv in anaerobic zone but no nitrates or DO in recycles

Possible **Solution:** : Reduce turbulence if possible.

OBSERVATION: INSUFFICIENT VFA IN ANAEROBIC ZONE

Possible **Cause**: Changes in influent waste strength

Monitor or Check: BOD, soluble BOD, TP and orthophosphate in influent to anaerobic zone

Possible **Solution:** : a) Supplement VFA with chemical addition b) Add fermented primary sludge

ADV Phosphorus Removal

3.3.1 Discuss corrective actions that can be taken when problems removing phosphorus biologically occur. 59.5%

OBSERVATION: RAPID P UPTAKE IN AERATION BASIN BUT EFFLUENT P IS HIGHER

Possible **Cause** : Secondary release occurring in aeration basin.

Monitor or Check: TP profile of aeration basin.

Possible **Solution:** : Reduce SRT by wasting more sludge.

Possible **Cause** : Secondary release occurring in sludge blanket in final clarifier.

Monitor or Check: Check P in RAS - Sludge blanket in final clarifier.

Possible **Solution:** : Reduce sludge blanket depth.

Possible **Cause** : If P increases at end of anoxic zone secondary release occurring in anoxic zone with excessive HRT.

Monitor or Check: P profile through anoxic zone.

Possible **Solution:** : Reduce anoxic zone HRT if possible.

ADV Phosphorus Removal

3.3.1 Discuss corrective actions that can be taken when problems removing phosphorus biologically occur.

Pass rate: 59.5%

OBSERVATION: GOOD P RELEASE IN ANAEROBIC ZONE BUT POOR P REMOVAL

Possible **Cause** : If anaerobic HRT is too long secondary release could occur after VFA are used up.

Monitor or Check: TP profile through selector basins

Possible **Solution:** Increase RAS to reduce anaerobic HRT.

INTRO Disinfection

1.3.1 Explain the relationship between chlorine dosage, chlorine demand and chlorine residual. Pass rate: 34.4%

Dosage: The amount of chlorine fed to achieve disinfection. This is normally reported as a concentration in milligrams per liter (mg/L) or pounds per day (lbs/day).

Demand: The amount of chlorine used to disinfect wastewater after a given contact time.

Residual: The amount of chlorine remaining after a given contact time.

A general expression of this relationship is:

Chlorine Residual = Chlorine Dosage − Chlorine Demand

INTRO Disinfection

3.2.1 Describe the laboratory test method most commonly used to measure fecal coliforms in wastewater treatment plants. Pass rate: 58.6%

The most commonly used test method is the membrane filter technique (Standard Method 9222D).

The colonies for fecal coliform are various shades of blue.

INTRO Disinfection

5.1.6 Given fecal coliform test results, calculate the fecal coliform geometric mean. Pass rate: 36.3%

GIVEN:

Weekly Fecal Coliform Sample Results (cfu/100mL) =

10, 20, 18, 50

FORMULA & SOLUTION:

The geometric mean can be calculated using either of the following two formulas:

Formula:

Geometric Mean= nth root of [FC1 × FC2 × FC3 × FC4...]

where n = number of samples

FC# = fecal coliform result of each sample

Geometric Mean = 4th root of [10 × 20 × 18 × 50]

= 4th root of 180,000

= 21

TI-30X IIS

Roots

If the volume of a cube is 125 cm^3, what is the length of each side?

Press	Display
3 [2nd] [^] ($\sqrt[x]{}$) 125 [ENTER]	3 $^x\sqrt{}$125. 5. DEG

ROOT / KEY / VALUE

4 [2nd] [^] ($\sqrt[x]{}$) 180000 [ENTER]


Abs
x³
x⁻¹
x!
x²
hyp
sin
cos
FACT
cos⁻¹

5.1.6 Given fecal coliform test results, calculate the fecal coliform geometric mean. Pass rate: 36.3%

Alternate Formula:

Geometric Mean = AntiLog [Sum of Log Data ÷ Number of Values]

Log of 10 = 1.000

Log of 20 = 1.3010

Log of 18 = 1.2553

Log of 50 = 1.6989

Geometric Mean =

AntiLog [(1.000 + 1.3010 + 1.2553 + 1.6989) ÷ 4]

= AntiLog [5.253 ÷ 4]

= AntiLog [1.313]

Geometric Mean = 21

Intro Activated Sludge 1.2.4

Describe the types of protozoa and organisms commonly found in activated sludge and observable under a microscope. Pass rate: 48.3%

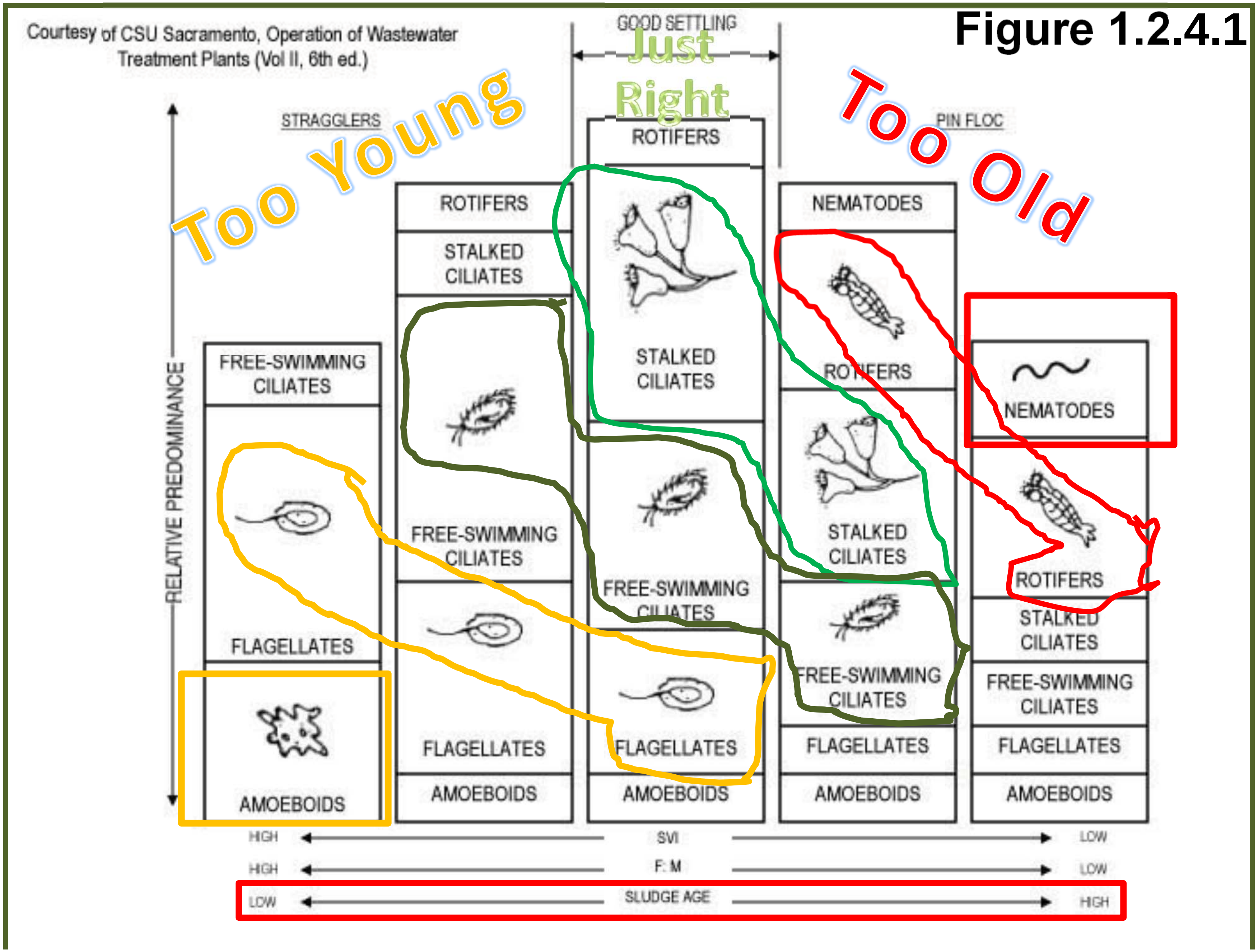
Protozoa are single-celled microscopic organisms, several hundred times larger than bacteria. It is the protozoa we observe under a microscope since bacteria are actually too small to see.

There are four types of protozoa commonly found in activated sludge systems. They are identified by their method of movement within the wastewater environment.

The four types are amoebae, ciliates (free-swimming and stalked), flagellates and suctoreans.

Rotifers are multi-celled (metazoa) organisms also commonly found in activated sludge systems. The relative predominance of these protozoa is commonly associated with the age of the activated sludge.

Goldilocks' Activate Sludge Protozoan Paradise



INTRO to Ponds, Lagoons, and Natural Systems

2.3.3 Describe the meaning of blower air pressure gauge readings. **Pass rate: 50%**

The normal operating discharge pressure from a blower is 5 to 14 psi.

High readings of an air gauge are caused by plugged airline, orifices, diffusers, or ice cap.

Low readings of an air gauge could be caused by a faulty blower, an air leak, or clogged blower inlet filter.

In either case, there is a possibility that the blower could overheat, causing damage to the unit. A hot blower should be shut-down and corrective action taken.

INTRO to Ponds, Lagoons, and Natural Systems
2.2.10 Describe how to check for efficient aeration of a lagoon. **Pass rate: 46.2%**

Monitor lagoon dissolved oxygen, watch surface aeration patterns for changes, read airline pressure gauge, check for changes in effluent BOD, and monitor all aeration equipment.

For proper treatment, an aerated lagoon should have an adequate supply of dissolved oxygen. The dissolved oxygen in the surface mixed zone should be at least 2 mg/L.

INTRO to Ponds, Lagoons, and Natural Systems

1.2.6 Discuss the relationship between bacteria and algae in a pond system. **Pass rate: 50% & 46.2%**

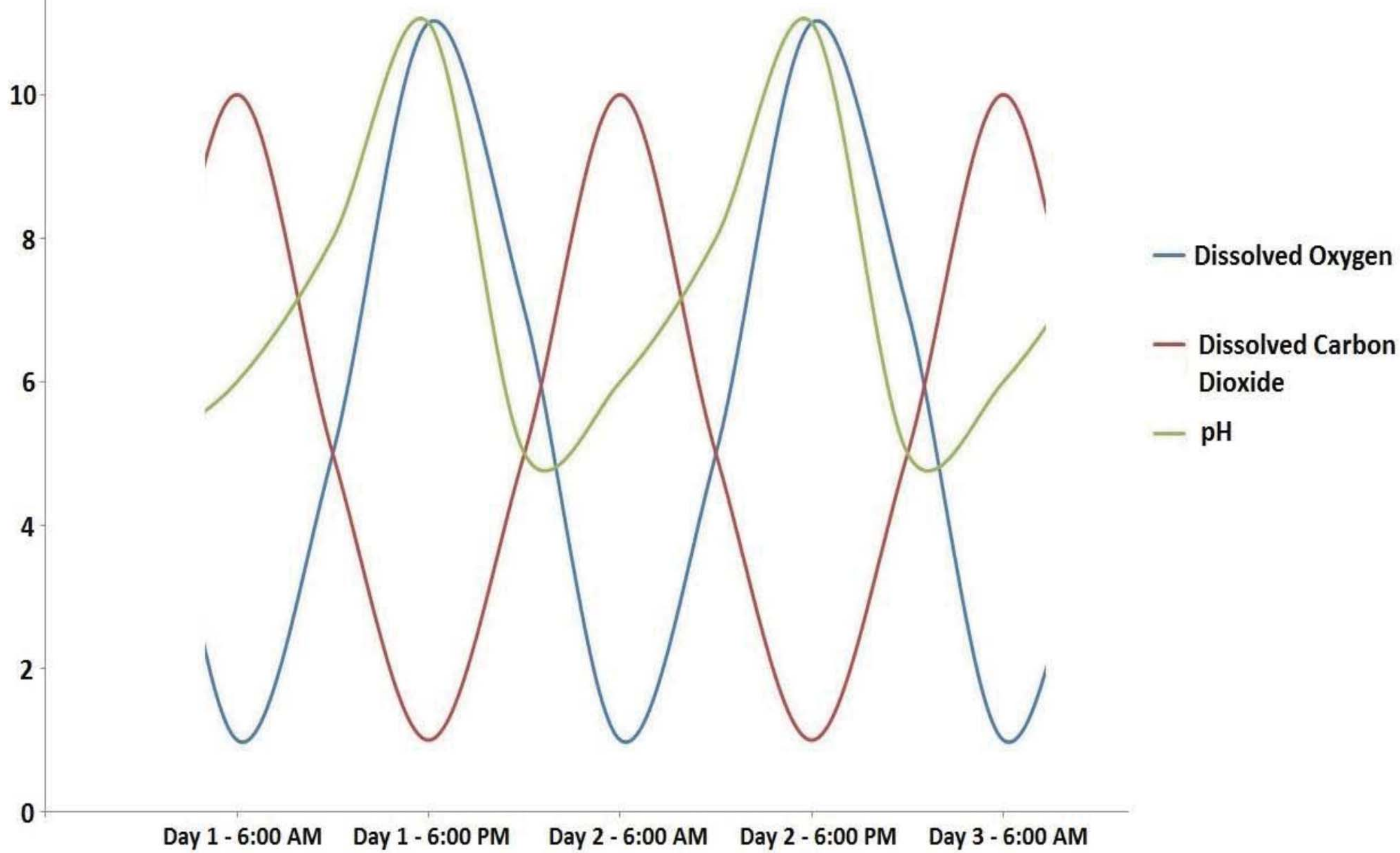
When the sun is out, algae uses up dissolved carbon dioxide (CO2) and gives off oxygen (O2) in the process of photosynthesis. At night, algae and microorganisms use dissolved oxygen (DO) and give off CO2 in the process of respiration; this lowers the pH. Thus, pH would be lowest at sunrise. **In a non-aerated stabilization pond**, this causes a daily swing in the concentration of DO and dissolved CO2.

Dissolved CO2 in the water forms carbonic acid (CO2 + H2O -> H2CO3), which lowers the pH. On long sunny days, most of the CO2 is used up by the algae, therefore there is less carbonic acid and the pH will rise. The pH can reach 11 or 12 in the evening of a sunny summer day.

INTRO to Ponds, Lagoons, and Natural Systems

1.2.6 Discuss the relationship between bacteria and algae in a pond system. **Pass rate: 50% & 46.2%**

Figure 1.2.6.1 Courtesy Katherine Robles, WIDNR



Respiration: Night. O_2 used up.
CO_2 is produced. Lowers pH

Photosynthesis: Day. Sunlight + CO_2 (used up).
Produces O_2. Raises pH
No sunlight = no photosynthesis

INTRO to Ponds, Lagoons, and Natural Systems

3.3.7 Discuss the effects of pumping sewage to a distant pond or lagoon site. **Pass rate: 50%**

Raw sewage may become septic if it has to be pumped a long distance (1-5 miles) from a lift station in town to a distant pond/lagoon site outside of town.

The septicity is caused by the long detention time of the wastewater in the pipe under anaerobic conditions before it reaches the pond site. Under anaerobic conditions, organic acids and sulfide compounds form. Organic acids can result in increasing the BOD of the wastewater once it reaches the pond site.

Hydrogen sulfide results from the bacterial breakdown of organic matter in the absence of oxygen, such as in sewers. The sewage, upon discharge to the influent manhole at the pond site, will release corrosive hydrogen sulfide gas leading to manhole deterioration. Because of this, pond influent manholes should be constructed and properly coated to protect against hydrogen sulfide corrosion.

Septic/Septicity

Anaerobic (no oxygen) conditions (long stretches of pipe)
Long detection time (1-5 mile distance)
Causes formation of organic acids & sulfides
Which cause high BOD

Hydrogen sulfide (H2S)

Bacterial breakdown of organics without oxygen causes formation of hydrogen sulfide (H2S) gas
Corrosive!!! Corrodes manholes discharged to influent manhole

Long distance wastes without O2
Septic/Septicity → Acids formed → Corrosion

ADV Stabilization Ponds and Aerated Lagoons

1.2.1 Identify the valve action necessary to bypass a Pond cell. Pass rate: 22.4%

Close the inlet and outlet valves on the unit to be bypassed.

Open the valve on the bypass line.

3. **close off** - block off the passage through; "We shut off the valve"

block off, shut off

barricade, block, block up, blockade, block off, bar, stop - render unsuitable for passage; "block the way"; "barricade the streets"; "stop the busy road"

ADV Stabilization Ponds and Aerated Lagoons

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

Pass rate: 56.7%

A. Poor treatment.

B. High effluent BOD.

C. Increase of sludge solids.

D. Potential for objectionable odors.

E. Excessive algae (blue-green filamentous mats).

Logical sequence:

Poor treatment means higher effluent BOD and increase of sludge solids. If nutrients are rich, you will have blue green mat issues, which all leads to odors

ADV Stabilization Ponds and Aerated Lagoons 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.

Pass rate: 59.7%

A. Algae: Chemical = copper sulfate,
Non-Chemical = filtration

B. Rooted weeds: Chemical = herbicides,
Non-Chemical = cutting/pulling, 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.

Introduction to Tertiary Filtration

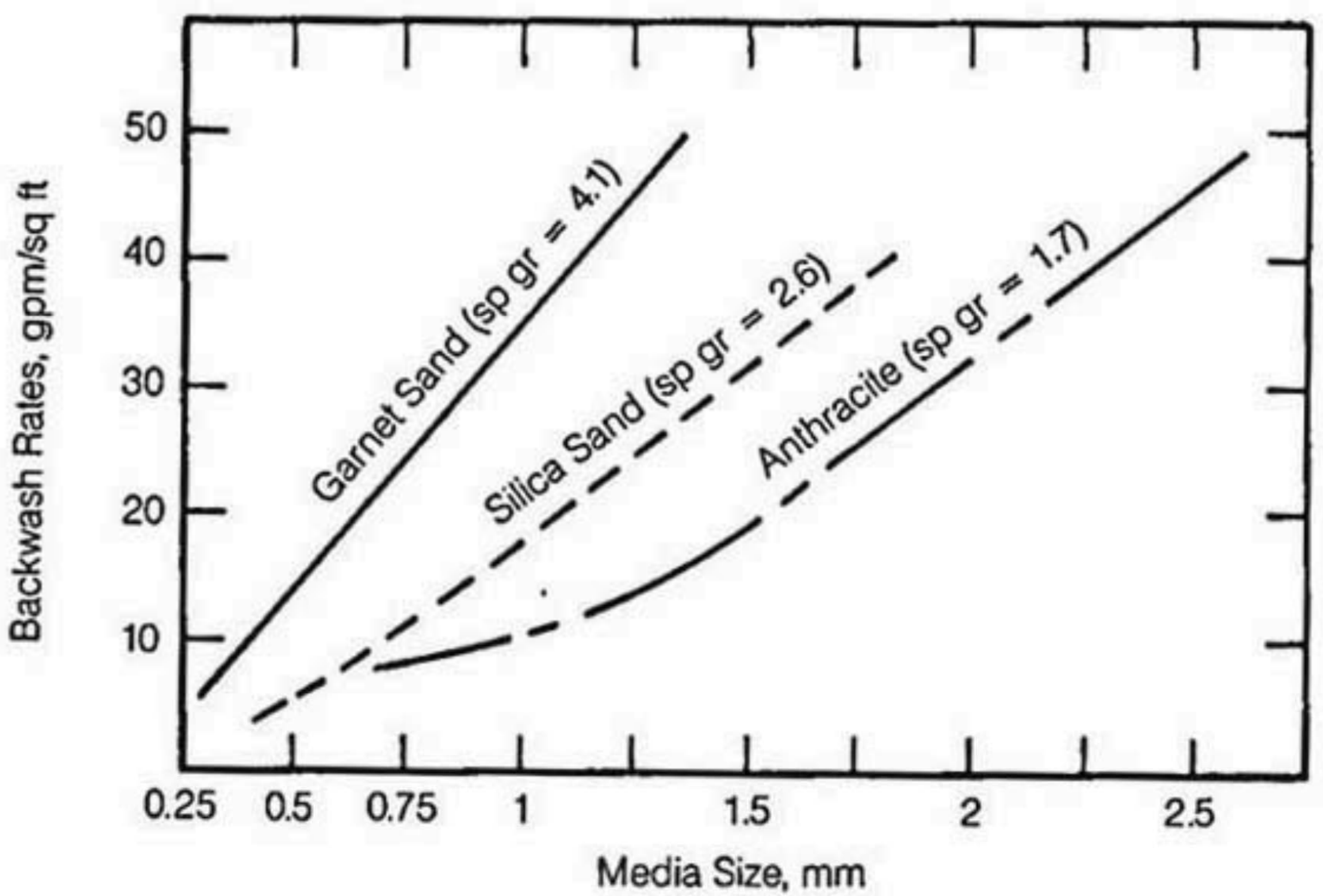
2.1.9 Discuss backwash rates for filter medias. **Pass rate: 27.3%**

Filters are either single, dual, or multi-media beds. Backwash rates are dependent upon the media and media size (see figure 2.1.9.1). Typical backwash rates are 10 – 20 gpm/sq ft.

Generally, backwash cycles are about 6 – 10 minutes for deep bed filters and 4 – 5 minutes for shallow bed.

In total the backwash process requires approximately 100 gal/sq ft. The most effective cleaning mechanism during backwash is the erosive collisions of particles against one another. This is accompanied by upward water flow and agitation through air scour. Minimum air scour rates typically range from 3 – 5 scfm/sq ft and are dependent on the depth of the filter bed.

Figure 2.1.9.1



WEF Manual of Practice No. 8 Diagram

Introduction to Tertiary Filtration

1.2.6 Discuss the common auxiliary cleaning aids that may be used during backwashing to aid in cleaning the media. **Pass rate: 53.6%**

Air scour and surface jets may be used to aid in cleaning the media during backwashing. Surface jets are used in some filters to increase shearing action during backwash which aids in the cleaning of the media and surface encrustations. Air scour increases turbulence and bed expansion during the backwash cycle. The increased agitation of the filter bed by the air scour improves the removal of solid particles from the media. Air scour reduces the formation of mudballs and reduces the amount of backwash water needed.

Introduction to Tertiary Filtration

3.1.5 Explain how to use the results from BOD and suspended solids test to determine filter effectiveness. **Pass rate: 53.4%**

When total BOD or TSS from a tertiary filter plant exceed 10 parts per million an operator should inspect the operation of the filter system.

In the event of higher BOD readings the operator should check for soluble BOD which may indicate problems with the secondary process.

Advanced Tertiary Filtration

1.2.2 Discuss types of media, effective media size, specific gravity, and where solids should be caught in the following types of filters. **Pass rate: 32.3% & 52.2%**

A. Shallow bed filter
B. Deep bed single-media filter
C. Deep bed multi-media filter

A. Shallow bed filter: have lower (finer) effective size (0.5 to 0.6 mm) sand media with specific gravity of 2.65; the majority of the suspended solids are trapped at the very top of the media
B. Deep bed single media filter: have coarser (larger) effective size (1.2 to 2.5 mm) sand media with specific gravity of 2.65; suspended solids are captured within as well as on the surface of the media.

Advanced Tertiary Filtration

1.2.2 Discuss types of media, effective media size, specific gravity, and where solids should be caught in the following types of filters. **Pass rate: 32.3% & 52.2%**

C. Deep bed multi-media filter: have various combinations of anthracite (specific gravity 1.6 to 1.7 with an effective size of 1.0 to 1.2 mm), sand (specific gravity 2.65 with an effective size of 0.5 to 0.6 mm), garnet (specific gravity 4.0 to 4.6 with an effective size of 0.2 to 0.3 mm), and even a low density coal (specific gravity 1.3 to 1.4 with an effective size of 1.2 to 1.4 mm); when backwashing, the beds are fluidized and media separated by specific gravity with the lightest on top and the heaviest on the bottom; this causes the light/coarse material to be on top grading down to the heavier fine material on the bottom; this allows the entire filter bed to capture solids with the large suspended solids trapped in the upper media and the fine suspended solids trapped in the lower media

Filtration media…what you need to know

Media	effective size	specific gravity	solids caught
Shallow Bed	Finer sand (0.5 to 0.6 mm)	2.65	the very top
Deep bed single media filter	coarser sand; (1.2 to 2.5 mm)	2.65	within as well as on the surface
Deep bed **multi**-media filter:	Anthracite; (1.0 to 1.2 mm)	1.6 to 1.7	light/coarse material to be on top grading down to the heavier fine material on the bottom
	Finer sand (0.5 to 0.6 mm)	2.65	
	Garnet; (0.2 to 0.3 mm)	4.0 to 4.6	
	low density coal; 1.2 to 1.4 mm);	1.3 to 1.4	Large SS: top Finer SS: bottom