Wisconsin Department of Natural Resources
Wastewater Operator Certification

Introduction to Preliminary & Primary Treatment Study Guide

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Subclass A

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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

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Part 1 - Preliminary Treatment

Chapter 1 - Principle, Structure and Function

Section 1.1 - Principle of Preliminary Treatment

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

A. Grit removal - to remove heavy, generally inorganic, solids prior to the primary clarifier.
B. Screening - to remove rags, sticks, and other large debris that could cause problems with downstream units.
C. Comminution - is a process of cutting and grinding solids prior to going to downstream treatment units. (various types of units - rotary or linear operations).
D. Chemical treatment - the use of chemicals to correct problems that may affect downstream operations, or to achieve specific results (i.e. Phosphorus removal).

1.1.2 Define the composition of grit.

Grit is defined as suspended solids in the raw wastewater influent flow. It is generally inorganic in its composition and settles - out rapidly when velocity of flow is decreased. Examples would be sand, gravel, coffee grounds, cinders, etc.

Section 1.2 - Structure and Function of Preliminary Treatment

1.2.1 Explain the function of grit removal systems.

Grit removal systems are generally facilities designed to control the velocity of the wastewater flow to cause inorganic solids to be deposited while organic material passes on to downstream treatment units. Normally, a velocity of 1 foot per second is maintained to achieve grit removal.

1.2.2 Describe three types of grit removal systems.

Types of grit removal systems would include:

A. Linear channels: the earliest type of grit removal consisting of long narrow channels to allow for grit deposition. Grit removal from the channels can be either manual (shovels and buckets) or various types of mechanical devices.

B. Aerated chambers: this type of system is like a small clarifier with a hopper bottom, and has difussers to provide aeration. Grit is deposited, and organic material is washed out by the action of the rising air bubbles. Grit removal from the chamber can be by mechanical means, gravity, or air lift pumps.

C. Cyclone devices: this type of system uses centrifugal force to remove the grit. It is not a very common type of grit removal unit.

1.2.3 Describe the structure and function of manually cleaned bar screens.

A bar screen is composed of parallel bars, either vertical or inclined, placed in a channel to catch rags, sticks, and other debris. These units need attention regularly for cleaning to prevent up-stream back-up and the potential of by-passing the unit.

1.2.4 Describe the structure and function of automatically cleaned bar screens.

This is a bar screen that has various types of mechanical equipment that automatically removes the accumulation of debris on the screen. This unit requires mechanical attention for repairs of the moving equipment.

1.2.5 Discuss the function and operation of comminutors.

Comminutors are devices that cut or grind solids to reduce their size so that the solids can be better handled in the downstream treatment units.

1.2.6 Discuss the function and operation of barminutors.

A barminutor is a comminutor, but it functions with a cutter system operating across the face of an inclined screen (basically, this system is a linear motion as compared with most other comminutors that use rotary cutters).

Chapter 2 - Operation and Maintenance

Section 2.1 - Operation of Preliminary Treatment

2.1.1 Discuss the situations where chemical pretreatment may be necessary to protect downstream processes.

A. pH control - the addition of acids or bases to adjust pH to protect downstream units from corrosion, and to assure the proper pH for biological treatment.
B. Pre-chlorination - used for odor problems and control of hydrogen sulfides - especially used when septic raw wastewater is encountered.
C. Phosphorus removal - some application of chemicals at the preliminary stage may be used to precipitate phosphorus in the primary clarifier.

2.1.2 Discuss alternative grinding systems to the use of comminutors and barminutors.

There are other types of grinding systems that are proprietary devices that basically function the same as normal rotary comminutors and the linear barminutors.

2.1.3 Identify where grit collects when it is not caught in the grit chamber.

Grit that is not removed in the grit chamber would settle-out in the wetwell (if flow is pumped prior to the primary), or the primary clarifier. The sludge removal equipment of the primary clarifier would transfer the grit to a digester where it just occupies space. In addition, grit can cause problems with plugging the sludge removal equipment (pipes, pumps and hoppers), and abrasion of pump impellers and shafts.

2.1.4 Explain why grit and screenings should be contained and properly disposed of.

The biggest problem with grit and screenings would be odor problems. A second problem is the health concerns that could be caused by this material (disease transmission).

2.1.5 Describe what determines the scheduling of disposal of grit and screenings, and what might cause increases in grit/screenings production.

Normal scheduling of grit removal should be dependant on amounts generated, on-site storage, and availability of disposal sites (landfill or burial). Adjustments would need to be made to this schedule if you are cleaning the sewer system or have experienced high influent hydraulic flows, both of which would increase your grit/screening production.

2.1.6 Identify two purposes for aeration in grit chambers.

Aeration in grit chambers is used to wash the grit to remove finely entrapped organic solids. Another purpose, would be to reduce odors and "freshen" the raw wastewater by providing dissolved oxygen.

2.1.7 Describe how to properly dispose of debris generated from preliminary treatment.

Because of odor and health concerns, grit and screenings from preliminary treatment should be either buried, landfilled, or incinerated.

2.1.8 Compare the impact on preliminary and primary treatment of septic tank contents vs. holding tank contents.

Holding tank wastes can be virtually treated the same as normal raw wastewater, with the exception that it will likely be septic.
Septic tank waste would have very high suspended solids, high BOD, and would almost without exception be septic. Because of this difference, much more care is required for septic tank wastes to ensure no overloading of the preliminary and primary systems. Especially, as related to septic effluent from a primary clarifier that might affect the secondary process.

2.1.9 Describe how an operator can protect downstream processes if the comminutor is shutdown for maintenance or repair.

Most plant designs provide a diversion channel that contains a manually cleaned bar screen that can be used when the comminutor is out-of-service for maintenance or repairs. In the event the plant does not have this unit, an operator should devise a barrack or screen that can be placed in the channel when the comminutor is out-of-service for repairs.

2.1.10 Explain the necessity of good ventilation around an aerated grit chamber, especially, when influent is septic or anaerobic.

Good ventilation around an aerated grit chamber when the influent is septic or anaerobic is necessary to prevent odor problems. More importantly, are the health concerns related to the release of hydrogen sulfide gas.

2.1.11 Describe the impact of rodding and jetting sewers on preliminary and primary treatment.

Any sewer cleaning operation could cause a significant increase in suspended solids, including, increased grit/screenings and primary sludge. Cleaning may cause influent flow to become septic.

Section 2.2 - Maintenance of Preliminary Treatment

2.2.1 Describe the possible affects on flow measurement and the collection system if bar screens are not regularly cleaned.

Flow measurement could be adversely affected if located upstream of a plugged bar screen. If the collection system enters the plant by gravity, a plugged bar screen could cause deposition of solids immediately upstream in the sewer system. A problem could occur if the flow bypasses a plugged bar screen, allowing rags and other debris to get to downstream pumps or other equipment.

2.2.2 Discuss where maintenance schedules for automatically cleaned bar screens are located.

The maintenance schedule for the mechanical portions of an automatically cleaned bar screen should be in the operators O&M manual or specifications from the manufacturer. Physical cleaning of grease and any other materials would be dependent on raw wastewater characteristics determined by visual inspection by the operator.

2.2.3 State the items to inspect and maintain regularly in comminutors and barminutors.

The most important items to inspect are the cutters (or teeth) and the shear bar to ensure good operation. Other items, depending on type of unit, would be to grease bearings, electric motor maintenance, universal joints, lubrication, and any other mechanical components as specified in the O&M manual or manufacturer's guides.

2.2.4 Explain what would determine the frequency for sharpening and/or replacing of comminutor teeth.

The sharpening and/or replacement of comminutor teeth is dependent on the raw wastewater characteristics (especially grit), and whether grit removal is part of the treatment system. Some suggested frequencies have been 6 months to 1 year, but should be as specified by the manufacturer and/or based on experience at a given plant.

2.2.5 Explain what should be included in a preventive maintenance schedule for grit removal and grit chamber aeration systems.

Depending on the type of system, a maintenance schedule should include lubrication (as specified), electric motor maintenance, conveyance system repair, physical cleaning, and surface coatings.
Normal maintenance would include inspection of the air compressor (lubrication, belts, filter, etc.), and electric motor maintenance. Some systems will require repair and cleaning of air lift pumps and diffusers.

2.2.6 Discuss the purpose of the comminutor rock sump, and suggest maintenance intervals.

The rock sump would provide a collection point to prevent small rocks from causing damage to the comminutor. This should be checked based on history of accumulation, construction, or cleaning on the collection system.

2.2.7 Explain where the lubrication procedure for comminutors would be located.

The lubrication procedures should be covered in the O&M manual or the manufacturer's instructions.

Chapter 3 - Monitoring, Troubleshooting, and Safety

Section 3.1 - Monitoring Preliminary Treatment

3.1.1 Describe how to determine if too much (or too little) material is settling-out in a grit chamber.

If it is suspected that too much material is settling-out in a grit chamber, a volatile solids test should be run. If volatile solids significantly exceed 5%, there is too much organic matter in the grit. An alternate procedure would be the historic records of grit removal quantities that can be compared to the present rates. Operator experience and visual observations will determine if the amount of grit being removed is satisfactory.
If it is suspected that not enough material is settling-out, the operator could check the historical records of grit removal quantities and compare them with the present rates. Another possibility, would be to check downstream units or channels to visually determine if grit deposition is taking place.

3.1.2 Explain how to measure the amounts of grit removed from a system.

By weight or volume. Buckets or dumpster volumes.

3.1.3 Describe how to determine organic content in grit, and state normal range of values.

Perform a volatile solids test. Volatile solids in grit would be in the range of 1-5 percent.

Section 3.2 - Troubleshooting Preliminary Treatment

3.2.1 Discuss the operational changes to consider in event of a power outage in preliminary treatment.

In the event of a power outage, the influent flow should be diverted around the comminutor to an auxiliary bar screen to prevent build-up of debris in and around the comminutor. Depending on the type of grit removal system, it would be advisable to shut-down the grit conveyance system so you can restart it manually. Observe the system to prevent possible damage.

3.2.2 List three potential problems that could be caused by improper use of chlorine in pretreatment.

A. The safe handling aspect of chlorine to prevent accidents and possible injury.
B. If the chlorine application is insufficient, it may not control odors.
C. If too much chlorine is applied, it could adversely affect the secondary treatment process.

3.2.3 Discuss the causes and corrective actions for odor problems at plant headworks.

CAUSES:
The major cause of odors at a plant headworks would be due to septic conditions in the collection system, certain industrial wastes, or poor housekeeping of the grit chamber and grit storage.
CORRECTION:
Corrective actions related to septic raw wastewater usually involve applications of chlorine or hydrogen peroxide, controlling industrial waste sources, and improved housekeeping.

3.2.4 Describe the potential problems and suggest corrective actions if:

A. Too little grit is being caught in the grit chamber.
B. Too much organic material is settling in the grit chamber.

A. Too little grit is being caught in the grit chamber:
If not enough material is being removed in the grit chamber, downstream units will be affected, such as wet-wells, pumps, primary clarifier, and the digester. This could cause pluggIng problems in pipes, extra wear on pumps, and other sludge handling equipment. It would slowly fill the digester with inorganic solids. Grit removal needs to be improved by placing additional grit removal units on line (if they are available), or by making process control changes in the operation of the grit removal units.

B. Too much organic material is settling in the grit chamber:
If too much material is being removed in the grit chamber, the grit will contain excess organic matter and would be extremely odorus. Grit removal units may need to be removed from service (if possible), or process control changes will be required in the operation of the grit removal units.

Section 3.3 - Safety in Preliminary Treatment

3.3.1 Describe why there is an increased risk of disease when working with grit and screenings.

Grit and screenings contain more raw sewage material and the possibility of a variety of contagious diseases.

3.3.2 Explain why odor problems at plant headworks may constitute a health hazard as well as being a nuisance.

Odorous sewage could contain a variety of gases. The main gas problems would be:
a. Methane.
b. Hydrogen sulfide.

3.3.3 Discuss where the possibility of confined space entry areas would be while performing maintenance on bar screens, grinders and grit tanks.

If pretreatment equipment is in lower levels or wet wells, confined space entry procedures should be used.

3.3.4 List the procedures for confined space entry required to perform maintenance tasks in a confined area.

A. Position proper signage if on a busy street.
B. Make sure additional manpower is on hand (minimum of two).
C. Test operate the two-way radio.
D. Test the gas level with meter.
E. Secure the harness and set-up the tripod lifting device.
F. Test the breathing apparatus.
G. Make sure first aid materials are available.
H. Test for proper ventilation.

l. Plan for continued monitoring of environment.

3.3.5 Describe the safety hazards related to maintenance of automatically cleaned bar screens.

Automatically cleaned bar screens have moving parts and equipment that could start-up and cause an injury. Before performing any maintenance, the operator should shut-off and lock-out all electrical systems powering this unit.
Determine if the bar screen is located in a confined space entry area and act accordingly.

3.3.6 Explain why geared-down machines are considered more dangerous than high-speed equipment.

Slower speeds can be dangerous because there is more power generated from the geared-down equipment and they are harder to stop.

Part 2 - Primary Treatment

Chapter 4 - Principle, Structure and Function

Section 4.1 - Principle of Primary Treatment

4.1.1 Explain the main purpose of primary treatment.

The main purpose of primary treatment is the removal of settleable solids and skimming of floating material.

4.1.2 Describe two ways to achieve primary treatment.

A. Primary settling.
B. Fine screening of various types.

4.1.3 Explain why primary treatment is more important if followed by trickling filters or rotating biological contactors, than if followed by an activated sludge process.

If no primary treatment is provided, solids will build-up in the media or basins of a trickling filter or rbc unit. Activated sludge has less of a problem because it is a dispersed growth system and does not have media that could be affected.

4.1.4 Describe the principle of primary settling as related to solids settling.

Primary settling is the physical process of separating, by gravity settling, solids from liquid. The organic suspended solids entering the primary clarifier has a density only slightly heavier than water. This means that quiet settling, with minimal turbulence, is required to separate the solids from the water.

Section 4.2 - Structure and Function of Primary Treatment

4.2.1 Discuss the components of circular and rectangular primary clarifiers, and identify the following parts:

A. Influent Baffle
B. Scum Trough
C. Effluent Weir
D. Scum Baffle
E. Sludge Hopper
F. Sludge Ploughs
G. Flight and Chain
H. Shoes

Components common to circular and rectangle clarifiers
A. Influent baffle: a structure at the influent of the clarifier designed to equally distribute flow into the clarifier.
B. Scum trough: used to collect grease or other floating solids.
C. Effluent weir: a device used on the effluent end of the clarifier to evenly distribute the flow through the clarifier.
D. Scum baffle: a plate used to retain floating solids in the clarifier.
E. Sludge hopper: an area within the clarifier where sludge is collected.

Component common to only circular clarifiers:

F. Sludge ploughs: devices used in circular tanks to collect or move sludge to the sludge hopper.

Components common to only rectangular clarifiers:
G. Flights/chains: sludge collecting devices in a rectangular clarifier.
H. Shoes: protective plates used on flights to protect them from wear.

4.2.2 Identify the common types of pumps suitable for pumping primary sludge and describe how they work.

A. Piston pump: a positive displacement type pump using a piston along with ball check valves to control flow.
B. Centrifugal trash pump with open impeller: operates by a motor and shaft turning an impeller inside a volute that displaces sludge.
C. Progressive cavity pump: has a screw-shaped rotor revolving within the walls of a rubber lined stator. The gaps between the rotor threads and stator are called the "cavities". As the rotor turns, material is moved through the "cavities" towards discharge.
D. Diaphragm pump: a type of positive displacement pump that uses a thick rubber disc that is driven up and down reducing the size of the pumping chamber, thus pumping sludge. A check valve is required on the inlet side of the pump. Diaphragm pumps can be either single or double disc models.

Chapter 5 - Operation and Maintenance

Section 5.1 - Operation of Primary Treatment

5.1.1 Explain why it is better, if possible, to fill a primary clarifier with clean water at start-up than with raw sewage.

With clear water you can see the equipment better in the tank and you have less of a problem if you have to dewater for correction of mechanical problems.

5.1.2 Describe how to determine if grit and heavy solids are building up in the sludge hopper of the primary clarifier.

You can inspect with a sludge judge, sample the primary sludge, and analyze the sludge for fixed suspended solids.

5.1.3 Discuss the ways of preventing accumulation of grease, grit, and heavy solids, in sludge hoppers and sludge lines.

Make sure the grit removal system is functioning properly. Have an active program to assure that grease removal devices within the service area are routinely cleaned to keep oil/grease out of the raw flow wastewater. Periodically, clean and degrease the lift stations.

5.1.4 Describe the purpose and operation of scum removal systems.

The purpose is to remove grease and/or scum from the system so it will not cause problems throughout the rest of the operation. This is normally done by various methods to collect floating grease/scum.

5.1.5 List the appropriate methods of dealing with primary tank scum skimmings.

A. Pump the scum skimmings to a digester.
B. Haul it to a landfill site, or bury it.

5.1.6 Explain the impact of the following on sludge pumping:
A. Solids loading rate
B. Automatic sludge removal systems
C. A full anaerobic digester

A. Solids loading rate: the higher the loading rate of solids, the more frequently sludge must be pumped.
B. Automatic sludge removal systems: would be a more efficient type of operation by removing sludge more often. Sludge can be removed from the system according to the loading over a 24-hour period of time.
C. A full anaerobic digester: if the anaerobic digester is overloaded (need to haul sludge), and sludge continues to be pumped to the digester, the returning supernatant will contain excess solids that will be recycled through the primary. This situation, unless it is corrected by sludge hauling, will cause poor quality primary effluent.

5.1.7 List the conditions that indicate sludge pumping should be done more frequently.

A. If floating sludge is noticed in the clarifier.
B. If gas bubbles are rising to the surface.
C. If sludge is odorous when not collected regularly.
D. If the plant is producing poor quality primary effluent.

5.1.8 State the range of values for percent removal of suspended solids expected from primary treatment.

40 - 60% of overall suspended solids should be removed by primary treatment.

5.1.9 Describe the equipment to use to determine if primary sludge is being completely removed.

A sludge depth finder.

5.1.10 Describe how actual detention time compares with theoretical detention time.

Actual detention time may be less than theoretical due to short circuiting that could be caused by uneven weirs or inadequate baffling.
Theoretical detention time assumes uniform flow through the clarifier, while actual detention time would be determined by dye tests.

5.1.11 State the recommended detention time for primary sedimentation tanks.

1 to 3 hours is considered normal.

5.1.12 Discuss the impact of solids content and volatile solids of primary sludge on the operation of anaerobic digesters.

If you are pumping thin sludge (low solids content) to a digester, you have increased heating costs, and more supernatant is returned to the head of the plant. Pumping higher solids content sludge at more frequent intervals will improve digester performance. If the percent volatility is low, problems with reduced gas production will occur. If the lower volatility is caused by excess grit in the sludge, you will be adding inorganic solids to the digester that will merely occupy space in the unit.

5.1.13 List the methods of changing sludge pumping rates.

A. Change the stroke length on a piston pump.
B. Change the variable speed pump setting.

5.1.14 List the reasons causing a piston pump to be running, but not pumping sludge.

A. Something is caught between the ball and ball seat.
B. The suction side valve is closed.
C. The pump could have a sheared pin.

5.1.15 List the indicators that an operator can use to tell when to shut-off the sludge pump.

A. By having a predetermined amount to be pumped.
B. By visual inspection (if possible).
C. By using a sight glass.
D. By taking a sample from a sample cock.

5.1.16 Describe the function of a torque limiting device, and explain the consequences if it is tampered with when taken out of service.

A torque limiting device is used to protect equipment from major damage. If tampered with, or taken out of service, it is possible that there could be significant damage to the equipment.

5.1.17 List the items an operator should consider when operating a primary clarifier during cold weather.

A. Watch for freezing of scum troughs and other equipment.
B. Watch the flight operation.
C. If sludge hauling is limited due to frozen ground, adequate sludge digestion or storage facilities may be needed.

Section 5.2 - Maintenance of Primary Treatment

5.2.1 Describe the items to consider in maintenance inspection of the following:
A. Clarifier Chains
B. Flights
C. Shoes
D. Bottom Rails
E. Gear Reducers

A. Clarifier chains:
1. Check the pins.
2. Check the chain wear.
3. Check the chain tension.

B. Flights:

1. Check for wear.
2. Check for cracking or misalignment.
3. Check the retaining bolts.

C. Shoes:
1. Check for wear.
2. Check the retaining bolts.

D. Bottom rails:
1. Check the alignment.
2. Check for levelness.
3. Check the general condition.

E. Gear reducers:
1. Check for general wear.
2. Check for missing teeth.
3. Check alignment.
4. Check for proper lubrication.

5.2.2 List the maintenance steps for centrifugal pumps, positive displacement pumps, progressive cavity pumps, and diaphragm pumps.

Centrifugal pumps:
a. Grease the shaft bearings.
b. Maintain the packing.
c. Maintain the impeller.

Positive Displacement Pumps:
a. Grease the shaft bearings.
b. Maintain the packing.
c. Maintain the piston.
d. Maintain the check valves.

Progressive Cavity Pumps:
a. Grease the bearings.
b. Check the wristpin oil.
c. Check the eccentric oiler.
d. Tighten the packing, if needed.

Diaphragm Pumps:
a. Grease the shaft bearings.
b. Maintain the diaphragm disc/discs.
c. Maintain the check valve.

5.2.3 Develop a checklist to follow prior to pumping sludge with a positive displacement pump.

A. Check the discharge and suction valves (both open position).
B. Check the oilers and oil levels.

C. Turn-on the pump.
D. Check the packing for leakage, and tighten if necessary.

5.2.4 List the places to check for wear on sludge collectors.

A. Wearshoes.
B. Drive chains.
C. Sprockets.
D. Flight clearance to walls and floors.

5.2.5 Discuss the lubrication and gear coating maintenance of the primary drive mechanism.

Use good quality gear lubrication. Check oil levels frequently. Grease shaft bearings.

5.2.6 List the items to consider when inspecting primary weirs and baffles for proper function.

A. Check the weirs for levelness.
B. The baffles should be checked to ensure short-circuiting is not occuring. A dye test is helpful to see if the baffles are effective.

5.2.7 Explain why it is necessary to adjust the tension of the clarifier chain after start-up and state how the adjustment is done.

Clarifier chains stretch with use and need to be adjusted soon after start-up. If chain adjusters are available, tighten these evenly. If not available, remove chain links.

Chapter 6 - Monitoring and Troubleshooting

Section 6.1 - Monitoring Primary Treatment

6.1.1 List two laboratory tests used to evaluate primary treatment.

A. Suspended solids test.
B. BOD test.

6.1.2 List the steps in the procedure for testing sludge for volatility and solids content.

A. Filter a measured volume of sample through a filter disk.
B. Dry for 1 hour at 104 degrees C.
C. Cool in desiccator at room temperature.
D. Weigh the sample.
E. Place sample in the muffle furnace at 550 degrees C. for 20 minutes.
F. Cool in desiccator.
G. Re-weigh the sample and compute volatile solids.

Section 6.2 - Troubleshooting Primary Treatment

6.2.1 Describe the impact on anaerobic digestion if the primary sludge pumps are routinely left running too long.

This action will cause a temperature drop, pH change, too much clear water, and a drop in production.

6.2.2 Explain why progressive cavity sludge pumps:
A. Should not run dry.
B. Should not be run against a closed head.

A. Should not be run dry: this would cause the pump to overheat and cause possible lock-up. Could damage the pump or shaft.
B. Should not be run against a closed head: would build-up pressure and overheat the pump and motor.

6.2.3 Describe what can happen if a positive displacement pump is pumping against a closed head.

This could shear pins, burn-out motors, blow-out packings, and break pipes.

6.2.4 Describe normal sludge concentration and the affect on sludge quality of sludge pumping rates.

Normal primary sludge should be about 3-5% solids.
A. Pumping sludge too fast: this would create a poor quality sludge due to the possibility of coning or pumping "thin" sludge.
B. Not pumping frequently enough: this would create a "thick sludge," but might cause clogging problems, anaerobic clairifier conditions (gas bubbles and floating sludge), and a poor loading situation for the anaerobic digester.

6.2.5 Describe what can happen if a piston pump is pumping to a fixed cover digester, and the overflow and pressure relief valves are not functioning properly.

This would create a pressure build-up, causing damage to the pump or digester cover.

6.2.6 Explain why operators should take precautions when turning off valves not to trap sludge between two valves.

There is a possibility of clogging the piping system if sludge is left in the pipe over a period of time.

6.2.7 Define "coning" in relation to pumping sludge, and suggest appropriate preventive action.

"Coning" would occur when sludge is pumped too fast from the sludge hopper, causing a "cone" to form in the hopper. This would allow thin sludge to be pumped, and the hopper would not be emptied properly. To prevent "coning," sludge should be pumped slowly to prevent this problem.

6.2.8 Explain why an operator should be aware of groundwater levels and the functioning of relief valves before dewatering clarifiers.

If you had a high groundwater level and faulty relief valve, it is possible that you could float an empty tank.

6.2.9 Describe the possible impact on primary treatment of the following:
A. Poor quality anaerobic digester supernatant.
B. Excessive backwashing of the tertiary filter.
C. Returning secondary sludge from a trickling filter plant to the head of the primary.
D. Waste activated sludge sent to the influent wetwell.

A. Poor quality anaerobic digester supernatant: This results in poor settleability of solids, floating sludge, and has very high primary effluent BOD. It could also be responsible for high ammonia and low pH.
B. Excessive backwashing of the tertiary filter: This could create a hydraulic overload of the primary, which would reduce detention time and cause a loss of clarifier efficiency.
C. Returning secondary sludge from a trickling filter plant to the head of the primary: This could cause a possible overloading of solids to the primary and cause septic conditions (floating sludge and rising gas bubbles).
D. Waste activated sludge sent to the influent wet well: This might cause septic conditions in the wet well due to settling of activated sludge. This would carry-over to the primary, causing poor settling and solids overloading of the clarifier.

6.2.10 Describe the impact of the following on primary treatment:
A. Poor grit removal
B. Low flows and hot weather
C. Waste solids returned to plant headworks
D. Inflow and infiltration
E. Short circuiting

A. Poor grit removal: This would cause overloading of inorganic solids. Causes excessive wear on the sprocket, chains, wearplates, and sludge pumps.
B. Low flows and hot weather: This will cause longer detention times, increased biologic activity, and possible septic conditions. It would create odor problems, high ammonia levels, low dissolved oxygen, rising gas bubbles, floating sludge, high effluent BOD, and a drop in pH.
C. Waste solids returned to plant headworks: Sidestream waste solids (tertiary filter backwash, waste activated sludge, or anaerobic supernatant) represent both a hydraulic and organic load of the primary treatment if it overloads the treatment units.
D. Inflow and infiltration: High inflow and infiltration would cause a short detention time, causing a reduction of primary treatment. This may also increase the amount of grit to be handled or grit getting into the primary clarifier.
E. Short Circuiting: This situation can be caused by uneven weirs, poor baffling, or hydraulic overloads. Unequal flows will cause short detention times and poor quality primary treatment.

6.2.11 Identify the possible causes and corrective actions for the following:
A. Poor removal of settleable solids.
B. Sludge and primary effluent dark and odorous (H_2S).
C. Sludge pumped to the digester is too thin.

A. Poor removal of settleable solids:
Cause: not pumping sludge frequently enough or pumping too fast, causing short circuiting

of the clarifier.
Action: pump at a slower rate and more frequently. Level weirs and check baffles.

B. Sludge and primary effluent dark and odorous (H2S):
Cause: clarifier is in a septic condition.
Action: remove sludge more frequently, check influent loading, and sidestreams.

C. Sludge pumped to digester is too thin.
Cause: pumping too long, or at too fast a rate.
Action: pump slower and for shorter periods of time. Pump more frequently at slower rates and shorter periods of time.

6.2.12 Identify possible causes and corrective actions of:
A. Frequent Shear Pin Failure
B. Broken Chain Or Sprockets
C. Noisy Drive Mechanism

A. Frequent shear pin failure:
Cause: Improper alignment of sprockets and chains. Chain adjusted too tight. May be an overloading of solids. Could be that an improper shear pin is being used.
Action: Properly align and adjust chains and sprockets according to manufacturers specs. Check for the proper size shear pin. Check influent and sidestream solids loadings and adjust the sludge pumping schedule.

B. Broken chain or sprockets:
Cause: Could be poor alignment, improper tension, or rusted and worn chains and sprockets.
Action: Replace worn and broken parts. Check all alignments and tensions.

C. Noisy drive mechanism:
Cause: Could be worn gears, poor lubrication, improper tension and alignment, or seal failure.
Action: Check for proper tension and alignment on chains and belts. Use lubrication maintenance schedule. Replace worn seals.

Chapter 7 - Safety and Calculations

Section 7.1 - Safety in Primary Treatment

7.1.1 Explain why air should be checked and good ventilation provided when working on sludge pumps and valves.

Since these units are located at a lower level, there is a possibility of noxious gases in these areas that could cause explosions, asphyxiation, or poisoning.

7.1.2 Explain the importance of having an alternative way of shutting-off the power to a piston pump.

As a safety precaution, due to the possibility of a broken pipe or packing failure. This could cause a flooding condition which could cause electrical hazards.

7.1.3 List the safety procedures when opening covers of piston pump check valves.

A. Shut-off power and tag the main breaker to the pump.
B. Shut-off the inlet and outlet valves.
C. Bleed-off the air chamber valves.
D. Remove the check valve covers with caution.

Section 7.2 - Calculations of Primary Treatment

7.2.1 Given data, calculate the percent removal of suspended solids or BOD.

Given:
Primary effluent = 120 mg/L
Raw wastewater = 200 mg/L

Formula:
% removal = [mg/L(in) - mg/L(out)] / mg/L(in) X 100

=(200 - 120) / 200 X 100

= 40%

7.2.2 Given data, calculate the average detention time for a primary tank.

Given:
Volume = 50,000 gallons
Flow = 20,000 gallons per hour
(333 gallons per minute)

Formula:
Detention time = volume of tank/Flow rate

= 50,000/20,000

= 2.5 hours

7.2.3 Given data, calculate the gallons of sludge pumped when running time and capacity of pump are known.

Example:
Pump capacity = 60 gpm
Time of pumping = 20 minutes

Formula:
Gallons pumped = Pump capacity x Pumping time

= 60 x 20

= 1,200 gallons

7.2.4 Given data, calculate solids loading to a primary clarifier.

Given:
Influent = 200 mg/L
Flow = 1.0 mgd

Formula:
Solids loading = Concentration(mg/L) x Flow(mgd) x 8.34

Solids loading = 200 x 1.0 x 8.34

= 1670 pounds per day

References and Resources

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