



Class I Wastewater

Presented by West Virginia Rural
Water Association

Class I Wastewater

- Be Advised that the Wastewater Certification Exam is Ever Changing. WV Rural Water Association is not always Kept up on these Changes, therefore the Class is not all Inclusive!



The Treatment Plant Operator

Chapter 1

Natural Wastewater treatment

- Water was first Purified by a Natural Cycle
- Sun
- Wind
- Time
- These three accomplished the purification of water



Modern Treatment

- Treatment Plants
- Now give nature a assist
- Most important thing at a treatment plant is the Operator



The operator keeps a plant working

Turns Valves

Pushes Switches

Collects Samples

Lubricates

Reads gages

Records Data

Maintains Equipment

Operator employed by

- City Sanitation District
- Public Agency
- Industries
- Private Contractors

Receiving Water

- Stream
- River
- Lake
- Ocean
- Surface Water
- Ground Water
- Where Water is Discharged



Wastewater Operator

- Water Quality

Protector



Main Objective of WWTP

- Protect the Public Health



Job Duties

- Be in Plant Planning
- Be Available during Construction
- Administrate
- Records
- Protect the Receiving Water

Job Duties

- Budget
- Management
- Future Planning
- Equipment Replacement
- Public Relations
- Safety



Why treat Wastes

Chapter 2

Pure Water

- Two Parts Hydrogen
- One Part Oxygen

Nothing Else

Wastes

- Organic Waste-Come from animal or plant sources. These Can be broken Down
- Inorganic Waste-Sand, Salt, Iron, Calcium.
Cannot be broken down biologically

Sludge and Scum

- Sludge will settle to the bottom of water or accumulate on the banks of receiving waters
- Scum will float on top of water
- Primary Treatment remove sludge and scum (Clarifiers)



Oxygen

- Aerobic Bacteria must have oxygen
- Anaerobic Bacteria does not need oxygen

Hydrogen Sulfide

- Rotten Egg Odor
- Corrosive
- Explosive
- Toxic



Diseases from Wastewater

- Typhoid
- Cholera
- Dysentery
- Polio
- Hepatitis



Pathogenic Organisms

- Bacteria, viruses, cysts, or protozoa that cause disease.
- Disinfection kills or inactivates most pathogenic organisms.
- Chlorine
- UV
- Ozone

Imhoff cone

- Measures the volume of
Suspended solids in
water

NPDES Permit

- National Pollutant discharge Elimination System
- Have the parameters your system must meet on them



Wastewater Treatment Facilities

Chapter 3

Major components of Wastewater Facilities

- Collection
- Treatment
- Disposal

Collection System

- Complex network of pipes and pumps
- Some areas are pumped some are gravity flow
- Influent is the raw or partially treated water entering a plant



Storm and combined Sewers

- Storm Sewer-pipe, conduit or channel that carries runoff from rain events
- Sanitary Sewer-Carries Wastewater
- Combined Sewers-Carries both Sanitary and storm water

Treatment Plants

- Water Flows through processes that remove wastes

Pretreatment

- Screening
- Shredding
- Grit Removal



Primary Treatment

- Solids settle out in this process
- Floatables are removed



Secondary Treatment

- Biological Treatment
- Organisms are used to Stabilize the Waste
- Convert organic matter to a form easily removed from wastewater

Disinfection

- Usually chlorine
- Prevents spread of disease
- Sulfur Dioxide used for dechlorination



Screenings

- Wood
- Roots
- Rags
- Debris
- Trash
- Usually removed by Bar screen

Screenings

- Disposal by burying or Burning
- Manual
- Automatic



Shredding

- Cutting up or shredding material
- Barminutor
- Comminutor

Grit

- Water must be 2 ft/sec to prevent grit from settling
- Grit should be removed early in the process
- Abrasive will damage pumps
- Cannot be broken down (Inorganic)

Grit Channel

- Allows Grit to Settle
- Flow Through velocity of 1 fps
- Grit removed manually or mechanically
- Usually buried
- Grit washers remove organics from grit

Flow Measuring Devices

- Parshall Flume (most Common)
- Weir
- Venturi Meter



Primary Treatment

- In Primary treatment velocity is reduced to 0.03 fps to allow Settleable solids to fall to the bottom
- Allows lighter material to float
- This is accomplished in a clarifier

Detention Time

- The time it takes to fill or pass water through a tank
- Primary Clarifiers 1.5 – 2 hours DT
- Secondary Clarifiers more than 2 hours usually
- The longer the Detention Time the better the treatment



Secondary Treatment

- Biological Treatment
- Trickling Filters
- Rotating Biological Contactors
- Activated Sludge



Secondary Clarifiers

- Comes after biological treatment
- Solids settle to the tank bottom and floatable are removed from off the top
- Clear effluent flows over a weir



Digestion

- Sludge from Clarifiers are pumped to a Digester
- Digesters are usually mixed continuously to:
- Bring food to organisms
- Keep a uniform Temp.
- To avoid formation of thick scum blankets

Digestion

- When sludge is not be mixed a clear liquid is formed on top called supernatant
- Supernatant is usually returned back to the head works



Racks, Screens, Comminutors and Grit Removal

Chapter 4

Safety

- The Wastewater industry has a higher accident rate than most other industries

safety

- Watch Footing
- Keep walk areas Clear
- Immediately clean up spills
- Lock out and tag out electrical equipment
- Wash hands often

Screening

- Removes large Debris
- Rocks
- Cans
- Bottles
- Rags



Grit Removal

- Removes Heavy organics
- Sand
- Rock
- Gravel
- Egg shells



Pre-aeration

- Freshens up wastewater
- Separate oil and grease

Racks

- Parallel bars placed at an angle for water to flow through
- Large solids and debris will be caught on the bars
- Bars are 3-4 inches apart
- Usually in bypass channels

Bar Screens

- The spacing of the bars are $3/8$ inch to 2 inches apart
- Usually Mechanically cleaned



Mechanically Cleaned Screen

- Reduce the problem of wastewater backing up
- These usually need to be greased and regular oil changes
- Always shut the unit off before removing something that is stuck

Shear Pin

- A strait pin that will fail or break when a certain load or stress is exceeded
- Protects equipment from damage due to excessive load or stress



Disposal

- Screenings are normally disposed of by:
- Burial (Landfill)
- Incineration



Comminutors

- Shred the Solids and leave them in the Wastewater
- The cuttable debris are shredded by teeth until they can pass through the openings
- They usually have a rotating drum for wastewater to pass through

Comminutors

- Cutting teeth are mounted in rows on the drum
- The teeth pass through cutter bars or combs
- Thus a sheering action is obtained
- Wastewater passes through the slots and flows out the bottom

Mercury Seals

- Mercury is toxic and Mercury Seals have been banned in the U.S.

Barminutor

- This unit consists of a bar screen with U shaped bars
- It has a rotating drum with teeth and shear bars
- The rotating drum travels up and down the bar screen
- Oil level is critical or water will get in oil

Grit

- Sand
- Egg Shells
- Cinders



Grit Channel

- Simplest way of removing grit
- Reduces velocity to 0.7-1.4 fps
- This lets grit settle while letting the lighter organic solids keep moving
- 1 fps is best velocity



Grit Washing

- The heavy coarse mixture of grit and organic matter is called DETRITUS
- Organic mater may be separated from the grit by washing the detritus
- The organic matter causes odors if left with the grit

Sedimentation and Flotation



Chapter 5

Sedimentation Units

- Settling Tank
- Sedimentation Tank
- Clarifier
- Primary Clarifier is the most common name



Two Types of Clarifiers

- Primary Clarifier
- Usually after Pre treatment
- Secondary Clarifier
- Usually after the secondary or biological treatment

Solids Removal

- Solids settle to the bottom
- Scraped to one end in a rectangular Clarifier
- Scraped to the center in a circular clarifier
- The Floatable Solids are skimmed off and incinerated, buried, or pumped to a digester

Weir

- The Effluent weir ensures even flow over the clarifier.
- Designed for small surface elevation water level adjustments



Circular Clarifier Parts

- Discuss page 115 in the manual



Daily Operation

- Inspection-stop, look, listen
- Cleanup-wash as needed
- Lubrication-to Manufactures specs
- Flights-Examine Bolts for looseness, wear, corrosion

Daily Operation

- Chain and Sprocket-Check for wear
- Recordkeeping-keep observations
- Sampling-Complete required testing
- Remove Sludge and Scum



Algae

- Washing with high pressure water hose
- Chlorine

Abnormal Conditions

- Toxic wastes
- Storm Flows
- Hydraulic Overloads
- Septicity



Trouble Shooting

- Pages 121-127



Sludge

- The particles that settle to the floor are called sludge
- As thick a sludge as possible should be pumped from the Clarifier
- 4-8 % is good
- Pull sludge out slow or you will pull to much water

Wastewater Stabilization Ponds

Chapter 9



Ponds

- Often used to treat wastewater instead of or in addition to conventional treatment processes
- Heavy solids settle to the bottom and are broken down
- Lighter solids is broken down by bacteria in suspension

Pond Parts

- Flow meter-Measures Flow
- Bar Screen-Removes coarse material
- Pond Inlets-distributes influent
- Depth and outlet Control-Regulates water level, outflow, and allows pond to be drained

Pond Parts

- Outlet Baffle-Prevents scum from escaping
- Dike or Levee-Separates Ponds and holds in water
- Transfer Lines-Conveys Wastewater from one pond to another
- Recirculation Line>Returns pond Eff. Rich in algae and oxygen from second pond to first for seeding

Pond Parts

- Chlorination-Adds Chlorine for disinfection
- Chlorine Contact Basin-Provides contact time for Chlorine to work
- Effluent Line-Conveys treated wastewater to receiving water or point of reuse



Definitions

- Stabilized Waste-Waste treated to the point that if released it would not cause a odor or nuisance to the receiving water
- Algae-Microscopic Plants with chlorophyll that live floating or suspended in water.
- Attaches to structures and produces oxygen during sunlight

Advantages of Ponds

- No expensive equipment
- No highly trained personal
- Economical to construct
- Good Treatment
- Good for changing loads



Pond Classification

- Aerobic Ponds has DO Throughout
- Anaerobic Ponds are without DO
- Facultative Ponds have the upper portion aerobic and the lower portion anaerobic. These are the most common



Photosynthesis

- Organisms with the aid of chlorophyll convert carbon dioxide and inorganic substances to oxygen using sunlight. All green Plants do this

Starting a Pond

- Start up is one of the most critical periods in a ponds life
- Should have 1 foot of fresh water before sewage is introduced
- This prevents odors



Reducing Pond Odors

- Recirculation
- Chlorination
- Masking Agents

Weed Control

- Keep edges clear of weed growth or Mosquito will breed
- Herbicides are ok
- Wind can control duckweed



Levee Maintenance

- Erosion is caused by wave action
- Also Surface runoff
- Protection of the Levee slope can be the use of stone riprap, broken concrete rubble
- Good bank protection includes broken street material, curbs, gutters, and bricks.

Batch Operation

- This means the pond does not discharge all the time and the operator has some choice as to when they discharge.



Trouble Shooting

- Pages 310-311



Sampling

- PH and DO should be tested several times per week in a pond
- Vary the time of day
- Keep records
- Grab Sample is a sample that is a sample collected at a time and place that tell the condition right then and there



Composite Sample

- Collection of individual samples taken at regular intervals and combined. The resulting mixture forms a representative sample



Disinfection Processes

Chapter 10

Pathogenic Organisms

- Disease causing Organisms
- Bacteria
- Viruses
- Parasites
- These can all Cause diseases

Purpose of Disinfection

- Destroy Pathogenic Organisms
- Prevent the Spread of Disease
- Wastewater processes remove some but not all Pathogenic Organisms

Methods of Disinfection

- Chlorine
- Ozone
- UV
- Chlorine is the most widely used



Chlorine

- Easy to Get
- Inexpensive
- Very effective even at low doses



Breakpoint Chlorination

- Adding Chlorine until the demand has been satisfied



Chlorine Demand

- The amount of chlorine required to satisfy the Chlorine demanding substances in the water
- Chlorine Dose – Chlorine Residual = Chlorine Demand

Chlorine Residual

- This is a trace amount of chlorine that must be left in the water after the chlorine demand has been satisfied
- Usually 0.5 mg/l but much lower in WV



MPN and Coliform

- Is the Most Probable Number of Coliform group bacteria per volume of water, usually 100 ml.
- Coliform is a bacteria found in all warm blooded animals including people. They are a indicator that water is polluted and contains pathogens

Disinfection

- Objective is the destruction or inactivation of pathogenic organisms

Mixing

- Good mixing is essential for effective disinfection and good sampling results



Safety

- Everyone must be involved and on board with the safety program
- Employee
- Employer
- Officials
- Budgets must be there to purchase the needed safety equipment



Chlorine Safety

- Chlorine is a gas
- The type of container is important for Chlorine
- Dry Chlorine can be in steel
- With moisture it must be in Silver, Glass, Teflon and certain plastics
- What does Chlorine being 2.5 time Heavier than air tell you?

Answer

- It will Settle to the bottom of the room instead of rise or mix in

Safety

- Look at Table on page 376



Treating Chlorine Exposure Mild Case

- Leave the Contaminated Area
- Move Slow
- Breath Lightly
- No Exertion
- Stay Calm
- Keep Warm
- Try not to cough



Extreme Case

- Use SCBA
- Remove Patient
- Remove Clothes they are still hurting the Person
- Keep patient warm, cover up
- Oxygen may be needed

Fusible Plug

- Safety Device
- Melts between 158-165 Degrees F
- This device prevents explosion if the surrounding temp. is too hot

Safety

- On Chlorine Cylinder Valves, do not use Wrenches longer than six inches
- Always take care of chlorine leaks right a way



Dechlorination

- The removal of chlorine from the Effluent before it is discharged into the receiving water
- Sulfur dioxide
- Sodium Sulfite
- Sodium Metabisulfite

Safety

- Sulfur Dioxide has much the same safety hazards and solutions as Chlorine
- It has a pungent odor
- Use ammonia to detect a leak just like chlorine



Sludge Digestion and Solids Handling

Chapter 12



Needs for Digestion

- Raw Sludge from Secondary Treatment is pumped to a digester
- Digesters are aerobic or anaerobic
- Sludge is decomposed to a simpler less harmful form



Anaerobic Digestion

- Makes sludge capable of being disposed of without causing a nuisance
- In this process methane gas is produced by the action of two different groups of bacteria
- Saprophytic Organisms or acid formers and methane Fermenters

Methane Fermenters

- Must have a PH of 6.6-7.6
- Not as many of them as the acid formers
- There must be conditions maintained for them to form to have good digester operation
- Good digester operation reduces volatile solids by 50-60 Percent

Anaerobic Digestion

- The Acid and Methane formation should be about equal
- Most common symptom of imbalance is to many acid formers
- Mixing is the most important factor in a digester

Temperature Zones

- Psychrophilic (Cold Temp.) Below 50° F
- Mesophilic (Medium Temp.) 68-113° F
- Thermophilic (Hot Temp.) Above 113° F
- Thermophilic best from 120-135 degrees



Supernatant

- When sludge settles to the bottom, this is the clear liquid that is left on top of the sludge
- It is usually returned back through the plant for treatment
- It cannot be released with the effluent



Digester Gas

- 65-70 Percent Methane
- 30-35 Percent Carbon Dioxide



Gas Dome

- Gas from the digester is removed from the dome
- Fixed cover tanks have a water seal to protect from excessive positive pressure or vacuum for negative pressure
- Without the water seal the pressure could become great enough to collapse the tank

Pressure and Vacuum Relief Valves

- The Pressure Relief Valve will operate when:
- The Waste Gas Burner cannot handle excess pressure
- This prevents the Water Seal from Breaking
- Vacuum Relief will operate if:
- Sludge is withdrawn too fast
- The tank could collapse without it

Flame Arrester

- Cools a flame below the ignition point if it develops in the gas line
- Service every three months



Manometers

- Indicate gas pressure
- Pressure Regulators control gas pressure in boilers
- Waste Gas Burners burn the excess digester gas



Sampling Well

- Sampling Well or Thief Hole allows for sampling of the Digester without a pressure loss
- Do not breathe the gas that is always in the sampling well

Digester Mixing

- Mechanical Mixing
- Gas Mixing
- Gas Mixing is used most often



Floating Covers

- Provide a flexible space for gas storage
- Properly Operating Floating Cover can control the Scum Blanket
- Explosive gas mixtures are less likely in a digester with a floating cover

Floating Cover Parts

- Corbels-Stick out from the wall and allow the cover to drop no deeper
- Roller Guides-are attached to the outer edge of the floating cover and keep the cover from scraping the wall of the digester
- Annular Space-is the space full of digesting sludge between the cover and the side wall

Anaerobic Digester Operation

- Excess Acid will upset the digester
- Likes to be warm
- Discharges liquid
- Uses food for Cell Production and Energy

Sludge

- Pump as thick of a sludge as possible
- Hold in the Clarifier to thicken
- Do not hold the sludge long enough for it to start gassing



Buffer Capacity and Coning

- The capacity of a solution to neutralize acids or bases
- Coning is the development of a cone shaped flow of liquid like a whirlpool
- Also called Coring



Sour Digester

- Neutralize with a Caustic substance
- Lime
- Anhydrous ammonia
- Soda ash
- Increase the PH to 7.0



Volatile Acids Alkalinity Relationship

- Key to successful digester operation
- Volatile Acids need to be low
- Alkalinity needs to be high
- Good digestion will occur
- Measure twice a week



Maintenance

Chapter 15

Records

- Keep Records of all Maintenance
- Keep records of Preventative Maintenance
- This can be done with a Equipment Service Card



Lets Build a Pump

- Go over this section in the Book



Pumps

Go over the different Pumps

