

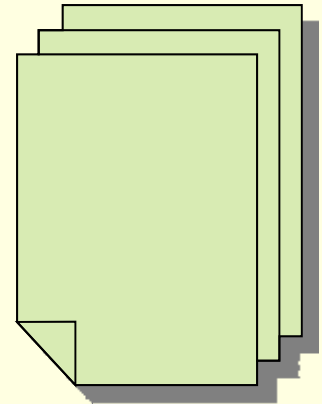
Tools for Activated Sludge Data Collection and Process Control



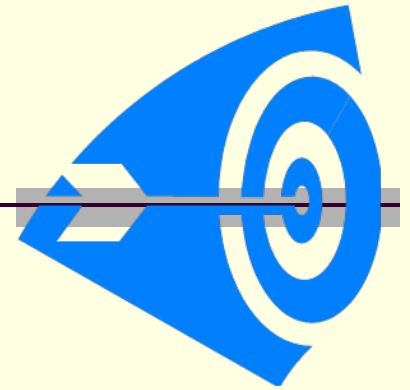
**New Mexico Rural Water Association
2011**

Data Collection

- Observations
- Measurements
- Sample collection and analysis
- Documentation



Physical Observations



- Color
- Odor
- Texture
- Foam/scum
- Sound (blowers, pumps)
- Aeration patterns/turbulence

Describe **fully** each process unit daily & document

Data Collection Locations

Plant Influent

- Flow
- pH
- Temperature
- BOD
- TSS
- TKN or ammonia



Aeration Tank Contents

- DO
- pH
- Temperature
- MLSS/ MLVSS (What's this?)
- Settleability_{30 min}
- Alkalinity
- Microscopic examination
- SOUR or Respiration Rate
- ORP or Oxidation Reduction Potential



Secondary Clarifier

- Sludge blanket depth
- RAS/WAS – MLSS
- Effluent
 - pH
 - TSS
 - Ammonia
 - Nitrate



Solids Concentrations

- Influent and effluent
 - TSS (Total Suspended Solids)
- Aeration tank, aerobic digester, RAS/WAS
 - MLSS (Mixed Liquor Suspended Solids)

Same lab procedure for both

Suspended Solids Sampling Points

Primary Locations

- Aeration Basin – discharge end
- RAS
- WAS

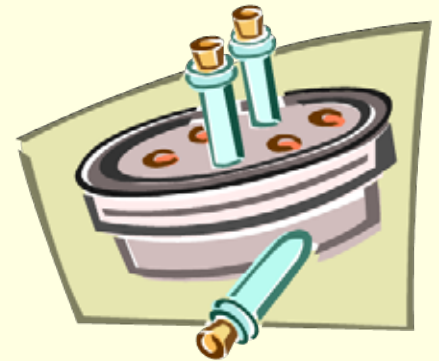
Other Locations

- Clarifier
- Recycle flows (digester decant, drying beds and belt press filtrate, etc.)

MLSS for Process Control ONLY

Centrifuge Method

- Developed in the 1930s
- Takes ~ 20 – 30 minutes
- Easy
- Relatively low cost
- Close enough for process control



A way to estimate MLSS without a lab

Centrifuge Procedure

Suspended Solids by Centrifuge

Equipment - Centrifuge, steep-walled tubes graduated in %, tubes horizontal at full speed

Procedure

1. Fill with well-mixed sample. "Flick" excess out.
2. Place tube in head across from another filled tube.
3. Close lid.
4. Run for 15 minutes at maximum speed.
5. Allow head to stop.
6. Open lid and take tube from head.
7. Read the volume of the solids to the nearest 0.1%.
8. If the graduations are in mL instead of %, divide mL of solids by the volume of the tube and multiply by 100 to get %.

TSS Meter Method

- Fairly new
- Takes under a minute
- Super easy
- Costly (but not as much as the lab equipment)
 - Needs lab procedure to calibrate instrument
- Close enough for process control

Quick, easy way to estimate MLSS

Flow Rates

- Must know how much material flows through various portions of the plant
- At small plants, weir boxes with V-notch weirs can be installed to measure flows
- RAS and WAS flow readings can be instantaneous
- If using flow meters, make sure they are properly calibrated

Flow Rates to Measure

- Influent or effluent (for plant Q)
 - RAS flows
 - WAS flows
 - Recycle flows
-
- Aeration basin Volumes are also needed



Reported in MGD for flows or MG for volumes

Dissolved Oxygen

DO should be determined daily in

- Aeration basins
- Anoxic or anaerobic/fermentation basins

Periodically check DO in locations across the basins and at different depths

- Will show areas of
 - Improper mixing
 - Plugged diffusers
 - Broken diffusers



30 Minute Settleability Test

Allows operator to find out how effectively solids will settle in the final clarifier or settling cycle

- Plotting the settleability on a graph tells you
 - Turbidity
 - Settling rate
 - Volume of settled sludge (SSV)
- Color and texture of sludge floc can also be observed

- Collect sample at discharge end of aeration basin or at end of aeration cycle just prior to settling cycle
- Use a good, clear, clean settlometer with a well mixed sample
- Record & plot % settled solids every 5 minutes for 30 minutes and again after 60 minutes
- Daily testing & documentation allows you to track trends

- The 30 min. settleability test in conjunction with the MLSS concentration allows you to determine the SVI

Variation

- Multiple Dilution Test
 - Dilute MLSS sample with unchlorinated secondary effluent
 - Helps distinguish between too much sludge and sludge that is bulking

Showing Denitrification Occuring



After settling for an hour
or more

pH and Alkalinity

pH

- Organisms like a pH of 7.0-7.5
- ***Bacteria DO NOT like change!***
- Routine pH testing will show any changes in pH
- pH must be tested within 15 minutes of sample collection
- pH meter must be calibrated daily when in use

pH Sampling Points

Routine pH testing

- Plant influent
- Aeration basin at discharge end
- Clarifier effluent
- Aerobic digester
 - Low pH values here can stress the process

Alkalinity

- Most wastewater alkalinity is bicarbonate
- As pH increases, alkalinity increases
- Alkalinity changes show-up BEFORE pH changes
- Alkalinity testing can be used to anticipate pH changes
 - Allows for tighter operational control
- Alkalinity is critical to nitrification
 - Requires 250 ppm alkalinity to start
 - Uses alkalinity during the process

Alkalinity Sampling Points

- Plant influent
- Aeration basin discharge end
- Plant effluent
- Alkalinity test strips are a quick, easy way to check



Total Alkalinity Procedure

- 1. Place 100 ml clarifier effluent in a 250 ml beaker
- 2. Place the electrodes of the calibrated pH meter into the beaker containing the sample
- 3. Titrate to a pH of 4.5 with 0.02 *N* sulfuric acid
- 4. Calculate total alkalinity as CaCO₃:

$$\text{TA, mg/L} = \frac{\text{mL of 0.02 } N \text{ H}_2\text{SO}_4 \times (0.02N)(50,000)}{100 \text{ mL}}$$

- Use this procedure only for water, not for sludge

Clarifier Data Collection

Sludge Blanket Depth

- Measure to ensure that solids are not accumulating too much
- Or that RAS rate is not so high that there is no blanket
- Typically should be $\sim 1/4$ the depth of the tank
- Core samplers are most common method
 - Can also be used to get clarifier solids concentration

- Procedure
- Blanket thickness, depth of blanket (DOB)
 - Clarifier Solids Concentration (CSC)

1. Identify sample site. The sample location on each clarifier must be clearly identified with tape, paint or other means. This is to ensure that each operator obtains samples from the same point in the tank. The sample is taken at the average depth of the clarifier which is:

Circular tank - $\frac{1}{3}$ radius in from the tank wall.

Rectangular tank - $\frac{1}{2}$ the tank length from the influent.

On a circular tank, make sure that the scrapers are 90-degrees from the cat-walk from which the sample is being taken. Samples taken just ahead of the scraper will show a thicker blanket with a thinner blanket behind the scraper.

2. At approximately the same time daily, slowly lower the core sampler to the bottom of the tank. The ball valve will open and the water/sludge will enter the sampler as it is lowered.
3. With a slight tug, lift the core sampler straight up. This closes the ball valve. Do not jerk or bounce the water core as this can result in loss of sample or mixing of the sludge.
4. Measure the thickness of the sludge blanket to an accuracy of tenths of a foot. Observe the DOB at the same time.
5. Pour the sampler contents into a sample container and spin in a centrifuge to obtain the average clarifier solids concentration (CSC) for the entire clarifier.
6. Store the sampler out of direct sunlight. A thorough washing inside and out with clean water will also help keep the plastic clear and easily read.

Microscopic Examination

Visual understanding of physical condition of sludge

- Floc size and structure
 - To estimate settling conditions
- Dispersed growth (in water between flocs)
 - to estimate effluent quality
- Protozoa and metazoa
 - To estimate overall microlife
- Filamentous organisms
 - To estimate settling and reasons for certain conditions to exist

Need good quality microscope

- For small plants
- Evaluation is usually limited to
 - Protozoa and metazoa counting
 - Filament abundance
 - Floc evaluation



General Evaluation

Note general shape and size of flocs

- Small, medium or large
- Round or irregular
- Do they look weak or strong?



Look at water between flocs

- Free bacterial cells and non biological particles not attached to floc will increase turbidity



Estimate Numbers of Protozoa & Metazoa in the following groups:

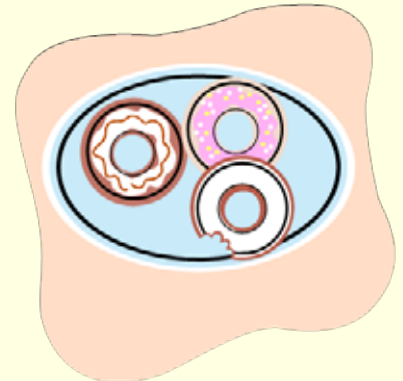
Amoeba

■ Unshelled

- usually associated with high organic loads & under-oxidized sludge

■ Shelled

- Usually seen with well-nitrified conditions and older sludge



Flagellates

- Only slightly larger than bacterial cells
- Move very fast
- Have “tails”
- Extremely hard to observe/count
- Large numbers usually indicate poor quality effluent (but not always)

Free-swimming Ciliates

- Bulk liquid free-swimmers in **large** numbers
 - Indicate overall poor effluent quality



- More crawlers found
 - Indicate better flocculation and effluent quality
- Carnivores
 - Found with older sludge



Stalked Ciliates

- Observed with well-flocculated conditions
- Better effluent quality

Except

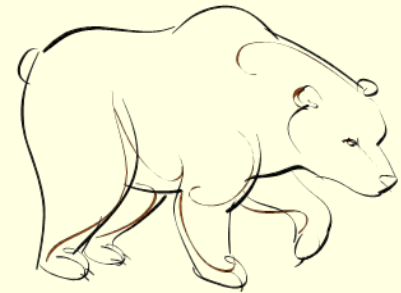
- *Vorticella*, *microstoma* and *Opercularia*
- Often associated with poor effluent quality

Rotifers

- Metazoa
- Usually found in older sludges

Other Metazoa such as

- Nematodes
- Water bears
- Aeolosoma worms
- Found in older sludges with low ammonia
- Often in extended aeration systems



Filaments

- Determine abundance
 - Few- fast settling sludge with turbid quality
 - Some to many-clarify the WW & settle fast enough to be controlled
 - Excessive-ID species for probable cause
- Location
 - In floc?
 - Bridging between flocs?
 - Growing free between flocs?



SOUR or Respiration Rate

- Indicates the health and activity of the microorganisms



- Is calculated using the OUR test results along with the MLSS or MLVSS results

- OUR Test only takes 10 minutes



Some Ways to Use SOUR Results

- Verify proper F:M ratio
- Determine if aeration TIME is sufficient
- Determine biodegradability of specific wastes
- Check activated sludge for nitrification ability
- Use to discover toxicity in plant influent

SOUR Procedure

1. Collect activated sludge sample
2. Aerate sample
3. Fill a 300 ml BOD bottle with sample
4. Insert BOD type stirring DO probe
5. Read and record sample Dos every minute for 10 minutes
6. Graph the results
7. Calculate the OUR
8. Calculate the SOUR

ORP

Oxidation (LEO)

- Losing Electrons - Oxidation

- LEO goes GER

Reduction (GER)

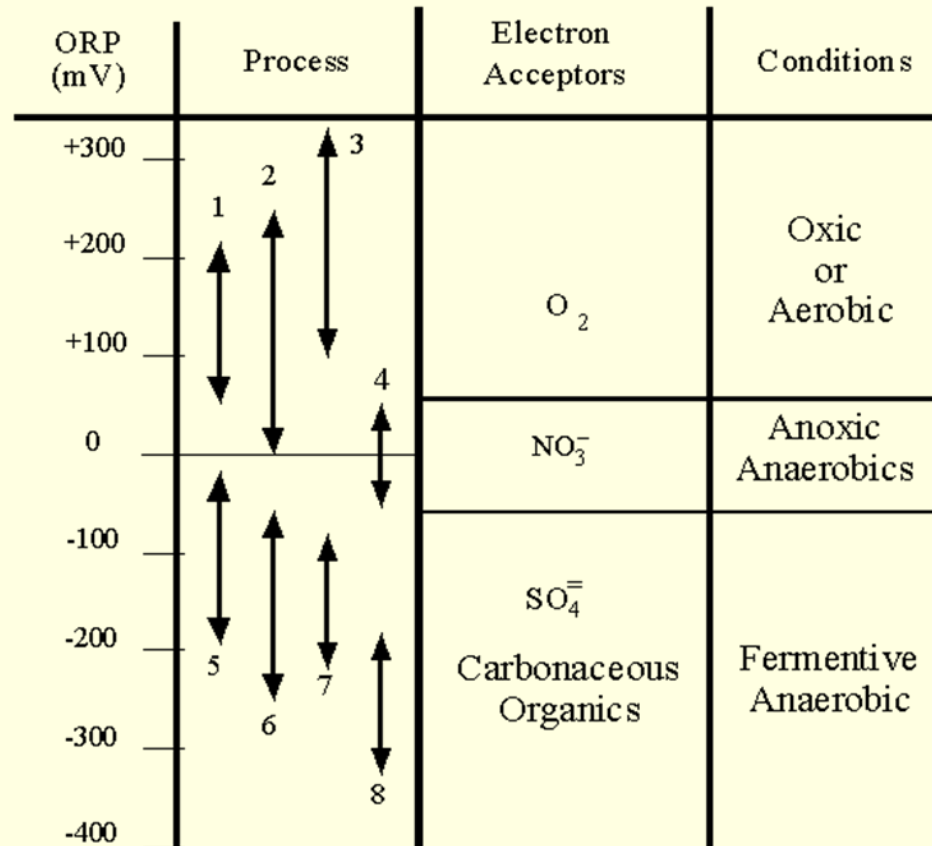
- Gaining Electrons - Reduction



ORP Oxidation Reduction *Potential*

- Indicates the *potential* for work to get done
- Is measured in mV
- Equipment needed is a pH meter that measures mV and an ORP probe w/ ATC
- Charts are available to estimate ranges in which **oxidation** or **reduction** reactions may take place
- Can also be used to control the activated sludge process by telling blowers when to turn on and off

ORP Chart



- 1- Organic Carbon Oxidation
- 2- Polyphosphate Development
- 3- Nitrification
- 4- Denitrification
- 5- Polyphosphate Breakdown
- 6- Sulfide Formation
- 7- Acid Formation
- 8- Methane Formation

Questions????????????????????????????????
