

Activated Sludge Process Control Overview



or

How to Host a **Four-Star** Party

New Mexico Rural Water Association
2011



Party Time!



Scenario

Operator is having some friends over to help him build a barn

- Wants them to do some work for him
- He wants to keep them happy so they'll do this work for him



■ Most of his friends are regular guys and can do the general construction that's required

■ BUT, he only has **one** friend who can do electrical work

■ This friend is Jewish

■ An Orthodox Jew

■ Who has emphysema



■ Also, his **only** friend who can do plumbing

■ Is a vegetarian

■ And has a heart problem that he takes medicine for that makes him constantly *cold*



His Party Plan



For the “regular” guys:

- Coffee and donuts for breakfast
- Burritos and beer for lunch
- Green chile chicken stew and beer for dinner
- He also invites a few single female friends – to keep it interesting
- He picks a beautiful spring day – no wind, warm, sunny





For his Jewish friend:

- Kosher bagels for breakfast
- Kosher hotdogs and pickles for lunch
- Kosher ...whatever...for dinner
- An extra standby oxygen tank
- A single Jewish female (he's sick, not dead) to keep it interesting



For his vegetarian friend:

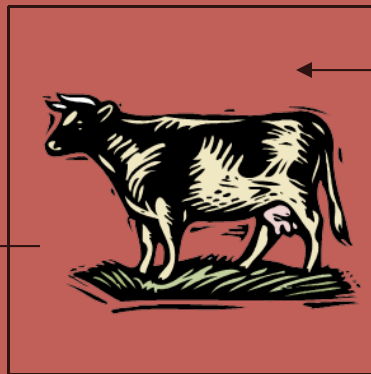
- Organic cereal and coffee for breakfast
- Salad for lunch with mineral water
- Cheese enchiladas with beer for dinner
- An electric heater in the work space
(extension cord from the house)
- A friend of a friend female vegetarian –
yes, to keep it interesting



So he invites fifteen(15) friends
He buys \$200 worth of food because
that's all the \$ he has to spend
Then each friend brings a friend!
And the neighbors across the way
hear the music and join them
What just happened to his party plan?



- Plus all the food is up at the house
- And there's a bull pen between the house and the site of the new barn
- With a bull in it



Pretend Bull

- Are his regular workers happy?
- How about hungry?



And the extra oxygen tank arrived late and the Jewish friend had already ran out of his supplemental air

And the extension cord for the heater wouldn't reach the barn where the vegetarian was working

- Are they comfortable and happy? Do you think they will feel like hanging around and doing the electrical and plumbing work?



- How's his party going? Do you think work on the barn is progressing well?
- Will his friends stay long enough to get the barn done?
- What should he do to rescue his party and get the barn project back on track?



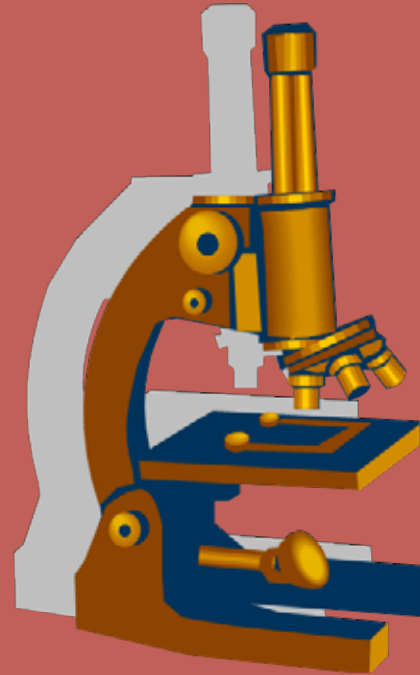
The Activated Sludge Process

- Millions of microorganisms
 - Biologically stabilize dissolved and particulate organic matter (Influent WW)
 - Convert organic matter into **cell mass –floc** (bacteria)
 - How do they do this?
- **Cell mass** separated from liquid by settling
- A portion of the **floc** (solids, MLSS, bacteria)
 - Is returned to stabilize incoming wastewater (RAS)
 - Some is removed or wasted to maintain the whole system in balance (WAS)



Microorganisms

- Single-celled bacteria
- Larger multi-celled life forms such as
 - Protozoa
 - Metazoa



Activated Sludge Is

- The **biological** portion of the treatment process
- Secondary treatment
- A suspended growth system (dispersed floc)
- **Organisms** break down the organic compounds while using them for **food**



Terms

MLSS

Mixed Liquor Suspended Solids

 Suspended solids in the aeration basin that is expressed in mg/L

 Or converted to pounds

 Used to quantify the amount of **microorganisms** in the aeration basin



DO

Dissolved oxygen

-  Atmospheric oxygen – O₂ gas
-  Necessary for aerobic processes
-  Must be absent for anaerobic processes



F:M Ratio

Food to Microorganism Ratio

-  Pounds of BOD into the aeration basin
-  Divided by the pounds of MLSS (bugs) in the basin
-  Bugs = microorganisms



MCRT

■ Mean Cell Residence Time

- Total pounds of MLSS under aeration
- Divided by pounds of TSS wasted

■ How long the “bugs” stay in the system (aeration basin + clarifier)

■ Similar to Sludge Age or SRT (Solids Retention Time)



SVI

Sludge Volume Index

-  Milliliters of sludge from the 30-min settleability test X 1000
-  Divided by the MLSS, mg/L

 Can indicate settling rates and problems



Conditions for BEST Bacterial Growth in Aeration Basins

- Temperature - ~60 F
- pH – 6.8 to 7.4
- DO – 1-2 mg/L
- Good mixing
- Proper nutrient balance (100:5:1)
 - Carbon to Nitrogen to Phosphorus
- No organic or toxic shock loadings



Nitrogen Removal

Nitrification

■ Biological conversion of ammonia to nitrate by special bacteria (nitrifiers)

■ Conditions:

- Dissolved oxygen - 2.0 mg/L
- Long detention time
- Alkalinity of 250 ppm
- At pH of 7.5-8.5
- Temperature optimum 86-95 F



Denitrification

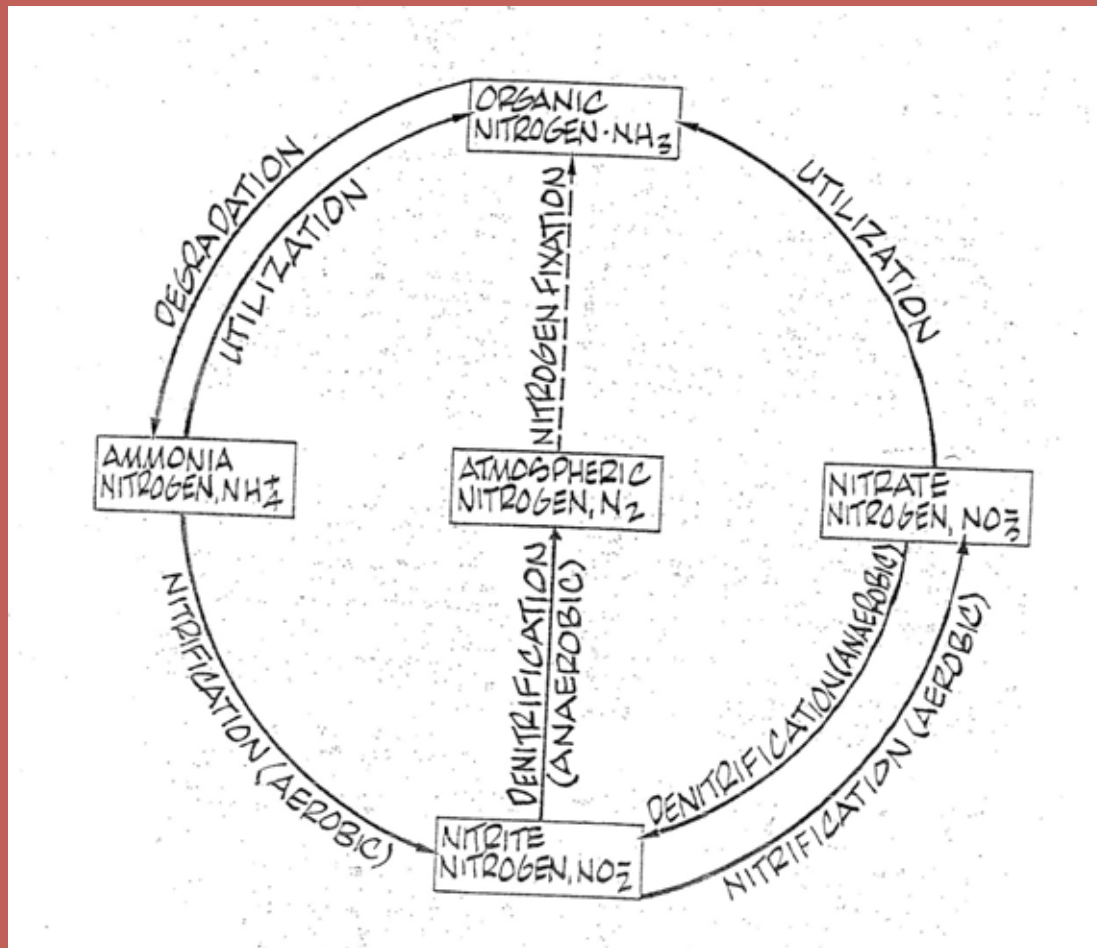
■ Biological conversion of nitrate to nitrogen gas by special bacteria

■ Conditions:

- Anaerobic or anoxic conditions
- Carbon (food) source
- DO – ≤ 0.2 mg/l
- Presence of nitrates
- pH 7.0-8.5
- Occurs at temperatures 41-86 F



Nitrogen Cycle



Main Operational Functions Operators Can Control

Aeration

- Provides bugs with oxygen
- Provides mixing
- *Most important part of the process!*

Mixing

- Brings food (influent) into contact with bugs
- Prevents dead zones



Why Activated Sludge Process Requires Operational Control

- Process depends on living organisms
- They are the ‘Workers’ who will clean up the wastewater
- Operator’s job is to keep the bugs healthy and happy



Return Activated Sludge (RAS)

- Brings settled bugs back into contact with food coming into the plant
- Helps maintain proper concentration of MLSS in aeration basin

Waste Activated Sludge (WAS)

- Rids the system of extra sludge generated by the reproduction of bugs
- Helps maintain constant biological level in the system



Questions or Comments



Moving on.....

