Making Your Plant Denitrify

Control the Process and Reap the Benefits

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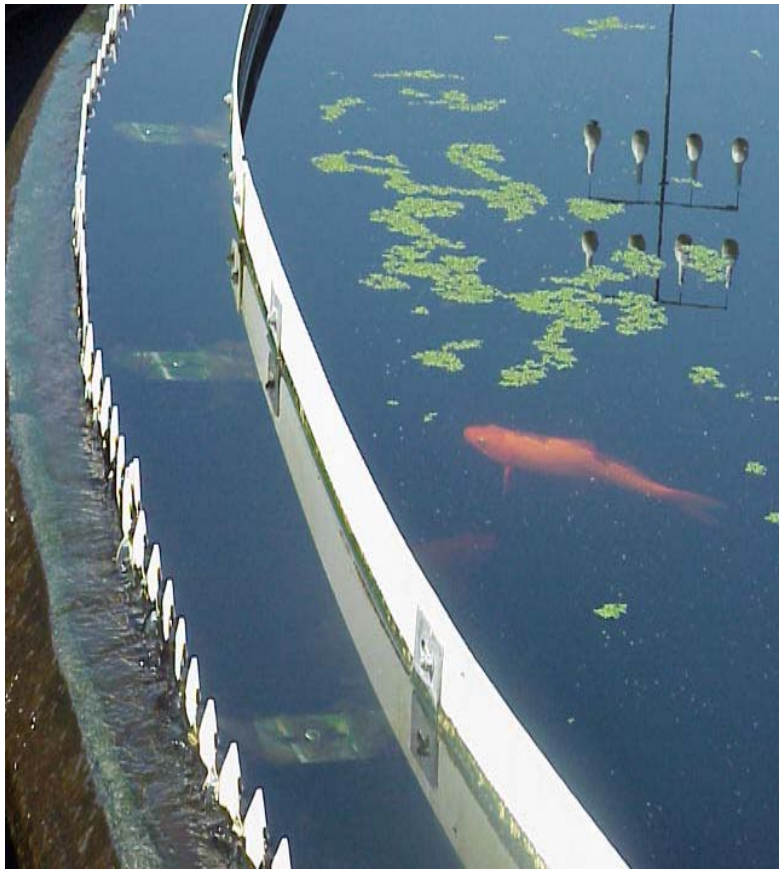
Why Denitrify?

- Required
  - New NPDES Permit Limits
    - Total Nitrogen
    - Nitrate
- Desired
  - Activated Sludge Improvements
  - Reduced Electrical Usage

Denitrification Benefits

- Meet the Permit
- Recycle Oxygen
- Recover Alkalinity/pH
- Improve Effluent
- Select against Filaments
- Improved Solids Proc.
- Save Dollars



Total Nitrogen Limits

- Total Nitrogen

  $TN = TKN + NO_2 + NO_3$

  TKN = Organic Nitrogen + Ammonia

  Nitrification: Ammonia to Nitrate

  NO_2: generally low

  Organic Nitrogen ~ TSS

- Nitrate, NO_3 parameter of concern

Tennessee Limits

- Ammonia Limits based on Stream:
  - Dissolved Oxygen
  - Toxicity to organisms
- Total Nitrogen
  - Limited if expanding on an impaired stream
  - Monitoring if simple renewal

Kentucky Limits

- Ammonia Limits based on Stream:
  - Dissolved Oxygen
  - Toxicity to organisms
- Total Nitrogen
  - Not limited at this time for municipal dischargers

Removing Nitrate Through Biological Denitrification

- Create the needed environment
  - Nitrate must be present
  - Anoxic, Dissolved Oxygen < 0.3 mg/L
  - BOD or food must be available
  - BOD organisms must be present

Speed of Denitrification

Fast

- DO = 0.0 mg/L
- Soluble BOD available

Slow

- DO > 0.3 mg/L
- Little Food
  - Endogenous Respiration
    - Extended Aeration
    - Digester

Making Your Plant Denitrify

- Locate the basin which best meets the denitrification requirements.
  - Primary clarifier, depends of piping
  - Aeration basin, perhaps
  - Final clarifier, no way!
  - Other basins, what do you have?

Aerator is Common Choice

- Turn the air “OFF”,
- Denitrify
- Turn the air back “ON”

#1 Activated Sludge Myth

- Aeration basin Dissolved Oxygen must be maintained at a set levels continuously. Dan Miklos, Advanced Treatment Science, Columbus, Ohio

- Biological treatment is more flexible than this!
  - Treatment and odor prevention will continue as long as there is O_2 or NO_3

Oxygen Usage Hierarchy

Free Dissolved Oxygen	Aerobic or Oxic Treatment
Little or No free Oxygen, but NO_3 present	Anoxic Treatment
Sulfate, SO_4 is the next choice of the Bugs	Anaerobic conditions are beginning. ODORS fm. H_2S

“Off – On” Aeration

Wastewater Treatment Plant Examples

Prison Wastewater Treatment

Operational Problems

- Low pH
- Bloodworms

- 1 Caustic feed added
- 2 OFF/ON
  - 3hr ON/ 3hr Off
  - Recycled alkalinity
  - pH maintained
  - Caustic eliminated
  - Bloodworms gone

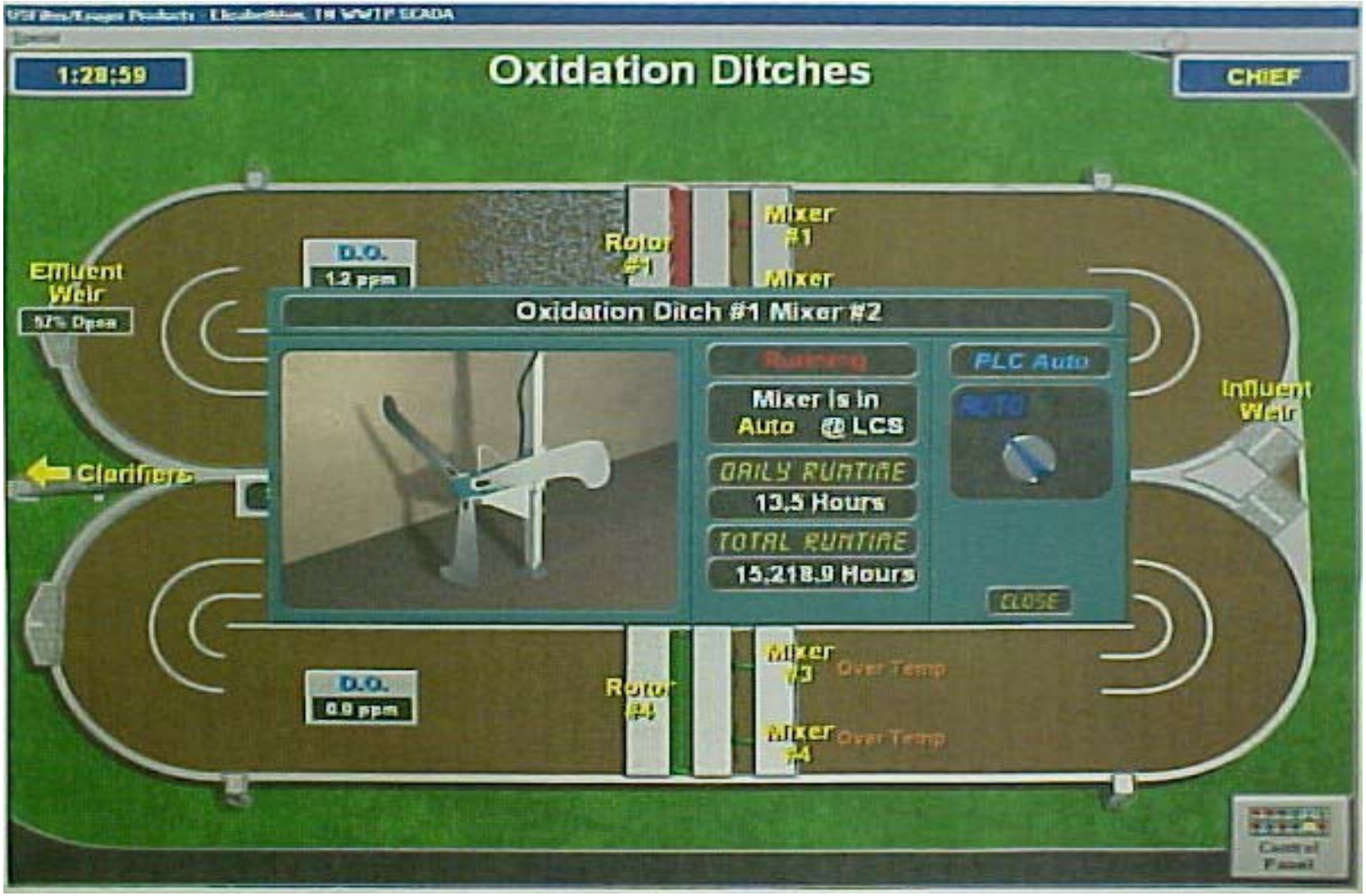
Prison Wastewater Treatment

- Current Data, EFF.
  - BOD ~1-2 mg/L
  - TSS ~1-2 mg/L
  - NH_4 ~0.3 mg/L
  - NO_3, 1-4 mg/l
  - pH ~7.0
- Aerator
  - pH 6.2-6.8
  - Alkalinity ~80 mgL

Small Oxidation Ditch

- 30 min. Settlometer =1000
- Microscopic evaluation = filaments
- History of low eff. pH
- Eff Alkalinity ~ 0.0mg/L
- Off/ On
  - 5hr ON/ 3hr off
- Best effluent ever and 30% electricity savings

Large Oxidation Ditch



Large Oxidation Ditch

- Kruger system
- Computer controlled Dissolved Oxygen

  Range

  0.2 to 1.5 mg/L

- $N0_3$ < 1.0 mg/L
- TSS ~ 1.0 mg/L
- BOD < 5.0 mg/L

Extreme Cycles

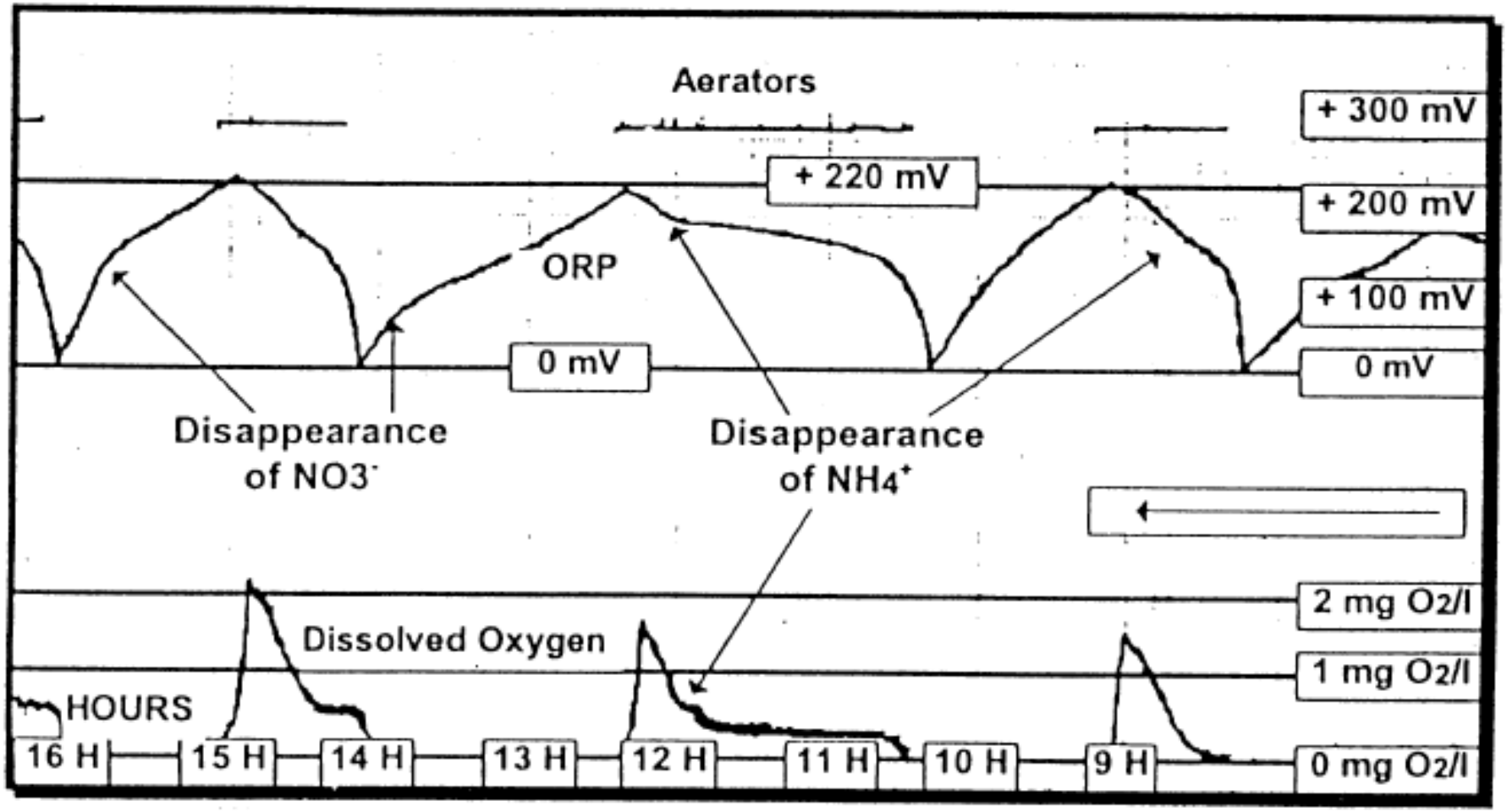
- Complete Mix /Plug Flow AS
- Basic Cycle
  - Off 2-6 pm
  - Off 12-6 am
- BOD ~ 3.0
- TSS ~ 1.0
- NH_4 <0.2
- NO_3 ~5.0

Determine “Off” Time

- ORP, Oxidation Reduction Potential
  - Common cycle
    - Aerate to + 200 mV
    - Air “off” to – 50 mV
  - Theoretical beginning of Sulfate reduction
    - -50 mV, Goronszy
    - -100 to –200mV Optimum range for H_2S creation
    - Odors will depend on concentration of H_2S & pH
  - Measure in the settled Biomass

ORP & DO Graph

Charpentier, et.al. Water Science & Tech. 1998



Determine “Off” Time

- Oxygen Uptake Rate, OUR
  - $\frac{O_2 \text{ mg/L} + (2.86 * NO_3 \text{ mg/L})}{\text{OUR mg/L/ Hr}}$ = Hours “Off”
- Monitor
  - pH, Alkalinity , Nitrate
  - Enzyme Fluorescence, more direct measure of biological metabolism.
- Trial and Error

Items of Concern

- Aeration Capacity to raise DO after "Off" cycle.
- Diffuser Type
- Mixing
- Switch Control
  - Manual, Timers, Computer
- Different Flows & Loads

If you nitrify, Why not denitrify?

- Benefits
  - Meet permit limits
  - Save money
  - Recycle oxygen and alkalinity
  - Select against filaments
  - Be a better operator!

Questions ?

Comments!

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