Probiotic® SOLUTIONS™

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Biological Waste Water Treatment

- Purify Wastewater for Reuse or Discharge
- Reduce BOD/COD
- Reduce Nitrogen
- Reduce Phosphorus

Nitrogen Removal Requirements Direction?

Nitrogen Removal

- Removal Requirements are Changing.
- Limits for Ammonia, Nitrate and Total N
- Nitrification and Denitrification
  - Key Processes for Nitrogen Removal

Nitrification

Nitrification is the first step to reducing Total N in a Wastewater Treatment Facility

- Reduce Ammonia to Nitrate - does not remove Nitrogen
- Requires High levels of Oxygen and BOD
- Oxygen serves as electron acceptor.
- The process is accomplished by microorganisms known as nitrifiers ….. Nitrosomonas, Nitrospira, Nitrospina gracilis, Nitrobacter

Denitrification

Denitrification is the second step to reducing Total N in Wastewater Treatment.

$$NO_3^- \rightarrow NO_3^- \rightarrow NO_g \rightarrow N_2O_g \rightarrow N_{2g}$$

- Requires BOD and typically zero DO
- The process is accomplished by microorganisms known as denitrifiers .....Achromobacter, Aerobacter, Bacillus, Brevibacterium, Flavobacterium, Lactobacillus, Micrococcu, Proteus, Spirillum, Pseudomonas...
- Heterotrophic- can use DO or NOx
- Carbon source is BOD, Volatile Fatty Acids (VFAs) simplest BOD carbon source

Denitrification con'd

- Denite requires about 3g BOD: 1g N
- Carbon is the electron donor and nitrated-N is electron acceptor
- Alkalinity is produced at ratio of 3.57 alk:1 nitrate-N reduced
- Half of alkalinity consumed during Nitrification can be recovered during Denitrification
- Temperature also impacts Denitrification, @ 10C reduces to to 75% of maximum
- Denitrification requires good mixing

Typical Options for Nitrification/Denitrification

Typical Nitrification/Denitrification

- Create separate aerobic zone(s) and anoxic zone(s).
  - One large reactor with fixed aeration (retrofit)
  - Use separate reactors for each process
  - Operations: Set up automated or manual ON-OFF operations with existing system

Nitrification/Denitrification

Operations

- Maintain mixing and regulate by Oxidation-Reduction Potential (ORP)
- As Nitrate is depleted ORP drops, ORP drops slowly at first then substantially the more nitrates are reduced
- Nitrate reduction occurs: ORP range of +50 to -50 mV
- ORP below -50 mV indicates that nitrate is depleted and that anaerobic conditions exist.
- May be time consuming for manual operation

Typical Options for Nitrification/Denitrification

Considerations

- High DO concentration required for complete Nitrification.
- Nitrification is dependent on the Oxygen Uptake Rate (OUR) of mixed liquor
- Quasi anoxic zones develop as distance from DO injection increases
    - In these low DO locations, the heterotrophic bacteria begin the nitrogen removal process

Typical Activated Sludge Process

Considerations:

- Ditch Configuration: MLSS enters anoxic zone first
  - This can consume raw organics up front and Denitrification rate will be higher than if only carbon source occur by endogenous respiration.
  - Denitrification rate occurring by endogenous respiration is a much slower

Is it possible to Accomplish both Processes at the same time?

- How could this process occur at the same time?
- Would you want it to happen?
- Where would it happen?

Simultaneous Nitrification/Denitrification

Simultaneous nitrification/denitrification (SND)

- Oxygen gradient within the biological floc
  - Low DO concentrations, that anoxic conditions are occurring within biological flocs due to the limitations in DO penetration of floc
  - DO is high on the outer surface of floc, nitrification
  - DO is low in the inner portion of floc, denitrification
  - Distinct anoxic and anaerobic zones are typically not observed

Simultaneous Nitrification/Denitrification

Simultaneous nitrification/denitrification (SND)

- DO levels 0.3 and 0.8 mg/L
- Nitrification rate decreases as DO decreases
- Denitrification rate increases as DO decreases
- SND Requires longer HRT and SRT, (greater than 14-15 days)

Considerations

- Develop larger floc, by improving settleability
- Lower Oxygen concentrations
- Provide bioavailable carbon source
- Provide biostimulates to increase microbial activity

References

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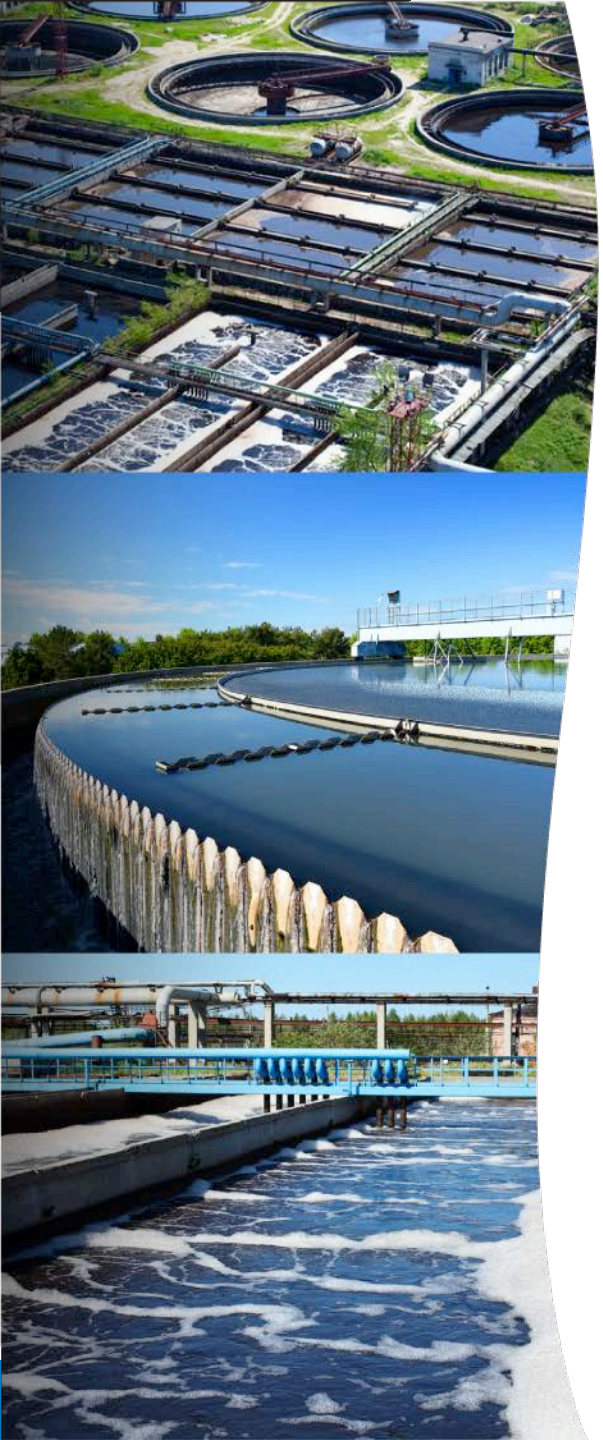

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Thank You

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