Anoxic selector, single stage nitrification process

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Presentation

- Review of Theory
  - Nitrification
  - Denitrification

- Characteristics of bioreactors
  - Aerated or Oxic
  - Un-aerated or Anoxic

- Nitrification Optimization
- Denitrification Optimization

- PRACTICAL APPLICATIONS @ WMARSS
Nitrification

- Oxidation of ammonia to nitrite in oxic conditions by nitrosomonas group (Optimum pH 8.0):
  - $2\text{NH}_3^+ + 3\text{O}_2 \rightarrow 2\text{H}^+ + 2\text{H}_2\text{O} + 2\text{NO}_2^-$

- Oxidation of nitrite by nitrobactor group:
  - $2\text{NO}_2^- + \text{O}_2 \rightarrow 2\text{NO}_3^-$ (nitrates)

- Oxygen mechanically provided by blowers

- Oxygen Consumption: 4.6 lbs of oxygen per lb of ammonia oxidized to nitrates (energy intensive!)

- Recover Nitrification Cost: De-nitrification

- Nitrobes that Nitrify are facultative (oxic or anoxic). In anoxic they can use NO$_3^-$ in lieu of direct O$_2$ for cellular respiration and denitrify
Aerated (Oxic) Bioreactor

Primary Effluent

$O_2 + \text{Pollutants} + \text{Microorganisms}$

RAS (microorganisms)

WAS
Denitrification

Using biomass in wastewater as carbon source for bacteria:

\[ C_5H_7NO_2 + 4.6 \text{NO}_3^- \rightarrow 2.8 \text{N}_2 + 5 \text{CO}_2 + 1.2 \text{H}_2\text{O} + 4.6 \text{OH}^- \]

(biomass) (nitrates) 

Because within the anoxic reactor no dissolved oxygen is supplied bacteria strip the oxygen molecule from the nitrates and consume the BOD present.

ADVANTAGES OF DENITRIFICATION

- Nitrate is reduced to nitrogen: \( \text{NO}_3^- \rightarrow \text{N}_2 \)
- BOD is consumed
- Alkalinity is replenished saving the buffer for subsequent pH sensitive biological reactions
Un-aerated Bioreactor (Anoxic Zone)

Primary Effluent → Anoxic Zone → Nitrate Recycle → RAS → WAS
Nitrification Optimization

Summary

- Test nitrification rate occasionally
- Select appropriate SRT
- Keep DO at min 2 mg/l @ peak conditions
- Keep pH about neutral (optimal 7.5 to 8.5)
- Provide sufficient alkalinity
- Replenish a portion of the alkalinity consumed during the nitrification process by denitrification
Denitrification Optimization
Summary

- Minimize DO in anoxic zone (< 0.2 mg/l)
- Maximize recycle capabilities
- Provide sufficient carbon source
WMARSS Aerial Digestors
4 final clarifiers
5 aeration tanks
4 primary tanks
Pelletization Facility
TF DAF cogen
4 Digestors Chlorination & Dechlor
4 final clarifiers

Brazos River

Influent Effluent
Admin
Filters
Sludge Lagoons

Influent
Effluent