BEST MANAGEMENT PRACTICES FOR AMMONIA REMOVAL IN WASTEWATER LAGOONS

SDARWS South Dakota Association of Rural Water Systems

Ammonia removal in lagoon systems relies on biological nitrification, a two-step process where ammonia-oxidizing bacteria (AOB) convert ammonia to nitrite, and nitrite-oxidizing bacteria (NOB) convert nitrite to nitrate. Because these bacteria are sensitive to temperature, oxygen, and pH, optimizing lagoon conditions is critical to maintaining effective ammonia removal year-round.

1. Maintain Adequate Dissolved Oxygen (DO)

- **Target DO levels:** Keep DO above 2 mg/L throughout the lagoon, especially in the upper aerated cells.
- **Aeration upgrades:** Consider fine bubble diffusers or mechanical aerators that provide both oxygen transfer and mixing.
- **Check mixing patterns:** Stagnant zones or short-circuiting can cause low DO areas where nitrification stops.
- **Seasonal adjustments:** During summer heat or winter ice cover, aeration may need to be adjusted to maintain oxygen levels.

2. Optimize Hydraulic Retention Time (HRT)

- **Avoid hydraulic overloading:** High flows reduce detention time and can wash out nitrifiers.
- **Use flow equalization or baffling:** These improve plug-flow conditions, allowing better contact time and settling.
- **Divide the lagoon into stages:** Primary cells can handle BOD removal, while secondary/tertiary cells promote nitrification.

3. Manage Organic Loading

- **Reduce carbon competition:** Heterotrophic bacteria that consume BOD can outcompete nitrifiers for oxygen.
- **Pre-treatment:** Settling, screening, or primary clarification can reduce organic loading before the lagoon.
- **Monitor influent BOD/TKN ratio:** Ideally, keep the BOD/TKN ratio below 4:1 for effective nitrification.

4. Monitor and Control pH and Alkalinity

- **Ideal range:** Nitrifying bacteria prefer pH between 7.0 and 8.0.
- **Alkalinity consumption:** Nitrification consumes about 7.1 mg of alkalinity (as $CaCO_3$) per mg of ammonia oxidized.
- **Add alkalinity if needed:** Use lime, soda ash, or sodium bicarbonate to buffer pH and prevent acidification.

5. Temperature Management

- **Understand temperature effects:** Nitrification slows drastically below 10°C.
- **Cold weather strategies:**
  - Increase detention time by lowering flow.
  - Retain some solids for insulation and bacterial mass.
  - Avoid excessive aeration that could cool the water.
  - **Design considerations:** Deeper cells can help buffer temperature swings.

6. Sludge and Solids Control

- **Remove excess sludge:** Solids buildup can reduce active volume and create anaerobic zones.
- **Perform sludge surveys:** Annual depth measurements help plan dredging.
- **Avoid resuspension:** Keep aeration gentle enough to prevent stirring up settled solids.

7. Regular Monitoring and Recordkeeping

- **Track key parameters:** Ammonia, nitrite, nitrate, DO, pH, temperature, and alkalinity.
- **Trend analysis:** Helps identify seasonal patterns and anticipate upsets.
- **Field testing:** Portable ammonia and DO meters are useful for quick checks.

8. Bioaugmentation and Seeding (Optional)

- **Inoculate with nitrifiers:** Commercial bacterial blends can jump-start nitrification after upsets or cold seasons.

- Feed in controlled doses: Avoid over-application; maintain aeration to support new populations.

9. Design and Retrofit Considerations

- **Add polishing cells or wetlands:** These provide extra time for nitrification and denitrification.
- **Upgrade to partial aeration systems:** Combining facultative and aerated zones can improve flexibility.
- **Incorporate baffles:** Prevent short-circuiting and improve flow distribution.

10. Seasonal Operation Adjustments

- **Spring/Fall transition:** Watch for algae die-off or temperature swings that can shock the system.
- **Winter:** Maintain aerators near the surface to keep ice holes open; reduce flow if possible.
- **Summer:** Prevent excessive algal blooms that drive up nighttime ammonia levels due to oxygen depletion.

Summary

Effective ammonia removal in lagoons depends on oxygen, retention time, and environmental stability. A well-managed lagoon system that balances these factors can achieve significant nitrification even under variable seasonal conditions. Regular monitoring, proactive maintenance, and small operational adjustments go a long way toward maintaining compliance and performance.