Ammonia Removal Best Practices Excel-Based Tool

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Introduction

Compliance Advisors for Sustainable Water Systems

- Technical Support Program that develops customized evaluation tools, SOPs, checklists and other unique documents that a system can utilize to return to compliance.

Why the tool was developed

- It was identified throughout Illinois wastewater systems that ammonia exceedances are one of the most common NPDES permit violation.
- A need for additional operator guidance was suggested creating a collaboration between Illinois, EPA Region 5 and ERG to develop this tool.

Where the tool can be found

- https://www.epa.gov/compliance/compliance-advisors-sustainable-water-systems-program#tools

Tools for Compliance Success

Compliance advisors have developed dozens of standard operating procedures (SOPs), checklists, tools and other products to help systems return to compliance. A few examples of these SOPs/tools include:

- Drinking Water Sampling Calendar (pdf) (32.95 KB) sampling requirements for drinking water systems can be complex and confusing to small operators. The example calendar illustrates when the operator should sample for different parameters.
- Cross Connection Handout (docx) (983.28 KB) – this handout is intended for drinking water system operators to distribute to customers. It describes backflow and cross connection scenarios and prevention practices.
- Drinking Water System Weekly Inspection Checklist (docx) (30.23 KB) – this is a checklist for drinking water system operators to use while they conduct a weekly inspection of their system.
- Ammonia Removal Best Practices Tool (xltm) (2.91 MB) - Excel-based best management practice (BMP) tool to evaluate elevated wastewater treatment plant ammonia effluent levels.

Tool Overview (Part 1)

General Background Information:

- **Why Ammonia Removal is important?**
- **Sources of Ammonia**
- **Diagnosing your system and using this tool**
- **How to control for Ammonia in wastewater systems**
  - 5 main control parameters
    - Alkalinity
    - Dissolved Oxygen
    - Solids Retention Time
    - Temperature
    - Biomass

Ammonia Removal Best Practices

EPA

Illinois Wastewater Plants

Why is Ammonia Removal Important?

Excessive ammonia discharged to receiving waters can cause serious ecological problems, such as eutrophication resulting in the depletion of dissolved oxygen, and excessive algal growth. Substantial concentrations of ammonia in wastewater can also cause toxicity to fish and wildlife.

Sources of Ammonia

Ammonia comes from many source. Biological sources include animal protein (meat, blood), Urea, and Amino Acids. Nitrogen in the air is fixated by plants into ammonia. Ammonia is also introduced to waterbodies by many municipal, industrial, and agricultural activities (for example, the use of fertilizers, corrosion inhibitors, production process chemicals, and cleaning chemicals).

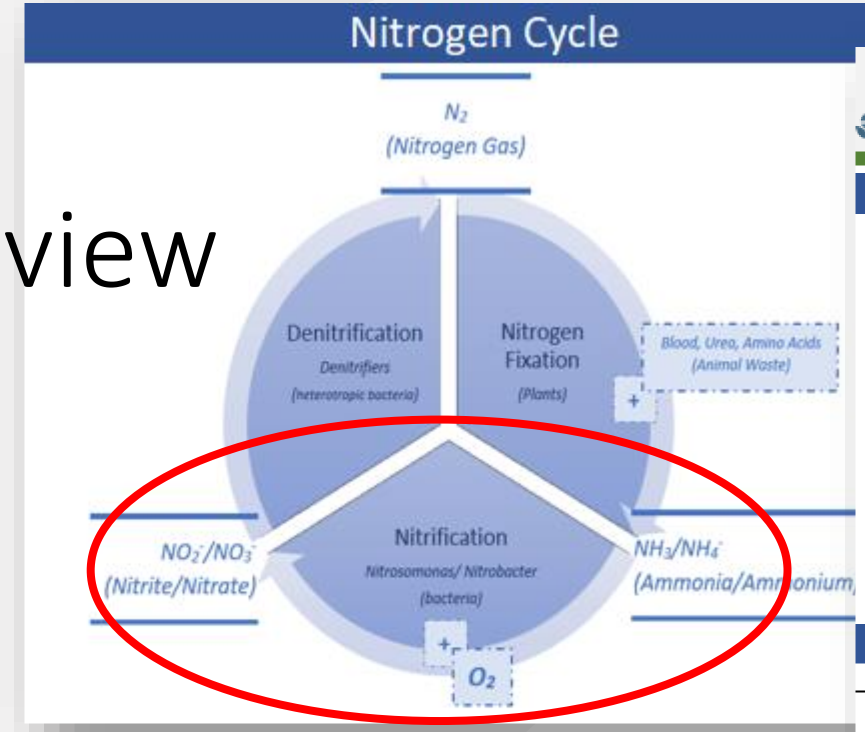
Diagnosing your system and using this tool

To diagnose your system after an ammonia exceedance, have the "System Profile Data Sheet" on hand including the necessary monitoring materials recommended. After initial data gathering, review the "Process Flow Chart" for actions and tips to reduce ammonia nitrogen based on the observed parameters of operation.

How to control for Ammonia in Wastewater Systems?

In order to remove ammonia from wastewater, ammonia needs to be converted to Nitrite/Nitrate or directly oxidized. This requires specific conditions in wastewater to allow for the preferred microorganisms to grow and multiply thereby removing ammonia from the system. The 5 main parameters that promote this process include Alkalinity, Dissolved Oxygen, Solids Retention Time, Temperature, Biomass. If your plant is experiencing excessive ammonia levels regularly or periodically, knowledge of one's own system is important to accurately analyze and promote specific conditions for ammonia removal by modifying or "optimizing" the treatment process. This analysis is guided by performing a system profile across different parts of the treatment system.

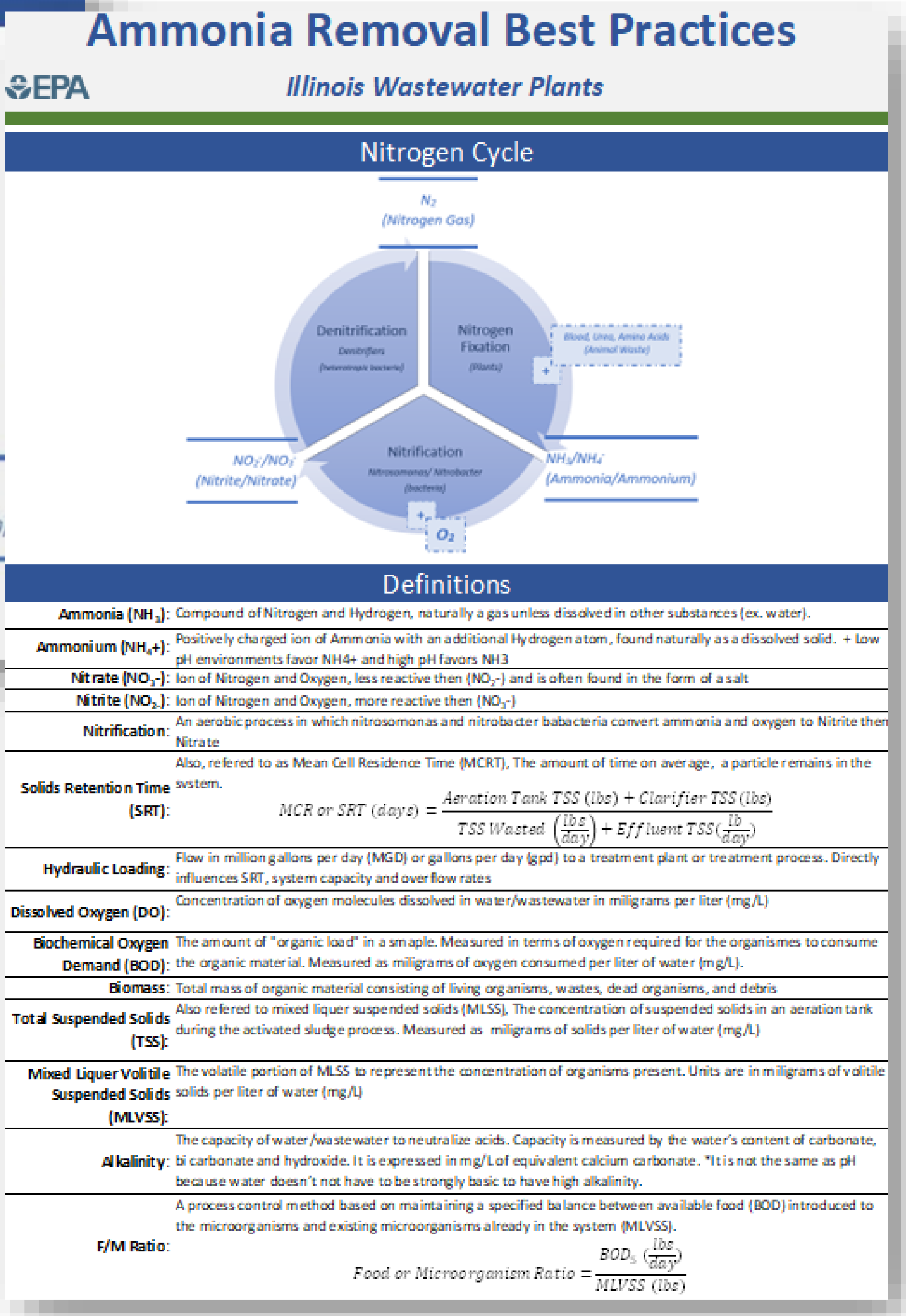
Tool Overview (Part 2)



Nitrogen Cycle

- Nitrogen Fixation
- **Nitrification**
  - An aerobic process in which Nitrosomonas and Nitrobacter bacteria convert ammonia and oxygen into Nitrite and Nitrate
  - ❖ **This tool is optimizing conditions for Nitrification**
- Denitrification

Definitions and formulas used throughout the tool



Ammonia Removal Best Practices

EPA — *Illinois Wastewater Plants*

Nitrogen Cycle

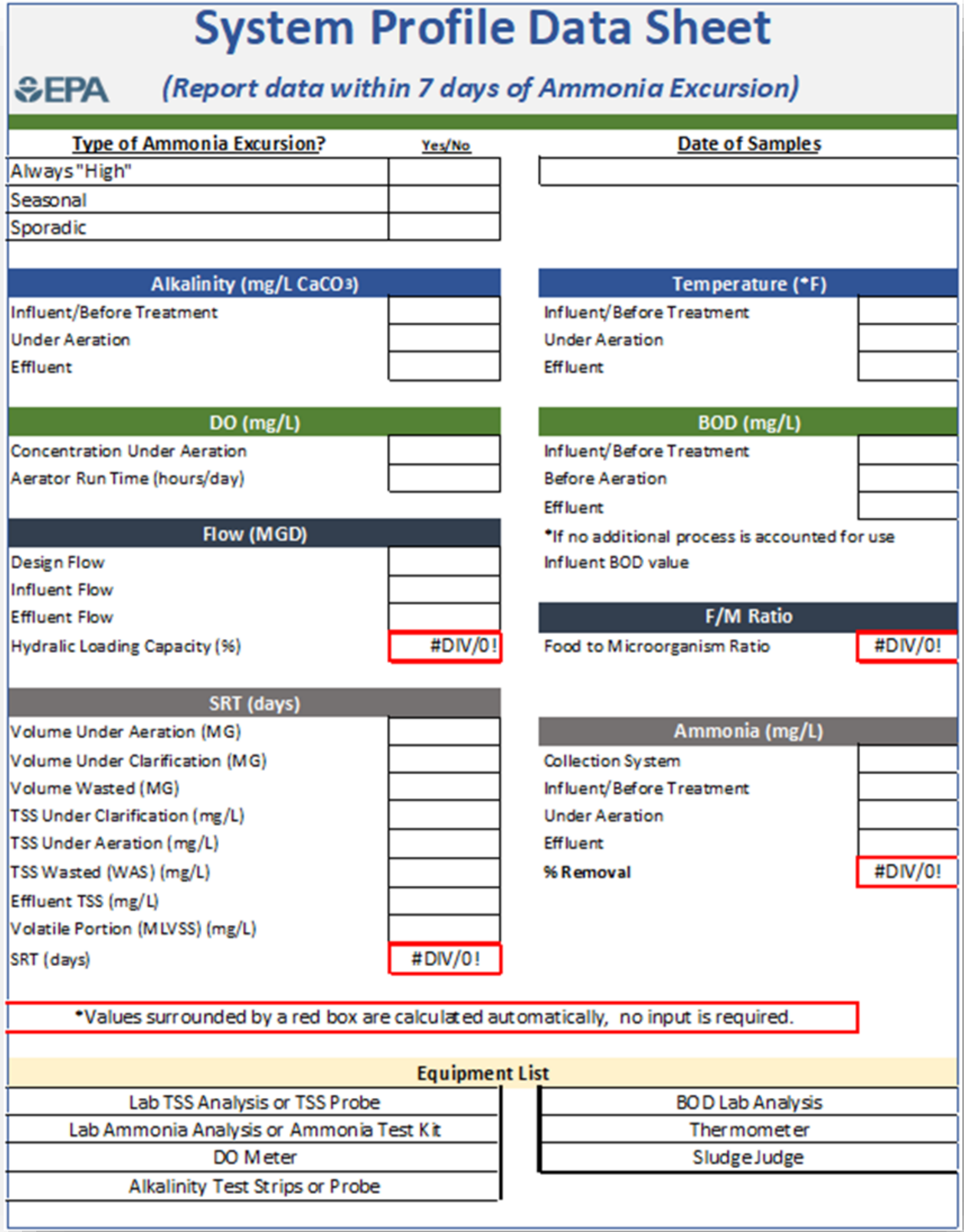
Definitions

Ammonia (NH_3):	Compound of Nitrogen and Hydrogen, naturally a gas unless dissolved in other substances (ex. water).
Ammonium (NH_4+):	Positively charged ion of Ammonia with an additional Hydrogen atom, found naturally as a dissolved solid. + Low pH environments favor NH4+ and high pH favors NH3
Nitrate (NO_3-):	Ion of Nitrogen and Oxygen, less reactive then (NO_2-) and is often found in the form of a salt
Nitrite (NO_2-):	Ion of Nitrogen and Oxygen, more reactive then (NO_3-)
Nitrification:	An aerobic process in which nitrosomonas and nitrobacter babacteria convert ammonia and oxygen to Nitrite then Nitrate
Solids Retention Time (SRT):	Also, refered to as Mean Cell Residence Time (MCRT), The amount of time on average, a particle remains in the system. $MCR\ or\ SRT\ (days) = \frac{Aeration\ Tank\ TSS\ (lbs) + Clarifier\ TSS\ (lbs)}{TSS\ Wasted\ \left(\frac{lbs}{day}\right) + Effluent\ TSS\left(\frac{lb}{day}\right)}$
Hydraulic Loading:	Flow in million gallons per day (MGD) or gallons per day (gpd) to a treatment plant or treatment process. Directly influences SRT, system capacity and over flow rates
Dissolved Oxygen (DO):	Concentration of oxygen molecules dissolved in water/wastewater in miligrams per liter (mg/L)
Biochemical Oxygen Demand (BOD):	The amount of "organic load" in a smaple. Measured in terms of oxygen required for the organismes to consume the organic material. Measured as miligrams of oxygen consumed per liter of water (mg/L).
Biomass:	Total mass of organic material consisting of living organisms, wastes, dead organisms, and debris
Total Suspended Solids (TSS):	Also refered to mixed liquer suspended solids (MLSS). The concentration of suspended solids in an aeration tank during the activated sludge process. Measured as miligrams of solids per liter of water (mg/L)
Mixed Liquer Volitile Suspended Solids (MLVSS):	The volatile portion of MLSS to represent the concentration of organisms present. Units are in miligrams of volitile solids per liter of water (mg/L)
Alkalinity:	The capacity of water/wastewater to neutralize acids. Capacity is measured by the water's content of carbonate, bi carbonate and hydroxide. It is expressed in mg/L of equivalent calcium carbonate. *It is not the same as pH because water doesn't not have to be strongly basic to have high alkalinity.
F/M Ratio:	A process control method based on maintaining a specified balance between available food (BOD) introduced to the microorganisms and existing microorganisms already in the system (MLVSS). $Food\ or\ Microorganism\ Ratio = \frac{BOD_5\ \left(\frac{lbs}{day}\right)}{MLVSS\ (lbs)}$

Tool Overview (Part 3)

System Profile Data Sheet

- Values surrounded by a red box are calculated automatically based on the data entered above.
- Bottom of the sheet has a short list of equipment needed to collect all the sufficient data.
- The data sheet is formatted to be printed out and brought in the field if desired.



EPA

System Profile Data Sheet

(Report data within 7 days of Ammonia Excursion)

Type of Ammonia Excursion?	Yes/No
Always "High"	
Seasonal	
Sporadic	

Date of Samples

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	
Under Aeration	
Effluent	

Temperature (°F)	
Influent/Before Treatment	
Under Aeration	
Effluent	

DO (mg/L)	
Concentration Under Aeration	
Aerator Run Time (hours/day)	

BOD (mg/L)	
Influent/Before Treatment	
Before Aeration	
Effluent	

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	
Influent Flow	
Effluent Flow	
Hydralic Loading Capacity (%)	#DIV/0!

F/M Ratio	
Food to Microorganism Ratio	#DIV/0!

SRT (days)	
Volume Under Aeration (MG)	
Volume Under Clarification (MG)	
Volume Wasted (MG)	
TSS Under Clarification (mg/L)	
TSS Under Aeration (mg/L)	
TSS Wasted (WAS) (mg/L)	
Effluent TSS (mg/L)	
Volatile Portion (MLVSS) (mg/L)	
SRT (days)	#DIV/0!

Ammonia (mg/L)	
Collection System	
Influent/Before Treatment	
Under Aeration	
Effluent	
% Removal	#DIV/0!

*Values surrounded by a red box are calculated automatically, no input is required.

Equipment List	
Lab TSS Analysis or TSS Probe	BOD Lab Analysis
Lab Ammonia Analysis or Ammonia Test Kit	Thermometer
DO Meter	SludgeJudge
Alkalinity Test Strips or Probe	

Tool Overview (Part 3)

Data Collection Using the System Profile Data Sheet

- Important to collect data as soon as an ammonia excursion is known as system conditions can change quickly and the resulting microbial population will reflect that.

Note: not all cells need to be filled in, a lagoon system is not going to have as many control mechanisms as an activated sludge system.

- Type of ammonia excursion
  - Always “high”
  - Seasonal
  - Sporadic
  - ❖ **understanding the type of excursion experienced can tell you a lot as to why the excursion is happening**

System Profile Data Sheet

EPA

(Report data within 7 days of Ammonia Excursion)

Type of Ammonia Excursion?	Yes/No
Always "High"	
Seasonal	
Sporadic	

Date of Samples

Alkalinity (mg/L $CaCO_3$)	
Influent/Before Treatment	
Under Aeration	
Effluent	

Temperature (°F)	
Influent/Before Treatment	
Under Aeration	
Effluent	

DO (mg/L)	
Concentration Under Aeration	
Aerator Run Time (hours/day)	

BOD (mg/L)	
Influent/Before Treatment	
Before Aeration	
Effluent	

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	
Influent Flow	
Effluent Flow	
Hydralic Loading Capacity (%)	#DIV/0!

F/M Ratio	
Food to Microorganism Ratio	#DIV/0!

SRT (days)	
Volume Under Aeration (MG)	
Volume Under Clarification (MG)	
Volume Wasted (MG)	
TSS Under Clarification (mg/L)	
TSS Under Aeration (mg/L)	
TSS Wasted (WAS) (mg/L)	
Effluent TSS (mg/L)	
Volatile Portion (MLVSS) (mg/L)	
SRT (days)	#DIV/0!

Ammonia (mg/L)	
Collection System	
Influent/Before Treatment	
Under Aeration	
Effluent	
% Removal	#DIV/0!

*Values surrounded by a red box are calculated automatically, no input is required.

Equipment List	
Lab TSS Analysis or TSS Probe	BOD Lab Analysis
Lab Ammonia Analysis or Ammonia Test Kit	Thermometer
DO Meter	SludgeJudge
Alkalinity Test Strips or Probe	

Tool Overview (Part 4)

Process Flow Chart

- Start at 1. and progressively move to 2. 3. 4. 5. as each parameter meets specifications.
- Each parameter has a **Yes** or **No** option and **Tips** to achieve the desired range
- The 5 steps correlate with data categories in the **System Profile Data Sheet**
- “Your Value” boxes are automatically populated based on data entered in the **System Profile Data Sheet**. The value will indicate a check mark, explanation point or X depending on how far it is outside the recommend range.
- Each modification may take more then 1 SRT (Biological Growth Cycle) for changes to be observed in system.

Process Flow Chart

EPA

Start at 1. and progressively move to 2. 3. 4. 5. as each parameter meets specifications.

Note that this process may take more than one SRT (biological growth cycle) to complete.

1. Alkalinity

Is the Alkalinity concentration between 75 mg/L $CaCO_3$ and 250 mg/L $CaCO_3$? — Your Value (mg/L CaCO3): 156

Yes	Proceed to **DO**
No	Consider the tips below to increase your alkalinity concentration to at least 75 mg/L

Tips

Alkalinity is the first parameter to change in the system as opposed to pH which has a lag time due to how quickly CO_2 can be released into the air. Low alkalinity results in incomplete nitrification and depressed pH. For nitrification to occur, 7.1 mg/CaCO3 is depleted per 1 mg of Ammonia oxidized to Nitrate/Nitrite.

To increase Alkalinity, you can add sodium bicarbonate or lime prior to aeration. The amount required dependent on how much ammonia needs to be oxidized (8:1 mass ratio of Alkalinity to Ammonia is commonly used).

Well water often has significantly higher alkalinity than surface water and can often be added to the treatment process supplementing a system's alkalinity needs.

2. Dissolved Oxygen (DO)

Is the DO concentration under aeration between 0.5 mg/L and 5 mg/L? — Your Value (mg/L): 2.5

Yes	Proceed to **Solids Retention Time** and **Hydraulic Loading Capacity**
No	Consider the tips below to move your DO concentration to the recommended range

Tips

The nitrification process consumes a large quantity of oxygen. If there is not enough DO available to the microorganisms then the process can be suppressed. Nitrifying bacteria need 4.6 mg of oxygen to convert 1 mg of Ammonia to Nitrite/Nitrate.

To increase DO in the system: increase blower, aerator speed or increase the cycle time "on".

Add additional aeration equipment to system as needed to maintain adequate DO and allow for a more even distribution.

Expose the microorganisms to the atmosphere by removing covers/vegetation and anything that would reduce air movement across the surface of the basin.

Ponds: remove floating aquatic vegetation (e.g., duckweed). Significant duckweed can reduce the natural oxygen transfer from the atmosphere to the pond water.

3. Solids Retention Time (SRT) & Hydraulic Loading Capacity (HLC)

Is the SRT between 7 and 14 days? — Your Value: SRT (days) 13.27

Is the hydraulic loading capacity between 50% and 99%? — Your Value: HLC (%) 80

Yes	Proceed to **Temperature**
No	Consider the tips below to move your SRT and/or HLC to the recommended range

Tips

Nitrifying bacteria are slow growing compared to other bacteria found in wastewater and require at least 7 days to become established. If the plant is running above design capacity (>100%) and SRT is too low, there may not enough time for the bacteria to absorb/convert ammonia to Nitrite/Nitrate. Conversely, if the system is being underutilized and has a high SRT, accumulated solids can be anaerobically digested and ammonia can be re-released into the system.

If the system allows, run treatment trains in parallel to decrease SRT or sequential to increase SRT

Take process units online or offline as appropriate to stay within the recommended percent capacity of system design (e.g., pond cells, aeration basins, secondary clarifiers).

Install baffling in key locations to slow down flow and prevent short circuiting.

Adjust the amount of solids removed from the system per day to achieve the recommended SRT.

During colder months, increase SRT to account for lower biological activity and slower growth from the nitrifying bacteria.

4. Temperature

*Is the temperature of the wastewater under aeration between 61*F and 113*F?* — Your Value (*F): 68

Yes	Proceed to **Biomass**
No	Consider the tips below to move temperature to the recommended range

Tips

Biological activity and nitrification are highly dependent on temperature; the lower the temperature the slower the biological activity. Below 41 degrees F, nitrification ceases.

Cover basins to retain heat.

Increase SRT to accommodate slower biological activity.

If the air is warmer than the water, create surface disturbance to allow more water to make contact with the air, this can be achieved by surface aerators or mixers.

5. Biomass

Is there enough food for the microorganisms to grow and multiply without overloading the system? (F/M Ratio 0.2 - 0.6) — Your Value (F:M ratio): 0.30

Yes	Proceed to **Additional Actions**
No	Consider the tips below to improve the F/M ratio

Tips

The performance of the system can be suppressed if there is not an adequate population of nitrifying bacteria to accommodate the incoming waste stream or if the incoming waste stream is too little for the microorganisms to reproduce. The system may be overloaded or underloaded for the following reasons:

- seasonal load patterns such as offseason or tourist seasons,

- microorganisms are under aeration for too long and they have consumed all of the existing food available,

- incomeing waste lacks specific components for continued nitrifying bacteria growth, such as industrial waste.

Supplement BOD by adding a food source to the system (e.g., dog food, glucose)

Provide supplemental mixing to keep food and microorganisms suspended and in contact with each other

Adjusting the active process units of the plant to account for the approximate loading observed (e.g., shutting down or isolating treatment trains to concentrate existing microbes or temporarily increasing capacity for seasonal loading fluxes).

Tool Overview (Part 5)

Additional Actions

- Sometimes there may be factors that the system operator cannot control that are contributing to ammonia noncompliance.
- In these cases, it is important to understand potential contributors by performing additional analysis.

Alternative Ammonia Removal Methods

- In cases where system design does not allow additional optimization for ammonia removal, alternative methods can be utilized.
- There is typically significant capital investment involved

Additional Actions

Are there any site-specific variables, such as those listed below, that are contributing to the elevated ammonia levels?

Microbial Assessment - How abundant are the nitrifying bacteria? (e.g., lab microscope assessment)

Shock load Identification - Are there major fluctuations in loading to the plant? (e.g., RV park discharge, septic hauler)

Collection System Survey - Where is the high ammonia influent coming from?

Industrial or Illegal Dumping - Could there be any unknown contributors to the system?

Lab Water Analysis - Could there be a contaminant that is depressing biological activity? (e.g., disinfecting agent from cleaning operations)

Internal Process Change - Were there any major plant adjustments or changes in operations within 1 SRT of the most recent ammonia excursion?

Alternative Ammonia Removal Methods

These methods are an option when the current system design and capacity do not allow for additional ammonia removal (the system is fully optimized in the current state). Methods are usually applied late in the process at plant effluent. There is typically significant capital investment or operational changes involved.

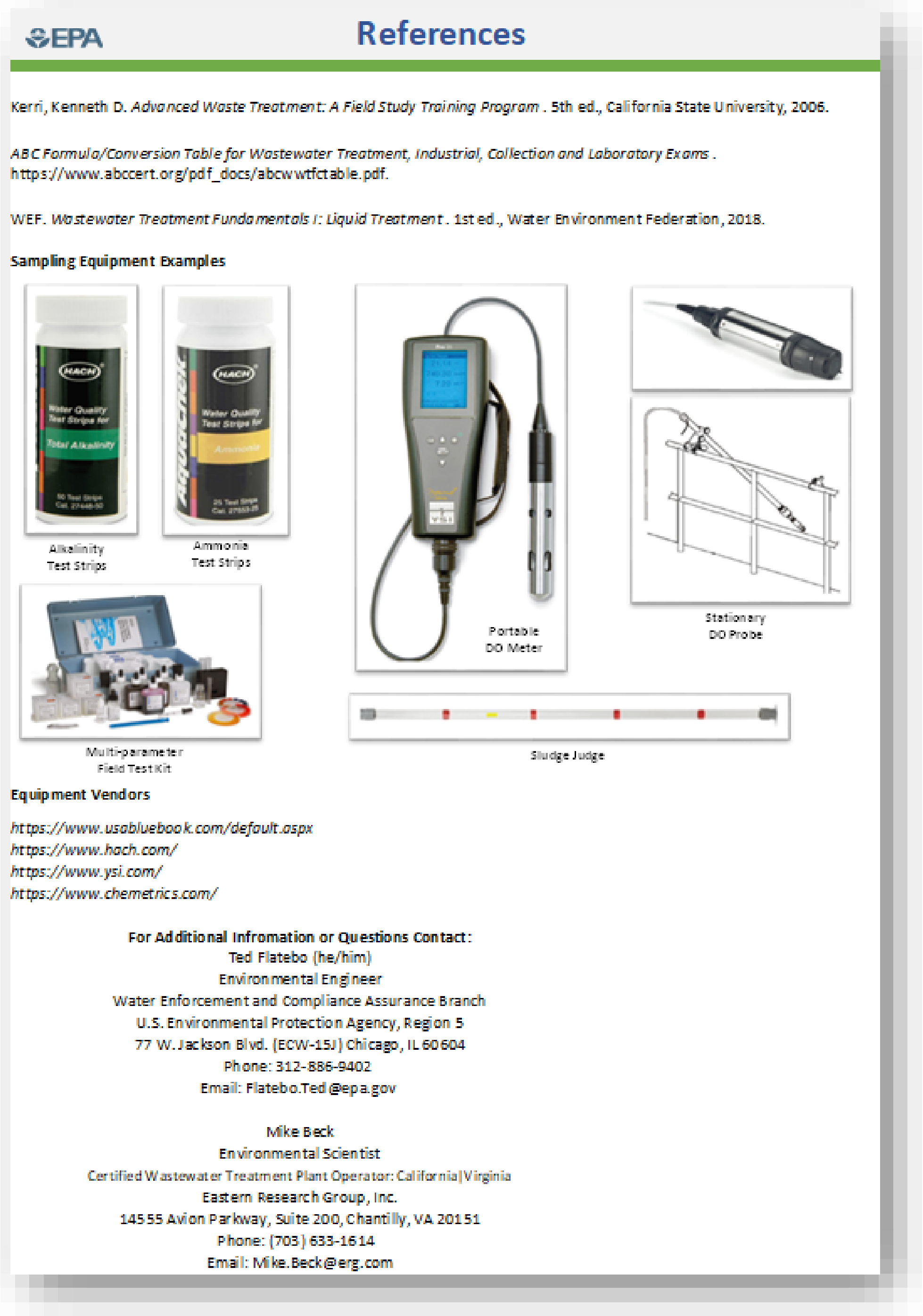
Ammonia Stripping - Ammonia is converted to a gas in the presence of high pH wastewater (10.5-11.5) and air.

Breakpoint Chlorination - Adding chlorine until the ammonia has been oxidized to nitrogen gas.

Ion Exchange - Passing ammonia-laden wastewater through a series of columns packed with natural or synthetic resins with a particular charge (zeolite/clinoptilolite).

Tool Overview (Part 6)

- **References**
- **Sampling equipment examples**
- **Contact Information**



References

Kerri, Kenneth D. *Advanced Waste Treatment: A Field Study Training Program*. 5th ed., California State University, 2006.

ABC Formula/Conversion Table for Wastewater Treatment, Industrial, Collection and Laboratory Exams. https://www.abccert.org/pdf_docs/abcwwtfctable.pdf.

WEF. *Wastewater Treatment Fundamentals I: Liquid Treatment*. 1st ed., Water Environment Federation, 2018.

Sampling Equipment Examples

Alkalinity Test Strips

Ammonia Test Strips

Portable DO Meter

Stationary DO Probe

Multi-parameter Field Test Kit

Sludge Judge

Equipment Vendors

https://www.usabluebook.com/default.aspx
https://www.hach.com/
https://www.ysi.com/
https://www.chemetrics.com/

For Additional Infromation or Questions Contact:
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Demonstration

System Example 1

Sampling Event 1

- System Type: Recirculating Sand Filter
- Initial Excursion Type: Always “High”
- Effluent Ammonia Limit: 5 mg/L

Note:

- City uses a surface water source for drinking water needs

System Profile Data Sheet

EPA *(Report data within 7 days of Ammonia Excursion)*

Type of Ammonia Excursion?	Yes/No
Always "High"	x
Seasonal	
Sporadic	

Date of Samples
9/1/2022

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	70
Under Aeration	60
Effluent	35

Temperature (°F)	
Influent/Before Treatment	65
Under Aeration	68
Effluent	70

DO (mg/L)	
Concentration Under Aeration	2
Aerator Run Time (hours/day)	24

BOD (mg/L)	
Influent/Before Treatment	350
Before Aeration	245
Effluent	30

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	1.5
Influent Flow	0.9
Effluent Flow	0.85
Hydralic Loading Capacity (%)	57

F/M Ratio	
Food to Microorganism Ratio	#DIV/0!

SRT (days)	
Volume Under Aeration (MG)	
Volume Under Clarification (MG)	
Volume Wasted (MG)	
TSS Under Clarification (mg/L)	
TSS Under Aeration (mg/L)	
TSS Wasted (WAS) (mg/L)	
Effluent TSS (mg/L)	
Volatile Portion (MLVSS) (mg/L)	
SRT (days)	#DIV/0!

Ammonia (mg/L)	
Collection System	15
Influent/Before Treatment	14
Under Aeration	12
Effluent	10
% Removal	29

Values surrounded by a red box are calculated automatically, no input is require

Equipment List	
Lab TSS Analysis or TSS Probe	BOD Lab Analysis
Lab Ammonia Analysis or Ammonia Test Kit	Thermometer
DO Meter	Sludge Judge
Alkalinity Test Strips or Probe	

System Example 1

Sampling Event 1

- The alkalinity does not fall within the recommend range, so the first answer is *No.
- Once a *No is answered, stop moving through the process flow chart until the parameter is within range using the tips provided.
- Why is alkalinity important?
    - Each parameter has a similar (why important?) section.
- Tips to increase alkalinity

Process Flow Chart

Start at 1. and progressively move to 2. 3. 4. 5. as each parameter meets specifications.

Note that this process may take more than one SRT (biological growth cycle) to complete.

1. Alkalinity		Your Value (mg/L CaCO3)
Is the Alkalinity concentration between 75 mg/L $CaCO_3$ and 250 mg/L $CaCO_3$?		! **70**
Yes	Proceed to **DO**	
No	Consider the tips below to increase your alkalinity concentration to at least 75 mg/L	

Tips
Alkalinity is the first parameter to change in the system as opposed to pH which has a lag time due to how quickly CO_2 can be released into the air. Low alkalinity results in incomplete nitrification and depressed pH. For nitrification to occur, 7.1 mg/CaCO3 is depleted per 1 mg of Ammonia oxidized to
To increase Alkalinity, you can add sodium bicarbonate or lime prior to aeration. The amount required dependent on how much ammonia needs to be oxidized (8:1 mass ratio of Alkalinity to Ammonia is commonly used).
Well water often has significantly higher alkalinity than surface water and can often be added to the treatment process supplementing a system's alkalinity needs.

System Example 1

- System Changes
  - Added sodium bicarbonate every other day to the influent to increase alkalinity

Sampling Event 2

- Systems operators collected new data 14 days after the start of the alkalinity addition.
- Alkalinity is now at 120 mg/L, well within the recommended range.
- System is now within compliance at 4 mg/L

Process Flow Chart

Start at 1. and progressively move to 2. 3. 4. 5. as each parameter meets specifications.
Note that this process may take more than one SRT (biological growth cycle) to complete.

EPA

1. Alkalinity		Your Value (mg/L CaCO3)
Is the Alkalinity concentration between 75 mg/L $CaCO_3$ and 250 mg/L $CaCO_3$?		✓ *120*
Yes	Proceed to **DO**	
No	Consider the tips below to increase your alkalinity concentration to at least 75 mg/L	

Tips

Alkalinity is the first parameter to change in the system as opposed to pH which has a lag time due to how quickly CO_2 can be released into the air. Low alkalinity results in incomplete nitrification and depressed pH. For nitrification to occur, 7.1 mg/CaCO3 is depleted per 1 mg of Ammonia oxidized to

To increase Alkalinity, you can add sodium bicarbonate or lime prior to aeration. The amount required dependent on how much ammonia needs to be oxidized (8:1 mass ratio of Alkalinity to Ammonia is commonly used).

Well water often has significantly higher alkalinity than surface water and can often b
treatment process supplementing a system's alkalinity needs.

System Profile Data Sheet

EPA *(Report data within 7 days of Ammonia Excursion)*

Type of Ammonia Excursion?	Yes/No
Always "High"	No
Seasonal	No
Sporadic	No

Date of Samples
9/15/2022

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	120
Under Aeration	90
Effluent	80

Temperature (*F)	
Influent/Before Treatment	65
Under Aeration	67
Effluent	70

DO (mg/L)	
Concentration Under Aeration	2
Aerator Run Time (hours/day)	24

BOD (mg/L)	
Influent/Before Treatment	348
Before Aeration	247
Effluent	25

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	1.5
Influent Flow	0.9
Effluent Flow	0.85
Hydralic Loading Capacity (%)	57

F/M Ratio	
Food to Microorganism Ratio	#DIV/0!

SRT (days)	
Volume Under Aeration (MG)	
Volume Under Clarification (MG)	
Volume Wasted (MG)	
TSS Under Clarification (mg/L)	
TSS Under Aeration (mg/L)	
TSS Wasted (WAS) (mg/L)	
Effluent TSS (mg/L)	
Volatile Portion (MLVSS) (mg/L)	
SRT (days)	#DIV/0!

Ammonia (mg/L)	
Collection System	15
Influent/Before Treatment	14
Under Aeration	7
Effluent	4
% Removal	71

/alues surrounded by a red box are calculated automatically, no input is require

Equipment List	
Lab TSS Analysis or TSS Probe	BOD Lab Analysis
Lab Ammonia Analysis or Ammonia Test Kit	Thermometer
DO Meter	Sludge Judge
Alkalinity Test Strips or Probe	

System Example 2

Sampling Event 1

- System Type: Multi-cell lagoon
- Initial Excursion: Always "High"
- Ammonia Permit Limit: 4 mg/L

Note: Significant vegetation on and around lagoon

System Profile Data Sheet

EPA *(Report data within 7 days of Ammonia Excursion)*

Type of Ammonia Excursion?	Yes/No
Always "High"	Yes
Seasonal	
Sporadic	

Date of Samples
8/1/2022

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	215
Under Aeration	150
Effluent	125

Temperature (°F)	
Influent/Before Treatment	67
Under Aeration	68
Effluent	71

DO (mg/L)	
Concentration Under Aeration	0.4
Aerator Run Time (hours/day)	6

BOD (mg/L)	
Influent/Before Treatment	312
Before Aeration	212
Effluent	20

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	1.2
Influent Flow	0.8
Effluent Flow	0.79
Hydralic Loading Capacity (%)	66

F/M Ratio	
Food to Microorganism Ratio	#DIV/0!

SRT (days)	
Volume Under Aeration (MG)	
Volume Under Clarification (MG)	
Volume Wasted (MG)	
TSS Under Clarification (mg/L)	
TSS Under Aeration (mg/L)	
TSS Wasted (WAS) (mg/L)	
Effluent TSS (mg/L)	
Volatile Portion (MLVSS) (mg/L)	
SRT (days)	#DIV/0!

Ammonia (mg/L)	
Collection System	15
Influent/Before Treatment	14
Under Aeration	10
Effluent	8
% Removal	43

/alues surrounded by a red box are calculated automatically, no input is require

Equipment List	
Lab TSS Analysis or TSS Probe	BOD Lab Analysis
Lab Ammonia Analysis or Ammonia Test Kit	Thermometer
DO Meter	Sludge Judge
Alkalinity Test Strips or Probe	

System Example 2

Sampling Event 1

- Step 1: Alkalinity concentrations look to be within range so answer *Yes to proceed to Step 2: DO
- DO concentration is low at 0.4 and not within range, therefore the answer is *No
- Why is dissolved oxygen important?
- Tips for increasing DO in a system

Process Flow Chart

EPA

Start at 1. and progressively move to 2. 3. 4. 5. as each parameter meets specifications.
Note that this process may take more than one SRT (biological growth cycle) to complete.

1. Alkalinity	Your Value (mg/L CaCO3)
Is the Alkalinity concentration between 75 mg/L $CaCO_3$ and 250 mg/L $CaCO_3$?	✔ 215

Yes	Proceed to **DO**
No	Consider the tips below to increase your alkalinity concentration to at least 75 mg/L

Tips

Alkalinity is the first parameter to change in the system as opposed to pH which has a lag time due to how quickly CO_2 can be released into the air. Low alkalinity results in incomplete nitrification and depressed pH. For nitrification to occur, 7.1 mg/CaCO3 is depleted per 1 mg of Ammonia oxidized to

To increase Alkalinity, you can add sodium bicarbonate or lime prior to aeration. The amount required dependent on how much ammonia needs to be oxidized (8:1 mass ratio of Alkalinity to Ammonia is commonly used).

Well water often has significantly higher alkalinity than surface water and can often be added to the treatment process supplementing a system's alkalinity needs.

2. Dissolved Oxygen (DO)	Your Value (mg/L)
Is the DO concentration under aeration between 0.5 mg/L and 5 mg/L?	✘ 0.4

Yes	Proceed to **Solids Retention Time** and **Hydraulic Loading Capacity**
No	Consider the tips below to move your DO concentration to the recommended range

Tips

The nitrification process consumes a large quantity of oxygen. If there is not enough DO available to the microorganisms then the process can be suppressed. Nitrifying bacteria need 4.6 mg of oxygen to convert 1 mg of Ammonia to Nitrite/Nitrate.

To increase DO in the system: increase blower, aerator speed or increase the cycle time "on".

Add additional aeration equipment to system as needed to maintain adequate DO and allow for a more even distribution.

Expose the microorganisms to the atmosphere by removing covers/vegetation and anything that would reduce air movement across the surface of the basin.

Ponds: remove floating aquatic vegetation (e.g., duckweed). Significant duckweed can reduce the natural oxygen transfer from the atmosphere to the pond water.

System Example 2

- System Changes:
- Removed aquatic vegetation around the parameter of the lagoon and on the lagoon surface
- Increased aerator run time to 18 hours a day

Sampling Event 2

- Systems operators collected new data 14 days after the changes were performed.
- DO is now at 2.0 mg/L
- Ammonia is now within compliance at 3 mg/L

System Profile Data Sheet

EPA *(Report data within 7 days of Ammonia Excursion)*

Type of Ammonia Excursion?	Yes/No
Always "High"	Yes
Seasonal	
Sporadic	

Date of Samples
8/14/2022

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	215
Under Aeration	150
Effluent	125

Temperature (*F)	
Influent/Before Treatment	67
Under Aeration	68
Effluent	71

DO (mg/L)	
Concentration Under Aeration	2
Aerator Run Time (hours/day)	18

BOD (mg/L)	
Influent/Before Treatment	312
Before Aeration	212
Effluent	20

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	1.2
Influent Flow	0.8
Effluent Flow	0.79
Hydralic Loading Capacity (%)	66

F/M Ratio	
Food to Microorganism Ratio	#DIV/0!

SRT (days)	
Volume Under Aeration (MG)	
Volume Under Clarification (MG)	
Volume Wasted (MG)	
TSS Under Clarification (mg/L)	
TSS Under Aeration (mg/L)	
TSS Wasted (WAS) (mg/L)	
Effluent TSS (mg/L)	
Volatile Portion (MLVSS) (mg/L)	
SRT (days)	#DIV/0!

Ammonia (mg/L)	
Collection System	15
Influent/Before Treatment	14
Under Aeration	6
Effluent	3
% Removal	79

Values surrounded by a red box are calculated automatically, no input is require

Equipment List	
Lab TSS Analysis or TSS Probe	BOD Lab Analysis
Lab Ammonia Analysis or Ammonia Test Kit	Thermometer
DO Meter	Sludge Judge
Alkalinity Test Strips or Probe	

low Chart

. 5. as each parameter meets specifications.

one SRT (biological growth cycle) to complete.

ty — Your Value (mg/L CaCO3): 215

/L CaCO3 and 250 mg/L CaCO3?

kalinity concentration to at least 75 mg/L

ips

stem as opposed to pH which has a lag time due to

alkalinity results in incomplete nitrification and

CO3 is depleted per 1 mg of Ammonia oxidized to

onate or lime prior to aeration. The amount

s to be oxidized (8:1 mass ratio of Alkalinity to

than surface water and can often be added to the

inity needs.

gen (DO) — Your Value (mg/L): 2

etween 0.5 mg/L and 5 mg/

aulic Loading Capacity

oncentration to the recommended range

ips

of oxygen. If there is not enough DO available to

essed. Nitrifying bacteria need 4.6 mg of oxygen to

rator speed or increase the cycle time "on".

eeded to maintain adequate DO and allow for a

removing covers/vegetation and anything that

the basin.

uckweed). Significant duckweed can reduce the

e pond water.

System Example 3

Sampling Event 1

- System Type: Small activated sludge plant
- Initial Excursion: Sporadic
- Ammonia permit limit 4 mg/L

Note: It is after the height of tourist season and loading into the plant has decreased

❖ An activated sludge plant contains enough complexity to input values for all cells.

Process Flow Chart

1. Alkalinity is below recommended range

System Profile Data Sheet

EPA *(Report data within 7 days of Ammonia Excursion)*

Type of Ammonia Excursion?	Yes/No
Always "High"	
Seasonal	
Sporadic	Yes

Date of Samples
8/15/2022

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	74
Under Aeration	60
Effluent	40

Temperature (°F)	
Influent/Before Treatment	67
Under Aeration	68
Effluent	71

DO (mg/L)	
Concentration Under Aeration	0.75
Aerator Run Time (hours/day)	12

BOD (mg/L)	
Influent/Before Treatment	312
Before Aeration	212
Effluent	20

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	1.5
Influent Flow	1.2
Effluent Flow	1.2
Hydralic Loading Capacity (%)	80

F/M Ratio	
Food to Microorganism Ratio	0.40

SRT (days)	
Volume Under Aeration (MG)	0.5
Volume Under Clarification (MG)	0.5
Volume Wasted (MG)	0.03
TSS Under Clarification (mg/L)	2100
TSS Under Aeration (mg/L)	2100
TSS Wasted (WAS) (mg/L)	8500
Effluent TSS (mg/L)	20
Volatile Portion (MLVSS) (mg/L)	0.6
SRT (days)	7.53

Ammonia (mg/L)	
Collection System	15
Influent/Before Treatment	14
Under Aeration	12
Effluent	10
% Removal	29

Values surrounded by a red box are calculated automati

Equipment List
Lab TSS Analysis or TSS Probe
Lab Ammonia Analysis or Ammonia Test Kit
DO Meter
Alkalinity Test Strips or Probe

Process Flow Chart

EPA

Start at 1. and progressively move to 2. 3. 4. 5. as each parameter meets specifications.

Note that this process may take more than one SRT (biological growth cycle) to complete.

1. Alkalinity	Your Value (mg/L CaCO3)
Is the Alkalinity concentration between 75 mg/L CaCO 3 and 250 mg/L CaCO 3 ?	74

Yes	Proceed to **DO**
No	Consider the tips below to increase your alkalinity concentration to at least 75 mg/L

Tips
Alkalinity is the first parameter to change in the system as opposed to pH which has a lag time due to how quickly CO 2 can be released into the air. Low alkalinity results in incomplete nitrification and depressed pH. For nitrification to occur, 7.1 mg/CaCO3 is depleted per 1 mg of Ammonia oxidized to
To increase Alkalinity, you can add sodium bicarbonate or lime prior to aeration. The amount required dependent on how much ammonia needs to be oxidized (8:1 mass ratio of Alkalinity to Ammonia is commonly used).
Well water often has significantly higher alkalinity than surface water and can often be added to the treatment process supplementing a system's alkalinity needs.

System Example 3

Sampling Event 2

- To increase alkalinity, the system elected to add lime as a source of CaCO3 since it was readily available. Increasing the alkalinity to 156mg/L, well within range.
- ❖ Ammonia in the effluent was reduced from 10 to 8
- 2. DO is close to still being within range. However, if the oxygen is not well distributed then it is a best practice to provide a buffer of additional DO.

System Profile

EPA *(Report data within 7 days of*

Type of Ammonia Excursion?	Yes/No
Always "High"	
Seasonal	
Sporadic	Yes

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	156
Under Aeration	135
Effluent	90

DO (mg/L)	
Concentration Under Aeration	0.4
Aerator Run Time (hours/day)	12

Flow (MGD)	
Design Flow	1.5
Influent Flow	1.2
Effluent Flow	1.2
Hydralic Loading Capacity (%)	80

SRT (days)	
Volume Under Aeration (MG)	0.5
Volume Under Clarification (MG)	0.5
Volume Wasted (MG)	0.03
TSS Under Clarification (mg/L)	2100
TSS Under Aeration (mg/L)	2100
TSS Wasted (WAS) (mg/L)	8500
Effluent TSS (mg/L)	20
Volatile Portion (MLVSS) (mg/L)	0.6
SRT (days)	7.53

Ammonia (mg/L)	
Collection System	15
Influent/Before Treatment	14
Under Aeration	10
Effluent	8
% Removal	43

Process Flow Chart

EPA

Start at 1. and progressively move to 2. 3. 4. 5. as each parameter meets specifications.
Note that this process may take more than one SRT (biological growth cycle) to complete.

1. Alkalinity

Is the Alkalinity concentration between 75 mg/L CaCO3 and 250 mg/L CaCO3 ? (mg/L CaCO3) ✓ 156

Yes	Proceed to **DO**
No	Consider the tips below to increase your alkalinity concentration to at least 75 mg/L

Tips

Alkalinity is the first parameter to change in the system as opposed to pH which has a lag time due to how quickly CO_2 can be released into the air. Low alkalinity results in incomplete nitrification and depressed pH. For nitrification to occur, 7.1mg/CaCO3 is depleted per 1mg of

To increase Alkalinity, you can add sodium bicarbonate or lime prior to aeration. The amount required dependent on how much ammonia needs to be oxidized (8:1 mass ratio of Alkalinity to Ammonia is commonly used).

Well water often has significantly higher alkalinity than surface water and can often be added to the treatment process supplementing a system's alkalinity needs.

2. Dissolved Oxygen (DO)

Is the DO concentration under aeration between 0.5 mg/L and 5 mg/L ? Your Value (mg/L) ✗ 0.4

Yes	Proceed to **Solids Retention Time** and **Hydraulic Loading Capacity**
No	Consider the tips below to move your DO concentration to the recommended range

Tips

The nitrification process consumes a large quantity of oxygen. If there is not enough DO available to the microorganisms then the process can be suppressed. Nitrifying bacteria need 4.6 mg of oxygen to convert 1mg of Ammonia to Nitrite/Nitrate.

To increase DO in the system: increase blower, aerator speed or increase the cycle time "on".

Add additional aeration equipment to system as needed to maintain adequate DO and allow for a more even distribution.

Expose the microorganisms to the atmosphere by removing covers/vegetation and anything that would reduce air movement across the surface of the basin.

Ponds: remove floating aquatic vegetation (e.g., duckweed). Significant duckweed can reduce the natural oxygen transfer from the atmosphere to the pond water.

System Example 3

Sampling event 3

- DO is now up to 2.5 by increasing aerator run speed and time.
- Ammonia in the effluent has also improved, coming down from 8 to 6 mg/L

System Profile Data Sheet

EPA *(Report data within 7 days of Ammonia Excursion)*

Type of Ammonia Excursion?	Yes/No
Always "High"	
Seasonal	
Sporadic	Yes

Date of Samples
8/29/2022

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	156
Under Aeration	135
Effluent	90

Temperature (°F)	
Influent/Before Treatment	67
Under Aeration	68
Effluent	71

DO (mg/L)	
Concentration Under Aeration	2.5
Aerator Run Time (hours/day)	18

BOD (mg/L)	
Influent/Before Treatment	312
Before Aeration	212
Effluent	20

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	1.5
Influent Flow	1.2
Effluent Flow	1.2
Hydralic Loading Capacity (%)	80

F/M Ratio	
Food to Microorganism Ratio	0.40

SRT (days)	
Volume Under Aeration (MG)	0.5
Volume Under Clarification (MG)	0.5
Volume Wasted (MG)	0.03
TSS Under Clarification (mg/L)	2100
TSS Under Aeration (mg/L)	2100
TSS Wasted (WAS) (mg/L)	8500
Effluent TSS (mg/L)	20
Volatile Portion (MLVSS) (mg/L)	0.6
SRT (days)	7.53

Ammonia (mg/L)	
Collection System	15
Influent/Before Treatment	14
Under Aeration	8
Effluent	6
% Removal	57

Values surrounded by a red box are calculated automatically, no input is require

Equipment List	
Lab TSS Analysis or TSS Probe	BOD Lab Analysis
Lab Ammonia Analysis or Ammonia Test Kit	Thermometer
DO Meter	Sludge Judge
Alkalinity Test Strips or Probe	

System Example 3

Sampling event 3

- 3. SRT is currently at 7.53 and is on the low end to select optimize for nitrifying bacteria growth
- Tips for increasing SRT

1. Alkalinity	(mg/L CaCO3)
Is the Alkalinity concentration between 75 mg/L $CaCO_3$ and 250 mg/L $CaCO_3$?	✔ 156

Yes	Proceed to **DO**
No	Consider the tips below to increase your alkalinity concentration to at least 75 mg/L

Tips

Alkalinity is the first parameter to change in the system as opposed to pH which has a lag time due to how quickly CO_2 can be released into the air. Low alkalinity results in incomplete nitrification and depressed pH. For nitrification to occur, 7.1 mg/CaCO3 is depleted per 1 mg of

To increase Alkalinity, you can add sodium bicarbonate or lime prior to aeration. The amount required dependent on how much ammonia needs to be oxidized (8:1 mass ratio of Alkalinity to Ammonia is commonly used).

Well water often has significantly higher alkalinity than surface water and can often be added to the treatment process supplementing a system's alkalinity needs.

2. Dissolved Oxygen (DO)	Your Value (mg/L)
Is the DO concentration under aeration between 0.5 mg/L and 5 mg/L ?	✔ 2.5

Yes	Proceed to **Solids Retention Time** and **Hydraulic Loading Capacity**
No	Consider the tips below to move your DO concentration to the recommended range

Tips

The nitrification process consumes a large quantity of oxygen. If there is not enough DO available to the microorganisms then the process can be suppressed. Nitrifying bacteria need 4.6 mg of oxygen to convert 1 mg of Ammonia to Nitrite/Nitrate.

To increase DO in the sys...

Add additional aeration e... a more even distribution.

Expose the microorganis... would reduce air moveme...

Ponds: remove floating a... the natural oxygen transf...

Solids Retention Time (SRT) & Hydraulic Loading Capacity (HL...		Your Value
Is the SRT between 7 and 14 days?	*SRT*	! 7.53
Is the hydraulic loading capacity between 50% and 99%?	*HLC (%)*	✔ 80

Yes	Proceed to **Temperature**
No	Consider the tips below to move your SRT and/or HLC to the recommended range

Tips

Nitrifying bacteria are slow growing compared to other bacteria found in wastewater and require at least 7 days to become established. If the plant is running above design capacity (> 100%) and SRT is too low, there may not enough time for the bacteria to absorb/convert ammonia to Nitrite/Nitrate. Conversely, if the system is being underutilized and has a high SRT, accumulated solids can be anaerobically digested and ammonia can be re-released into the

If the system allows, run treatment trains in parallel to decrease SRT or sequential to increase

Take process units online or offline as appropriate to stay within the recommended percent capacity of system design (e.g., pond cells, aeration basins, secondary clarifiers).

Install baffling in key locations to slow down flow and prevent short circuiting.

➡ Adjust the amount of solids removed from the system per day to achieve the recommended SRT.

During colder months, increase SRT to account for lower biological activity and slower growth from the nitrifying bacteria.

System Example 3

Sampling Event 4

- Decreased Wasting from 30,000 to 22,000 gal.
- Increased TSS(MLSS) under aeration from 2100 to 2800 therefore increasing SRT to **13.27** days giving the Nitrifying Bacteria time to grow and multiply
- Ammonia is now within compliance at 3 mg/L

Solids Retention Time (SRT) & Hydraulic Loading Capacity (HL…

		Your Value
Is the SRT between 7 and 14 days?	*SRT*	✓ 13.27
Is the hydraulic loading capacity between 50% and 99%?	*HLC (%)*	✓ 80

Yes	Proceed to **Temperature**
No	Consider the tips below to m…

Nitrifying bacteria are slow growing… at least 7 days to become establis… and SRT is too low, there may not… Nitrite/Nitrate. Conversely, if the sy… accumulated solids can be anaer…

If the system allows, run treatment…
Take process units online or offline… capacity of system design (e.g., pc…
Install baffling in key locations to sl…
Adjust the amount of solids remove…
During colder months, increase SF… from the nitrifying bacteria.

System Profile Data Sheet

EPA ***(Report data within 7 days of Ammonia Excursion)***

Type of Ammonia Excursion?	Yes/No
Always "High"	
Seasonal	
Sporadic	Yes

Date of Samples
9/15/2022

Alkalinity (mg/L CaCO3)	
Influent/Before Treatment	156
Under Aeration	135
Effluent	90

Temperature (°F)	
Influent/Before Treatment	67
Under Aeration	68
Effluent	71

DO (mg/L)	
Concentration Under Aeration	2.5
Aerator Run Time (hours/day)	18

BOD (mg/L)	
Influent/Before Treatment	312
Before Aeration	212
Effluent	20

*If no additional process is accounted for use Influent BOD value

Flow (MGD)	
Design Flow	1.5
Influent Flow	1.2
Effluent Flow	1.2
Hydralic Loading Capacity (%)	80

F/M Ratio	
Food to Microorganism Ratio	0.30

SRT (days)	
Volume Under Aeration (MG)	0.5
Volume Under Clarification (MG)	0.5
Volume Wasted (MG)	0.022
TSS Under Clarification (mg/L)	2800
TSS Under Aeration (mg/L)	2800
TSS Wasted (WAS) (mg/L)	8500
Effluent TSS (mg/L)	20
Volatile Portion (MLVSS) (mg/L)	0.6
SRT (days)	13.27

Ammonia (mg/L)	
Collection System	15
Influent/Before Treatment	14
Under Aeration	6
Effluent	3
% Removal	79

Additional Process Considerations

Temperature

- Contributes to seasonal changes in plant performance
- Tips

Biomass

- Is there enough incoming food to support the current microbial population.
- F/M ratio is a good indicator of this.
- Tips

4. Temperature		Your Value (°F)
Is the temperature of the wastewater under aeration between 61°F and 113°F?		68
Yes	Proceed to **Biomass**	
No	Consider the tips below to move temperature to the recommended range	

Tips

Biological activity and nitrification are highly dependent on temperature; the lower the temperature the slower the biological activity. Below 41 degrees F, nitrification ceases.

Cover basins to retain heat.

Increase SRT to accommodate slower biological activity.

If the air is warmer than the water, create surface disturbance to allow more water to make contact with the air, this can be achieved by surface aerators or mixers.

5. Biomass		Your Value (F:M ratio)
Is there enough food for the microorganisms to grow and multiply without overloading the system? (F/M Ratio 0.2 - 0.6)		0.30
Yes	Proceed to **Additional Actions**	
No	Consider the tips below to improve the F/M ratio	

Tips

The performance of the system can be suppressed if there is not an adequate population of nitrifying bacteria to accommodate the incoming waste stream or if the incoming waste stream is too little for the microorganisms to reproduce. The system may be overloaded or underloaded for the following reasons:
- seasonal load patterns such as offseason or tourist seasons,
- microorganisms are under aeration for too long and they have consumed all of the existing food available.

Supplement BOD by adding a food source to the system (e.g., dog food, glucose)

Provide supplemental mixing to keep food and microorganisms suspended and in contact with ea

Adjusting the active process units of the plant to account for the approximate loading observed (e.g., shutting down or isolating treatment trains to concentrate existing microbes or temporarily increasing capacity for seasonal loading fluxes).

When treatment conditions are within range of the 5 parameters and Ammonia compliance is still not achieved.

- Often more information is needed
  - Are site-specific variables contributing to elevated ammonia levels?
- Why the type of ammonia excursion is important
  - Seasonal: Temperature (ex. summer water temps vs. winter), Biomass (ex. tourist influx)
  - Sporadic: Potential industry discharge slug, septic hauler illegal discharge (i.e. popped manhole) or illegal drug production.

Additional Actions that systems can take

- Microbial Assessment
- Shock load identification
- Collection System Survey
- Industrial or Illegal Dumping
- Water Toxicity Analysis
- Internal Process Change

Additional Actions
Are there any site-specific variables, such as those listed below, that are contributing to the elevated ammonia levels?
Microbial Assessment – How abundant are the nitrifying bacteria? (e.g., lab microscope ass
Shock load Identification – Are there major fluctuations in loading to the plant? (e.g., RV park discharge, septic hauler)
Collection System Survey – Where is the high ammonia influent coming from?
Industrial or Illegal Dumping – Could there be any unknown contributors to the system?
Lab Water Analysis – Could there be a contaminant that is depressing biological activity? (e.g., disinfecting agent from cleaning operations)
Internal Process Change – Were there any major plant adjustments or changes in operations within 1 SRT of the most recent ammonia excursion?

When all else fails (Alternative Ammonia Removal Methods)

- The system may just not be capable of converting enough Ammonia even when fully optimized
- Practical as a polishing step to meet very low limits.

Alternative Ammonia Removal Methods
These methods are an option when the current system design and capacity do not allow for additional ammonia removal (the system is fully optimized in the current state). Methods are usually applied late in the process at plant effluent. There is typically significant capital investment or operational changes involved.
Ammonia Stripping – Ammonia is converted to a gas in the presence of high pH wastewater (10.5-11.5) and air.
Breakpoint Chlorination – Adding chlorine until the ammonia has been oxidized to nitrogen
Ion Exchange – Passing ammonia-laden wastewater through a series of columns packed with natural or synthetic resins with a particular charge (zeolite/clinoptilolite).

Conclusion

- This tool is an example of a systematic approach to solving challenges:
  1) identify the issues
  2) change a variable and track the results
  3) repeat the process as more data is collected to achieve desired solution.
- It takes time, changing too many variables at once makes it difficult to determine what was the major contributing factor that can be leveraged in the future that led to the return to compliance.
- Also, biological systems don’t react instantly to changes, there is often a lag period of multiple days to weeks.

Conclusion

- It is often not just one parameter that is contributing to Ammonia noncompliance. There can be multiple influences that together are contributing to the challenges. Progressing methodically through the 5 parameters can identify the factors that are influencing you own system more than others.
- This is just one tool in an operator’s toolbox, sometimes is takes multiple “tools” to solve the problem at hand.
- This Tool is continuously being modified based on operator input

References

Kerri, Kenneth D. *Advanced Waste Treatment: A Field Study Training Program*. 5th ed., California State University, 2006.

ABC Formula/Conversion Table for Wastewater Treatment, Industrial, Collection and Laboratory Exams. https://www.abccert.org/pdf_docs/abcwwtfctable.pdf.

WEF. *Wastewater Treatment Fundamentals I: Liquid Treatment*. 1st ed., Water Environment Federation, 2018.

Sampling Equipment Examples

Alkalinity Test Strips

Ammonia Test Strips

Portable DO Meter

Stationary DO Probe

Multi-parameter Field Test Kit

Sludge Judge

Equipment Vendors

https://www.usabluebook.com/default.aspx
https://www.hach.com/
https://www.ysi.com/
https://www.chemetrics.com/

Additional Resources

- References
- Sampling equipment

Questions

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