Ammonia Recovery for Digester Health

2-3-2022

BioTownAG

Sustainability for the Real World

Agenda:

1. Bio Town Overview
2. Reason why Ammonia Recovery was needed (Burning Platform)
3. Chemistry of the process
4. Bio Town's Ammonia Recovery Process
5. Challenges of the system
6. Closing thoughts

Questions

1. Bio Town Ag Overview

We Create Value from Waste

- Brian and Lorene moved to farm in 1980
- Farm started out as swine and grain operation.
- Ventured into beef cattle in the early 90's.
- Town of Reynolds was named BioTown in 2006 by then Gov. Mitch Daniels.
- First 2 digesters at Bio Town AG came online in 2011 along with 3 engines
  - 3rd digester was commissioned in 2014 with 3 additional engines added to capacity.
- Continue to grow into other industries such as:
  1. Commercial fertilizer
  2. Composting and different soil blends
  3. Starting own beef brand (Legacy Maker Meats)

2. Why is AR needed?

NH_3 Necessity

NH_3 is valuable for both agricultural fertilizers and chemical industries.

Ammonia (in small amounts) is essential for plant growth and an important building block on cellular level for creating proteins & amino acids.

NH_3 Toxicity

Causes eutrophication in surface waters – allows excessive nutrients to accumulate that then causes 'green scum' layer to form, blocking sunlight and oxygen for other water species

Toxic to many marine species at specific levels

Impairs air quality – ammonia gas reacts with other air pollutants to form ammonia salts that affects breathing.

- Regulatory Rules (Federal and State Specific)
  - Most IN livestock facilities are not allowed to discharge more than 2 ppm to surface waters of the state, unless special permits are obtained.

Goal of Ammonia Recovery Systems

To reduce emissions and pollutants to air, land, and water

To naturally create a feasible and economical end-product (fertilizer

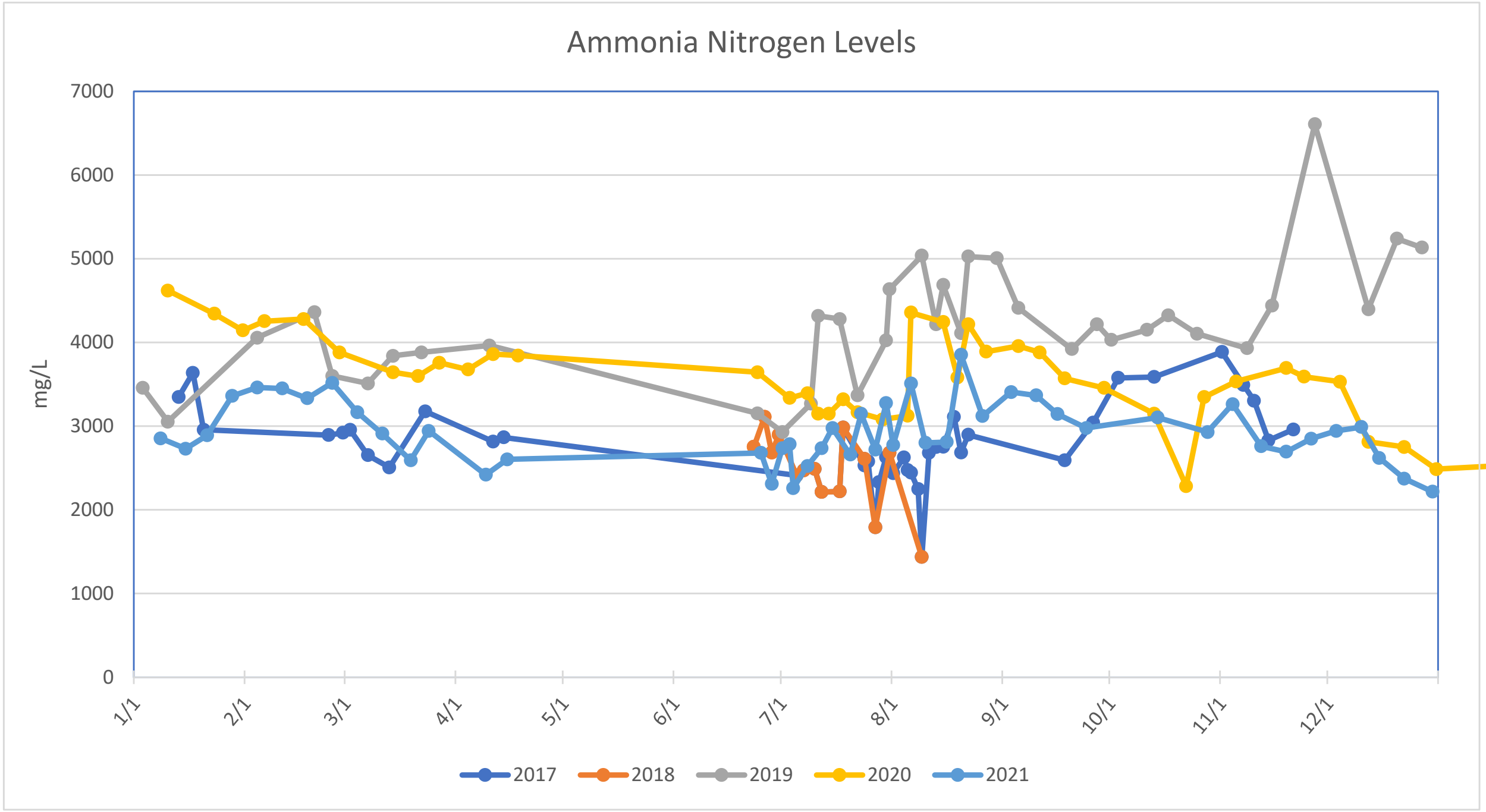
To reduce ammonia in recycled process liquids

Water evaporation through stack

Elevated ammonia levels start to effect the methanogens before any other microorganism

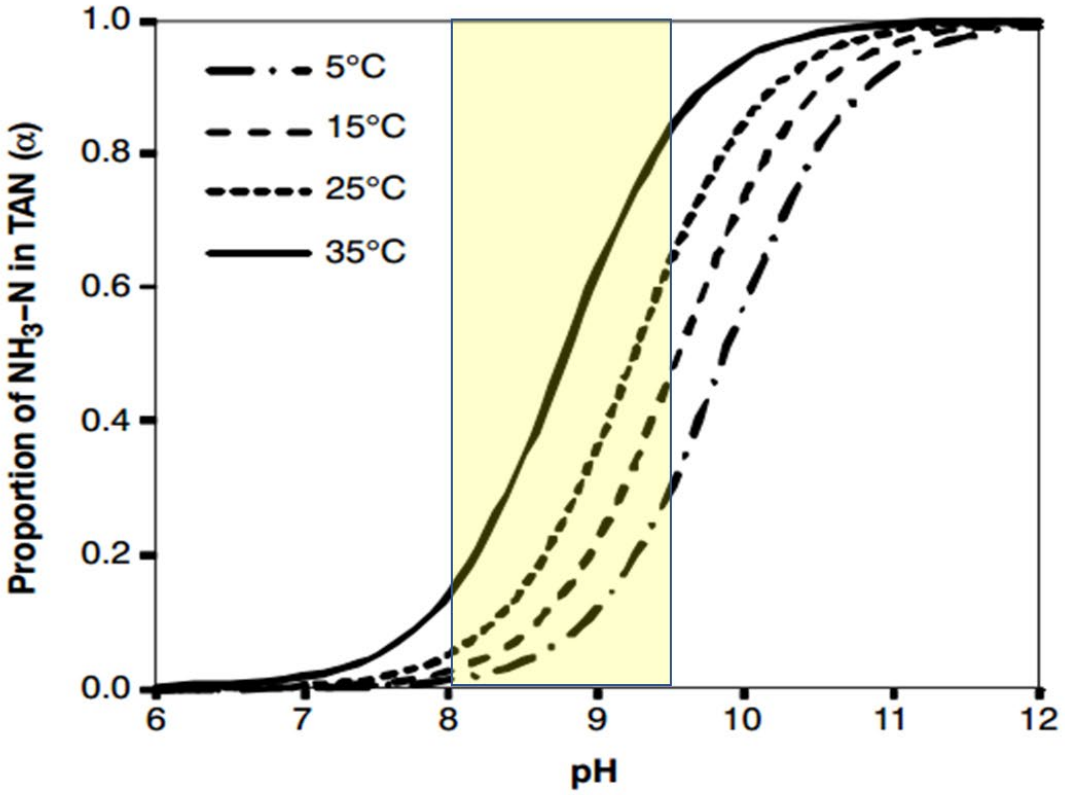
For every gallon of water we use at the digester we must store until we can land apply. Space is a constraint so fresh water is **LAST** resort making batches at the digester.

Picture representation of make-up water loop on farm


Ammonia Nitrogen Levels
7000
6000
5000
4000
3000
2000
1000
0
mg/L
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
2017
2018
2019
2020
2021

3. Chemistry of the Process

- NH4+ +OH- ←→ NH3 + H2O aqueous form and gaseous form exist in equilibrium together.
- When the pH and temperature increase, this equilibrium is thrown off and shifts more towards the gaseous form.
- Soluble ammonia becomes a gas at high temperatures and high pH.



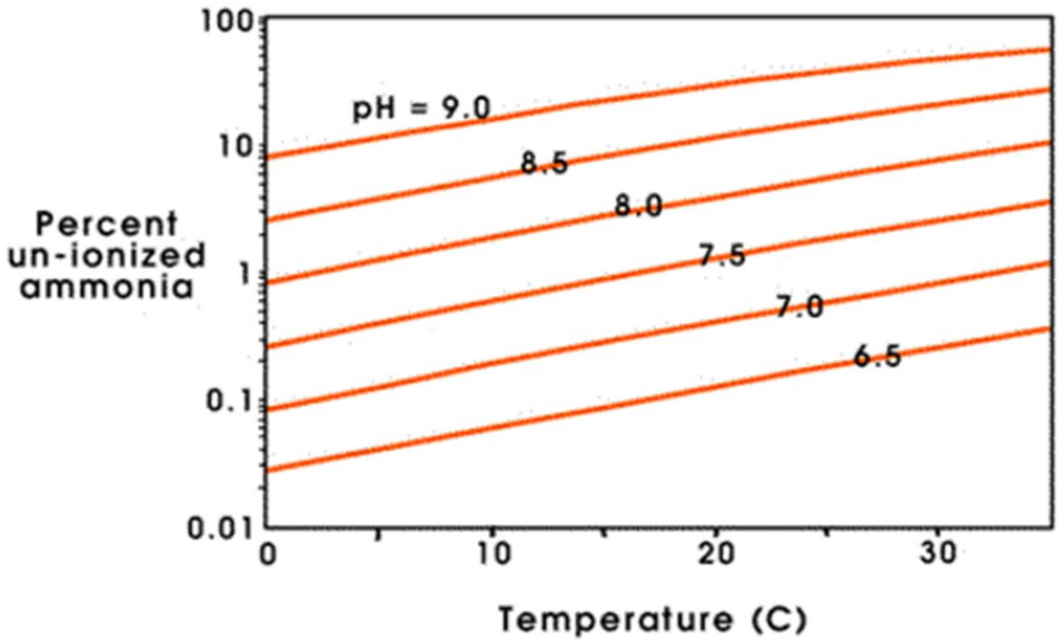
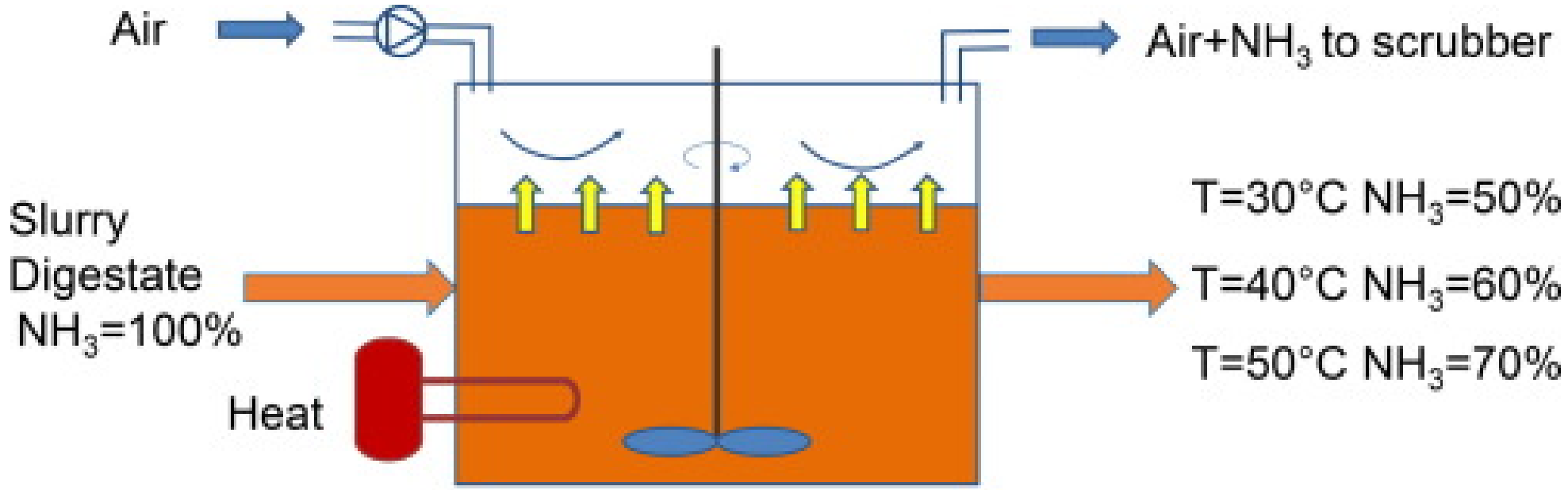


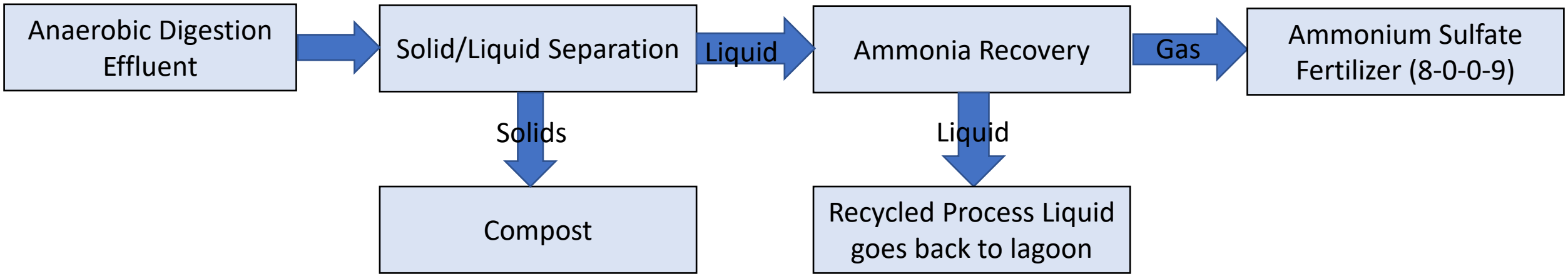
Figure 1. Proportion of total ammoniacal nitrogen that is ammonia (α) as a function of temperature and pH in aqueous solutions.

4. Ammonia Recovery Process

1. Digester effluent is pretreated non-chemically by various solid/liquid separation equipment to strip as many suspended solids from the liquid as possible.
2. The digestate is then heated to process temps upwards of 160 F. With the increased pH and temperature, soluble ammonia converts to ammonia gas.
3. The digestate is supersaturated in CO_2. By aerating the digestate, saturated CO_2 is released, causing pH to increase.
4. The stripped ammonia gas is collected in a tower and doused with sulfuric acid to generate liquid ammonium sulfate.



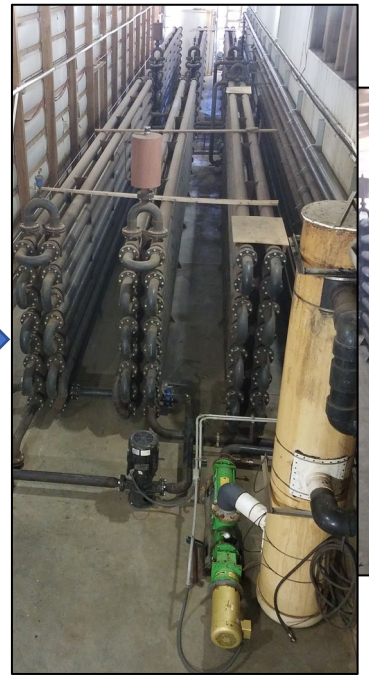
Bio Town Ag Process Flow Chart



1st line separation

2nd line separation

Can handle 150 gpm



These two machines in the process consume large amounts of power.

5. Challenges of the system

1. Controlling pH is challenging during start-up of system. It requires much manual intervention to bring the system up to full capacity.
   - Continuous calibration of the pH and specific gravity probes is required to keep the system in balance.
2. Our system is very heat dependent to separate ammonia. Currently we pull that heat from our engines, but if system goes down that can cause issues upstream with water loop overheating
3. Very costly to run.
   - Cost of 93% sulphuric acid keeps increasing
   - Due to high iron in water we must change out sock filters daily
   - Power consumption is high which draws from what could be exported for revenue
   - Maintenance and upkeep of pumps, motors, and electrical components
4. Have to change operation philosophy when running AR system.
   - Effluents have to be managed differently from digester to keep steady flow to downstream equipment
   - Pumps, separators, heat exchangers must have consistent flow otherwise system will shut down
5. Equipment issues

6. Closing Thoughts

- This system helps us to maintain microbial health to maximize methane production
- It is a cost neutral system at best even with the offtake of 8-0-0-9 fertilizer (until this year)
- We normally try to shut the system off during land application
- There are probably many improvements that can be made to the system to maximize recovery and potential revenue.

- This is not a lights out system. It takes a lot of energy and focus at least where ours is today.

Questions: