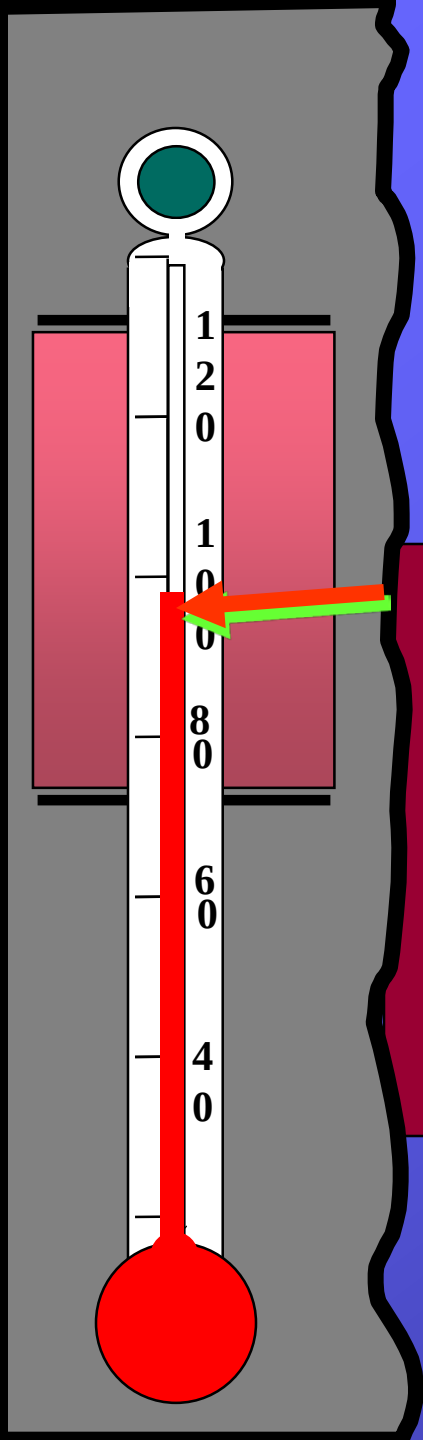


Ohio Water Environment Association

Preserving & Enhancing Ohio's Water Environment

Columbus - October 22, 2015

SNDR

Storage Nitrification/ Denitrification Reactor

Biosolids Treatment

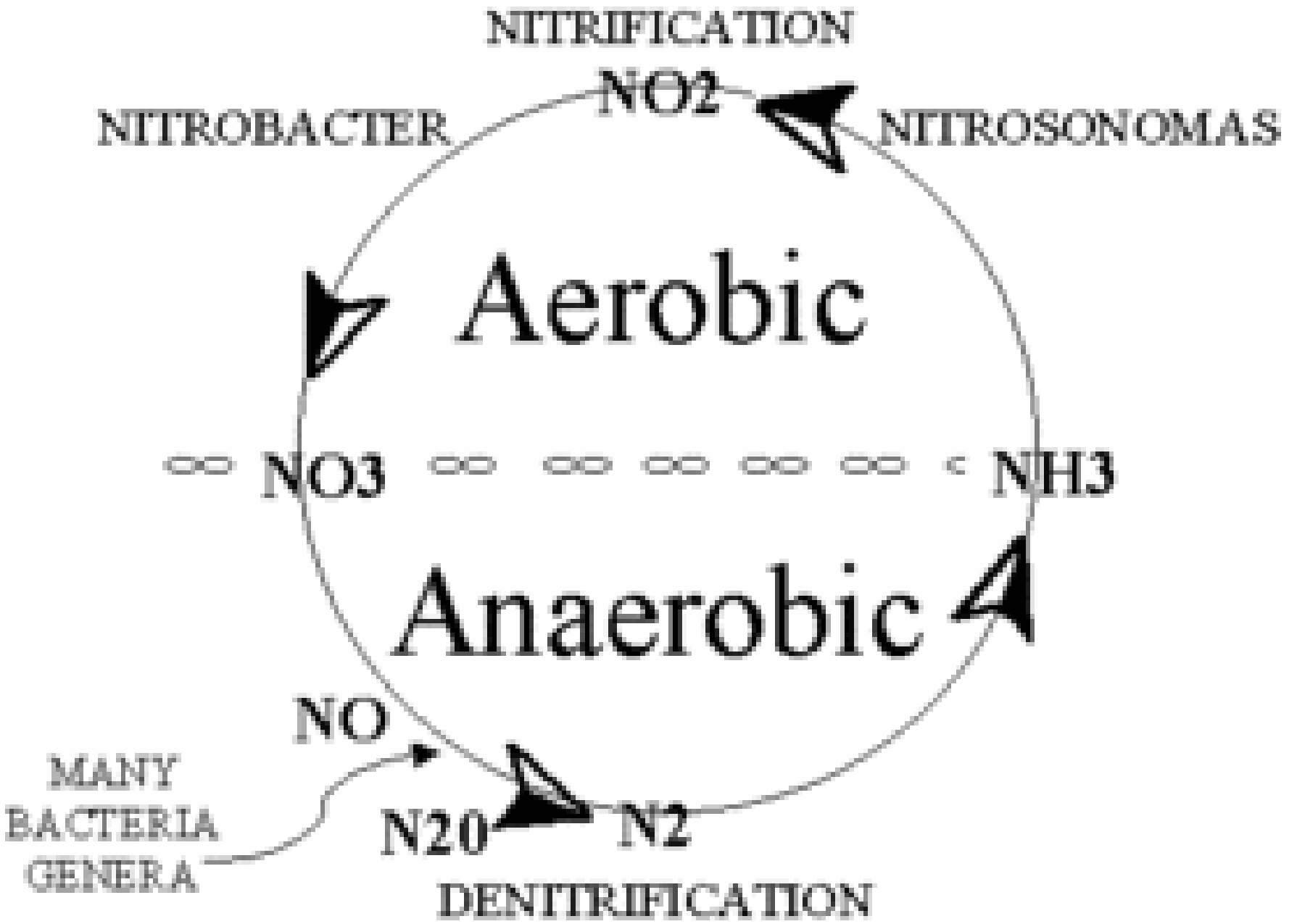
Thermal Process Systems

SNDR Process™

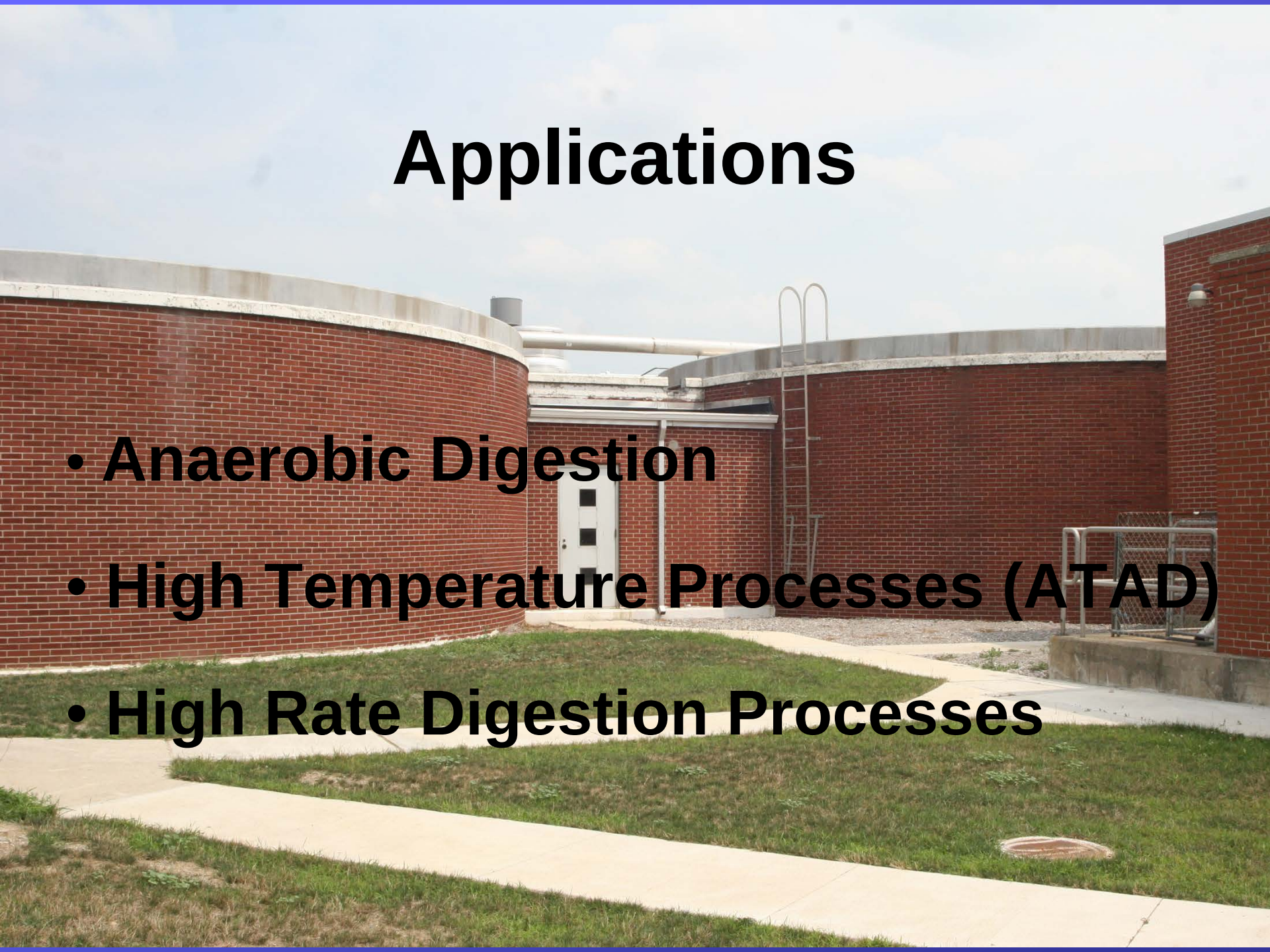
SNDR Outline

- Applications
- Reactions
- Conditions
- Considerations
- Advantages
- Case Study

NITROGEN CYCLE (SIMPLIFIED)



Applications



- Anaerobic Digestion
- High Temperature Processes (ATAD)
- High Rate Digestion Processes

Nitrification

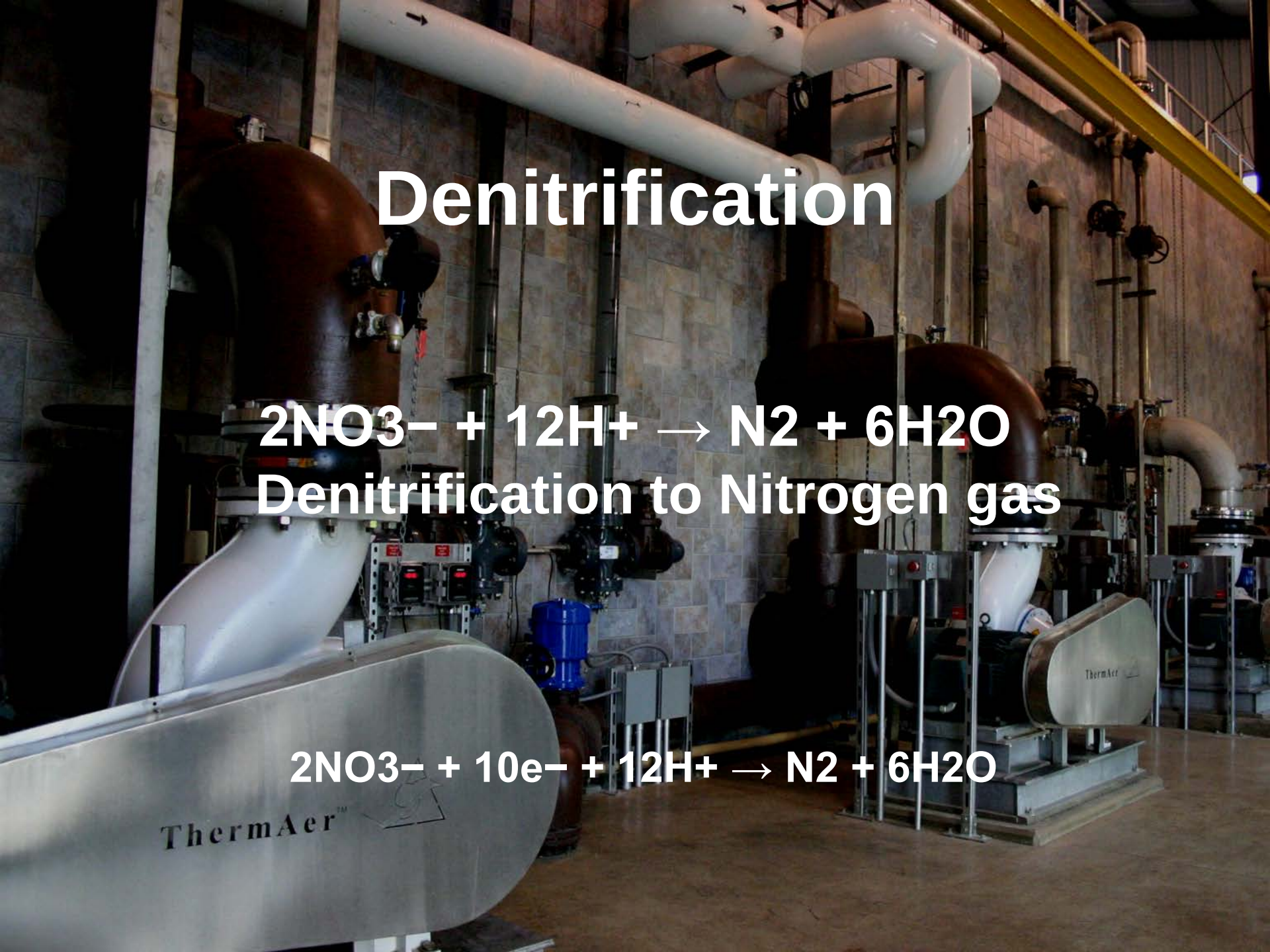
$$NH_4^+ + 3/2\ O_2 \rightarrow NO_2^- + 2H^+ + H_2O$$

Nitrification to Nitrite

$$NO_2^- + 1/2\ O_2 \rightarrow NO_3^-$$

Nitrification to Nitrate

$$NH_3 + O_2 \rightarrow NO_2^- + 3H^+ + 2e^-$$
$$NO_2^- + H_2O \rightarrow NO_3^- + 2H^+ + 2e^-$$

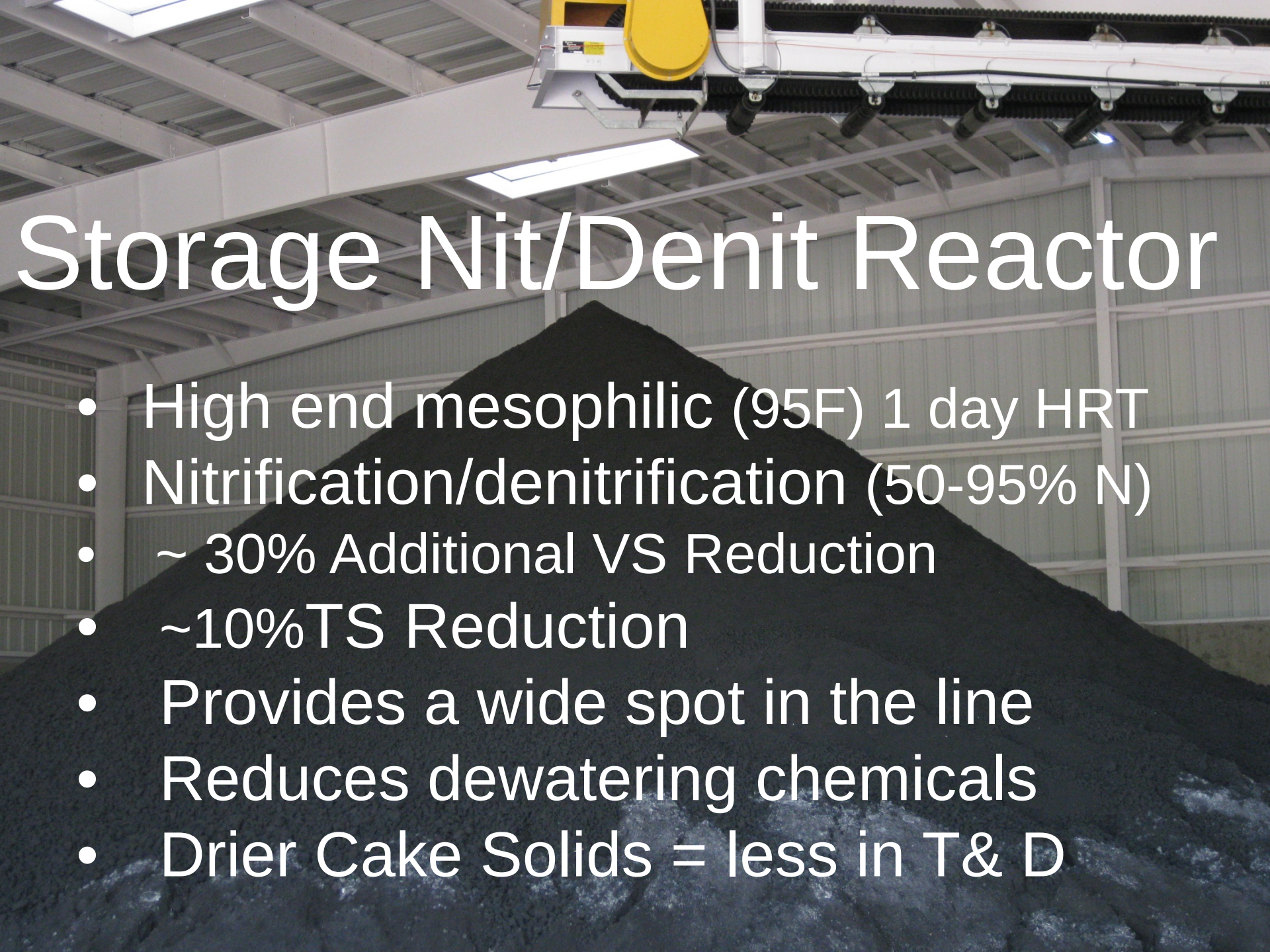


Denitrification

$2NO_3^- + 12H^+ \rightarrow N_2 + 6H_2O$

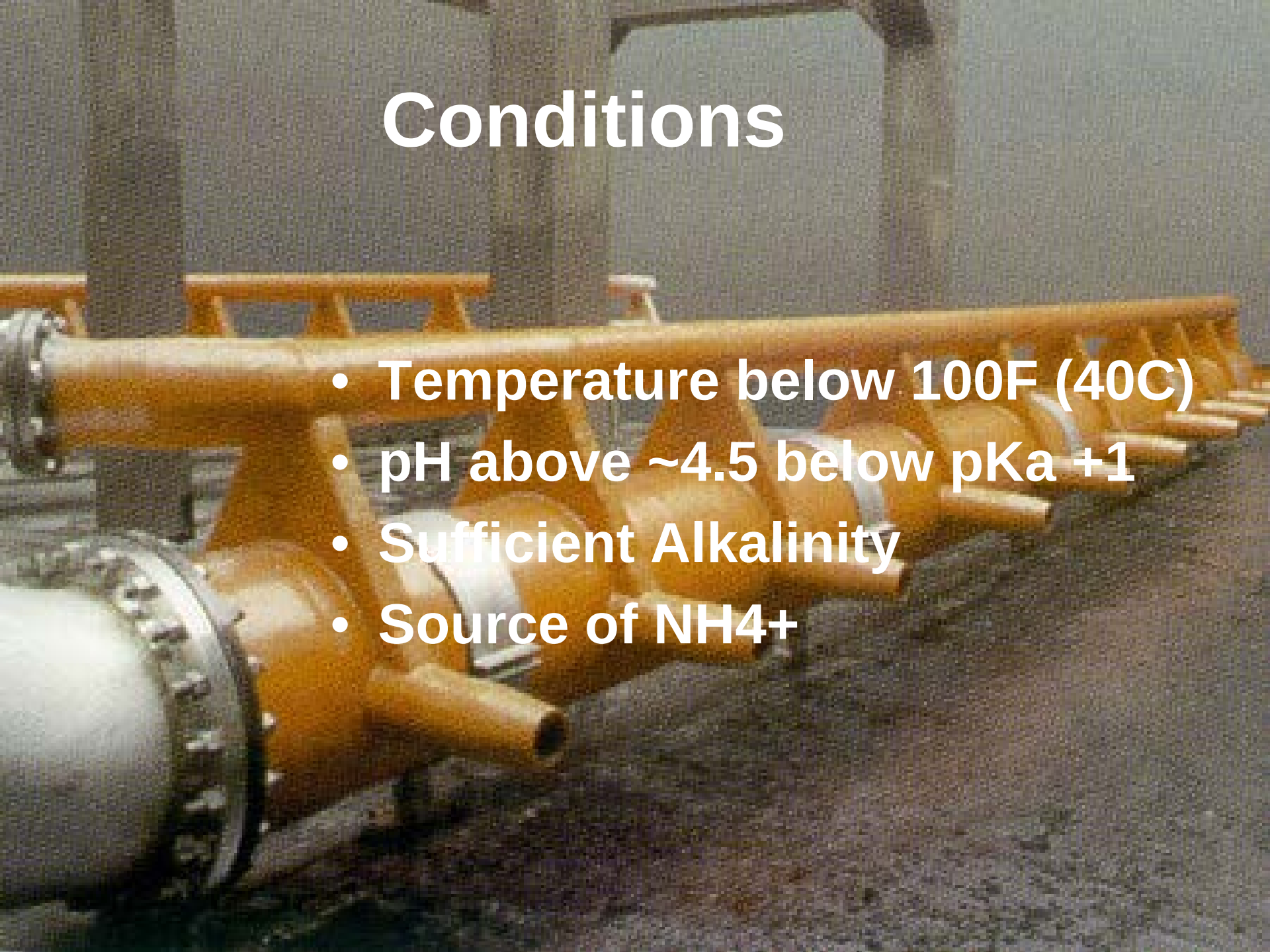
Denitrification to Nitrogen gas

$2NO_3^- + 10e^- + 12H^+ \rightarrow N_2 + 6H_2O$



Storage Nit/Denit Reactor

- High end mesophilic (95F) 1 day HRT
- Nitrification/denitrification (50-95% N)
- ~ 30% Additional VS Reduction
- ~10%TS Reduction
- Provides a wide spot in the line
- Reduces dewatering chemicals
- Drier Cake Solids = less in T& D



Conditions

- Temperature below 100F (40C)
- pH above ~4.5 below pKa +1
- Sufficient Alkalinity
- Source of NH4+

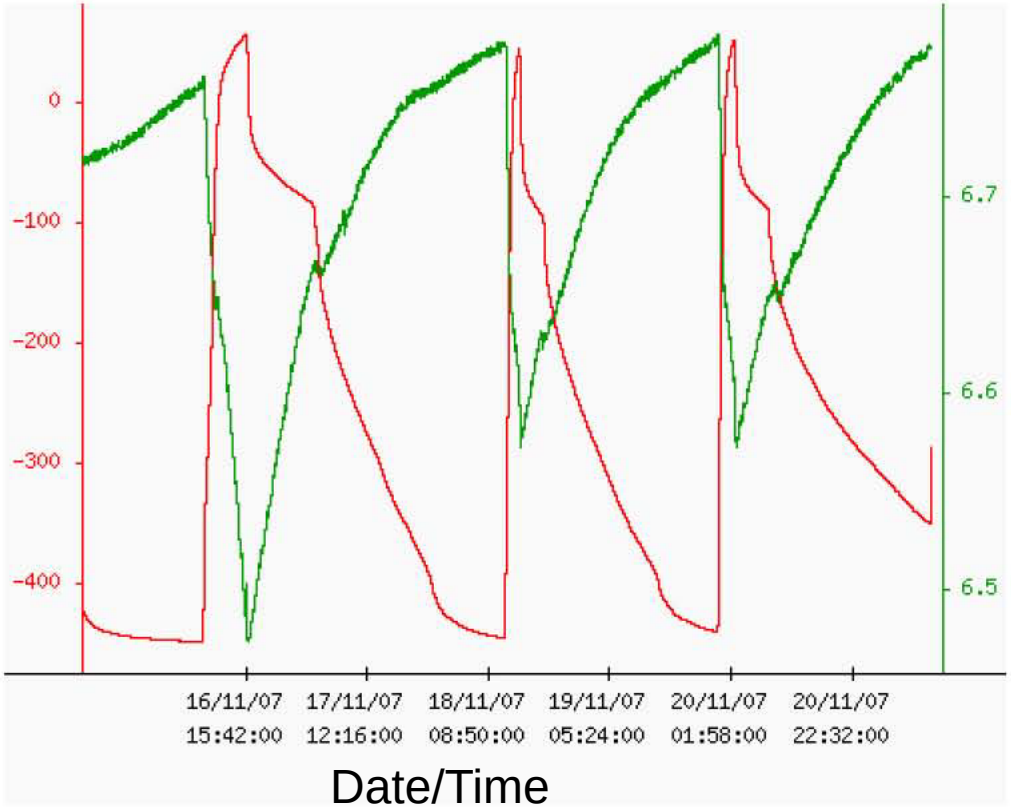
Retrofit of Existing Anaerobic Tank System

On-Line Monitoring

- **Temperature**
- **pH**
- **REDOX (ORP)**
- **levels…liquid, foam**

Nitrification/Denitrification Cycle

ORP (mV)



pH

Operational Considerations

pH in SNDR from transfer

Buffering of the pH occurs in the transfer

3000 to 5000 mg/L as $CaCO_3$

Soluble COD transferred over

Blower is off during and after transfer

SNDR Advantages

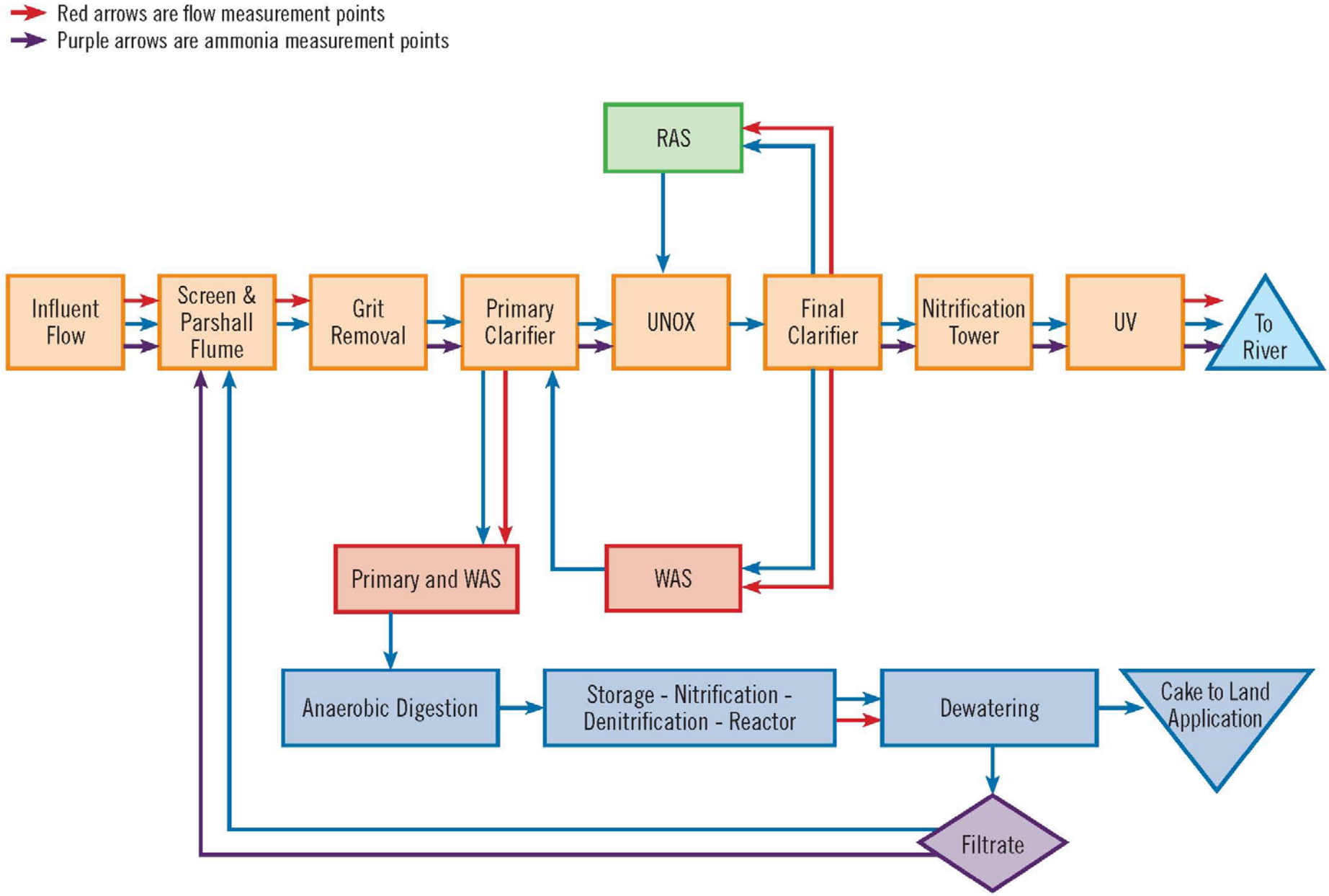
- Increased cake solids (mono/divalent)
- Less solids to store and transport
- Lower ammonia in recycle stream (~70%)
  Acts as biological scrubber
- Mesophilic temperature (air out = 95)
- Reduces operator exposure
- Reduces corrosion of equipment
- Odor free cake solids for storage or reuse

Product Parameters

Parameter	Concentration
N	2.3 – 5.5 %
P	1.3 – 3.6 %
K	0.5 – 1.0
OM	50 – 60 %
C/N	6 -10 : 1


WASTEWATER
TREATMENT PLANT
TOWN OF SPEEDWAY

FIGURE 1 Speedway Wastewater Treatment Plant



Speedway WWTP

- 1954 - 4 mgd trickling filter facility
- 1972- upgraded 7.5 mgd secondary treatment utilizing an innovative pure oxygen activated sludge facility – UNOX –
- 1991 - addition of nitrification towers
- 2001- replaced Zimpro process with Anaerobic Digestion
- 2001- added BFP for thickening and dewatering

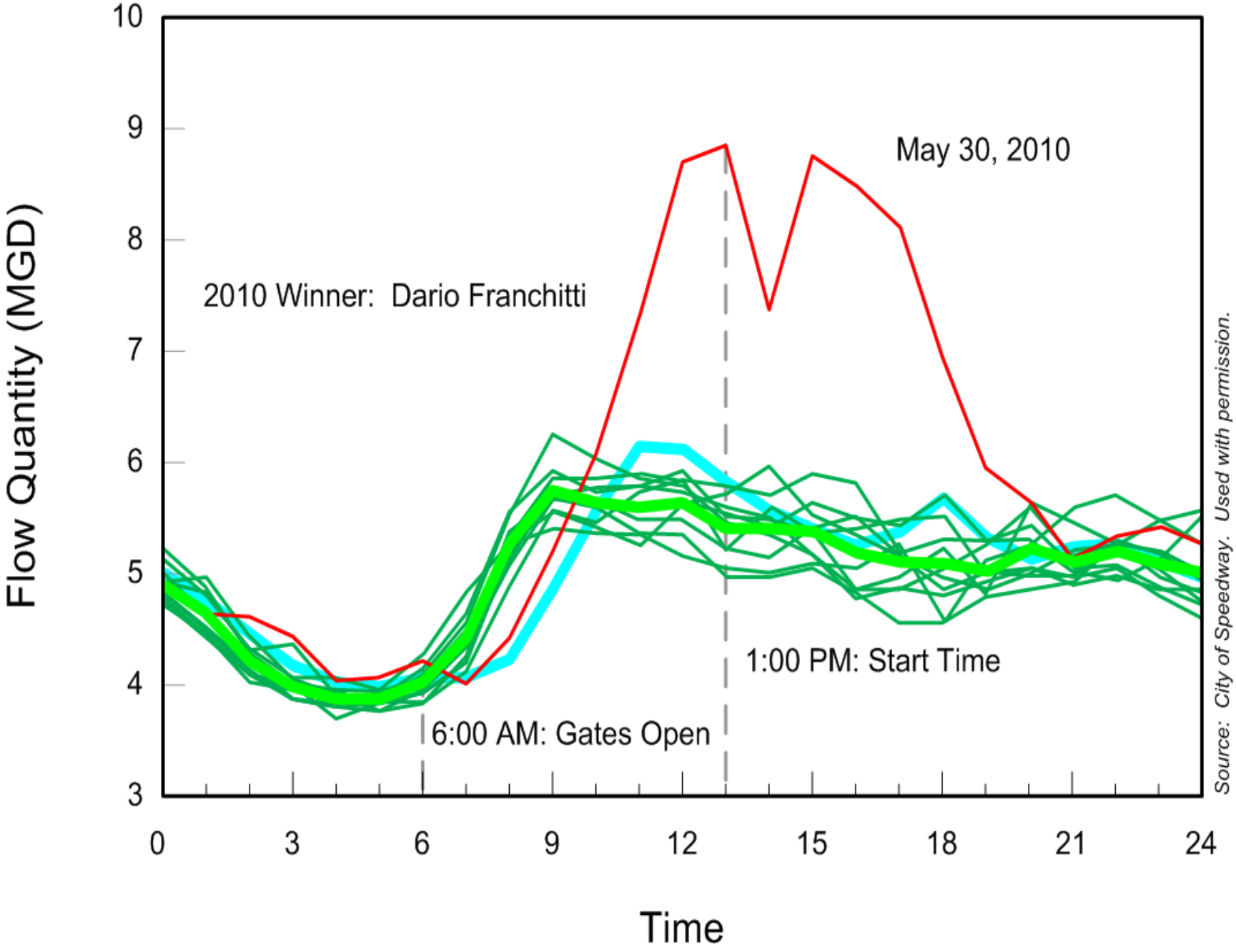

ICE
ICE


Speedway, IN


SULZER

SNDR Design

- Biological solids loading
- Volatile fatty acid oxidation
- Net nitrification/denitrification oxygen requirements
- Mixing is controlled by jet pump Operates at various speeds depending on oxic or anoxic mode
- Provides better oxygen transfer during oxic and mixing in anoxic


Flow Quantity (MGD)
10
9
8
7
6
5
4
3
0
3
6
9
12
15
18
21
24
Time
May 30, 2010
2010 Winner: Dario Franchitti
1:00 PM: Start Time
6:00 AM: Gates Open
Source: City of Speedway. Used with permission.

TROUBLE WITH AMMONIA

Speedway, IN

– NPDES permit requirement

- 1.5mg/l summer
- 1.6 mg/l /winter.

- Between 2008 and 2010, approximately 30 percent of the daily discharges exceeded the permitted ammonia level
- **Why so much ammonia?**

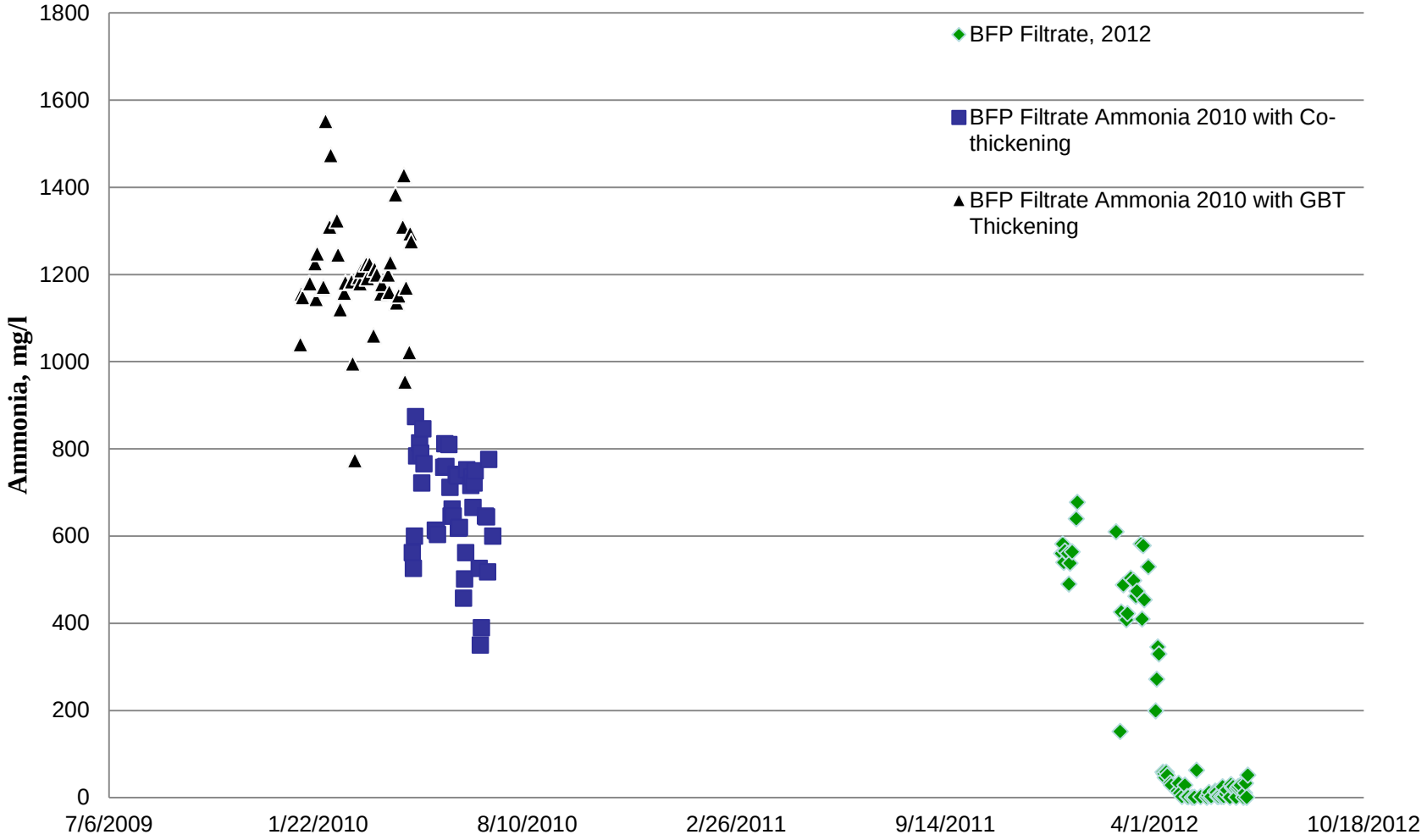
Ammonia Loading

Location	Average Concentration mg/l	Maximum Concentration mg/l	Average Loading lb/d	Maximum Loading lb/d
Raw Sewage	9.92	30.2	460	1,824
SIU stream w/o pretreatment	32	41	23	100
BFP Filtrate recycle	1,023	3,460	386	1,069
Total			869	2,993


DANGER
MOVING MACHINERY
CAUTION

Speedway, IN SNDR

Ammonia at the Indy 500



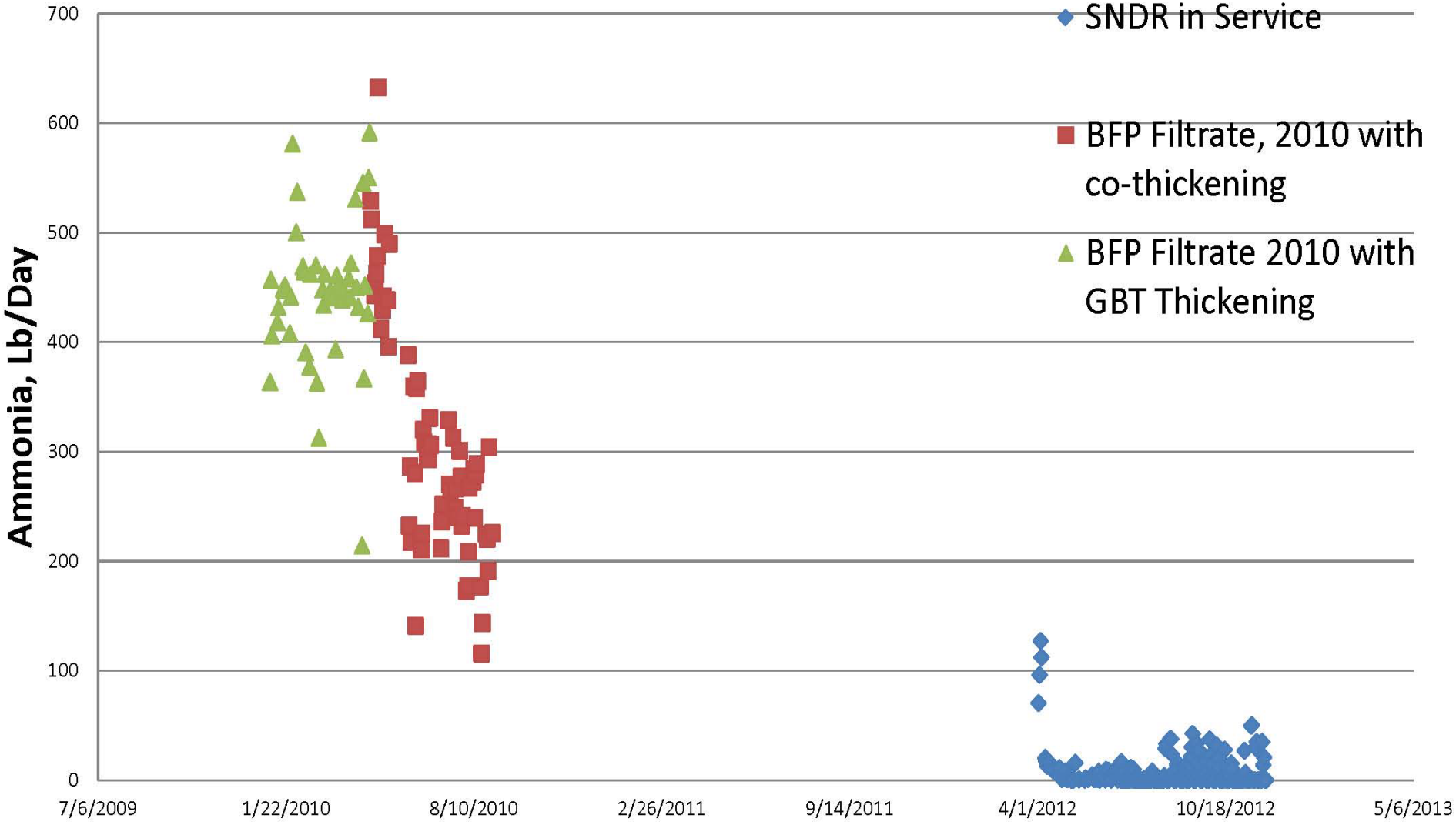
SNDR Control

- pH is primary control
- Secondary control: foam, temperature & ORP
- During oxic cycle, alkalinity is consumed and pH decreases and ORP increases
- Switch to anoxic cycle air turned off, (or trimmed), pH increases and ORP decreases

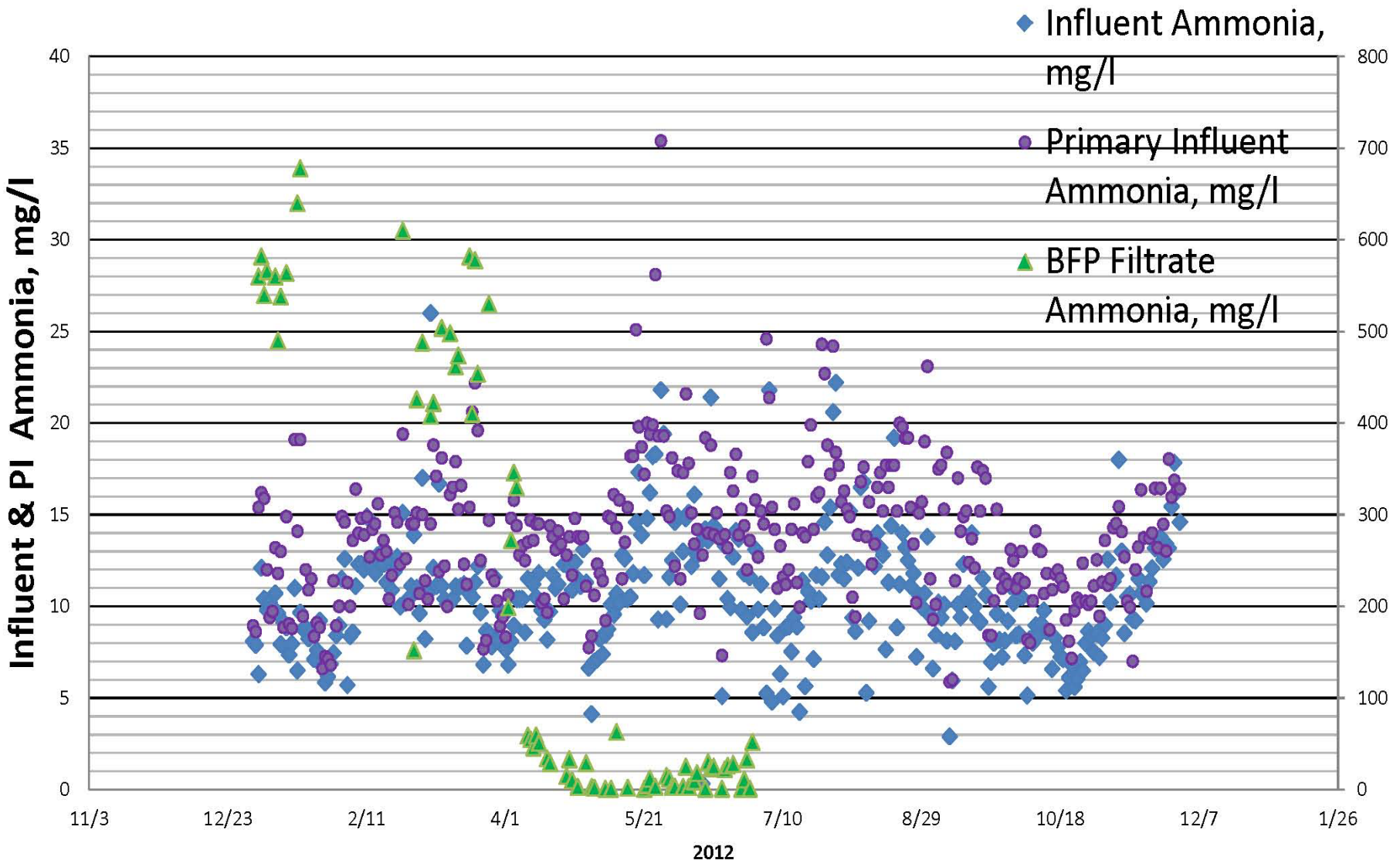
SNDR operation

- Pump and Blower equipped with VFD
- Typically air on ~75% of time
- Process controlled by pH and ORP
- Able to meet the high uptake demand on initial feed cycle and lower oxygen demand in anoxic cycle
- Vary blower and recycle rate independently

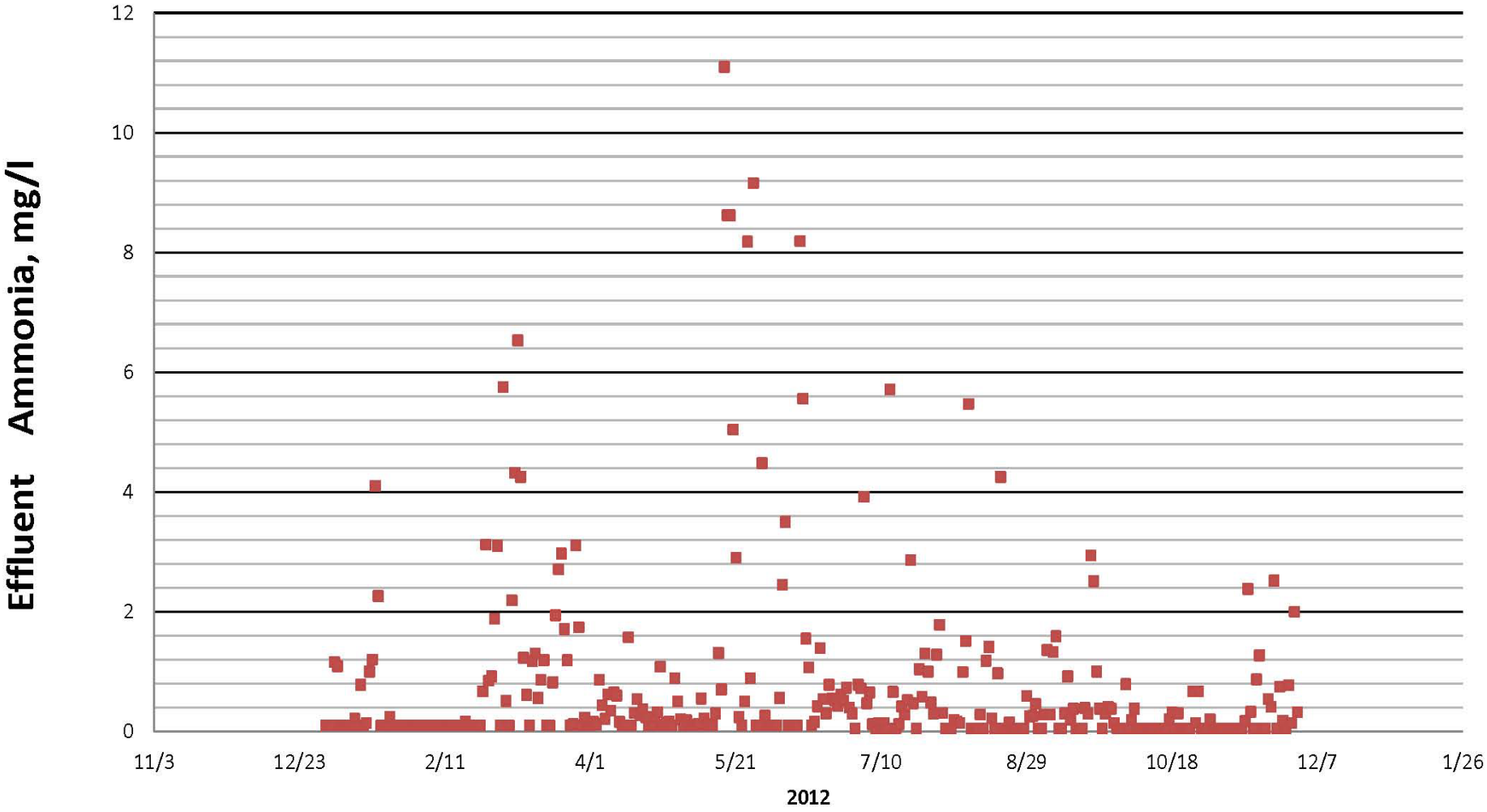
Ammonia Loading from Filtrate



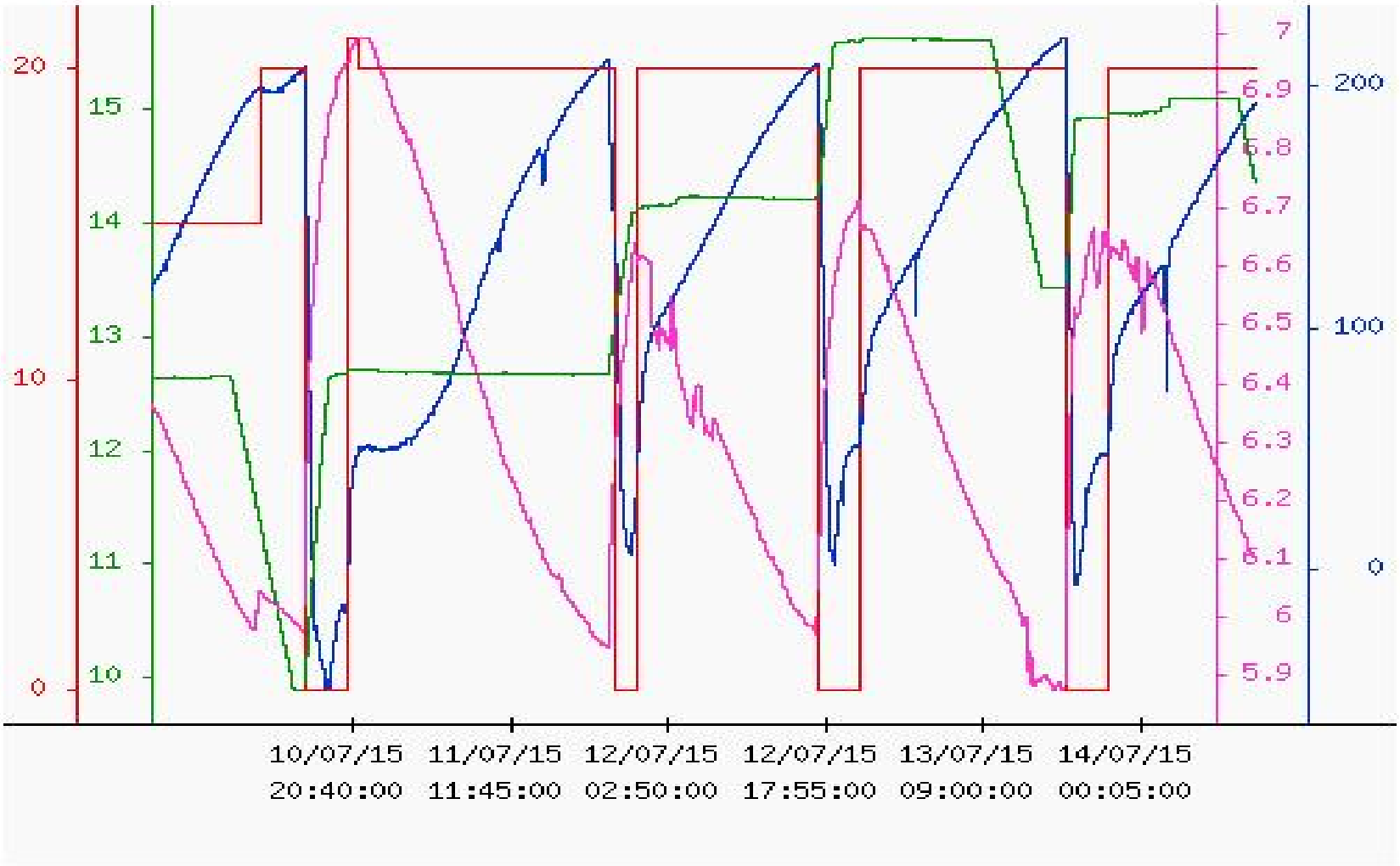
Ammonia, Raw, PI, Filtrate, mg/l



Effluent Ammonia, mg/l

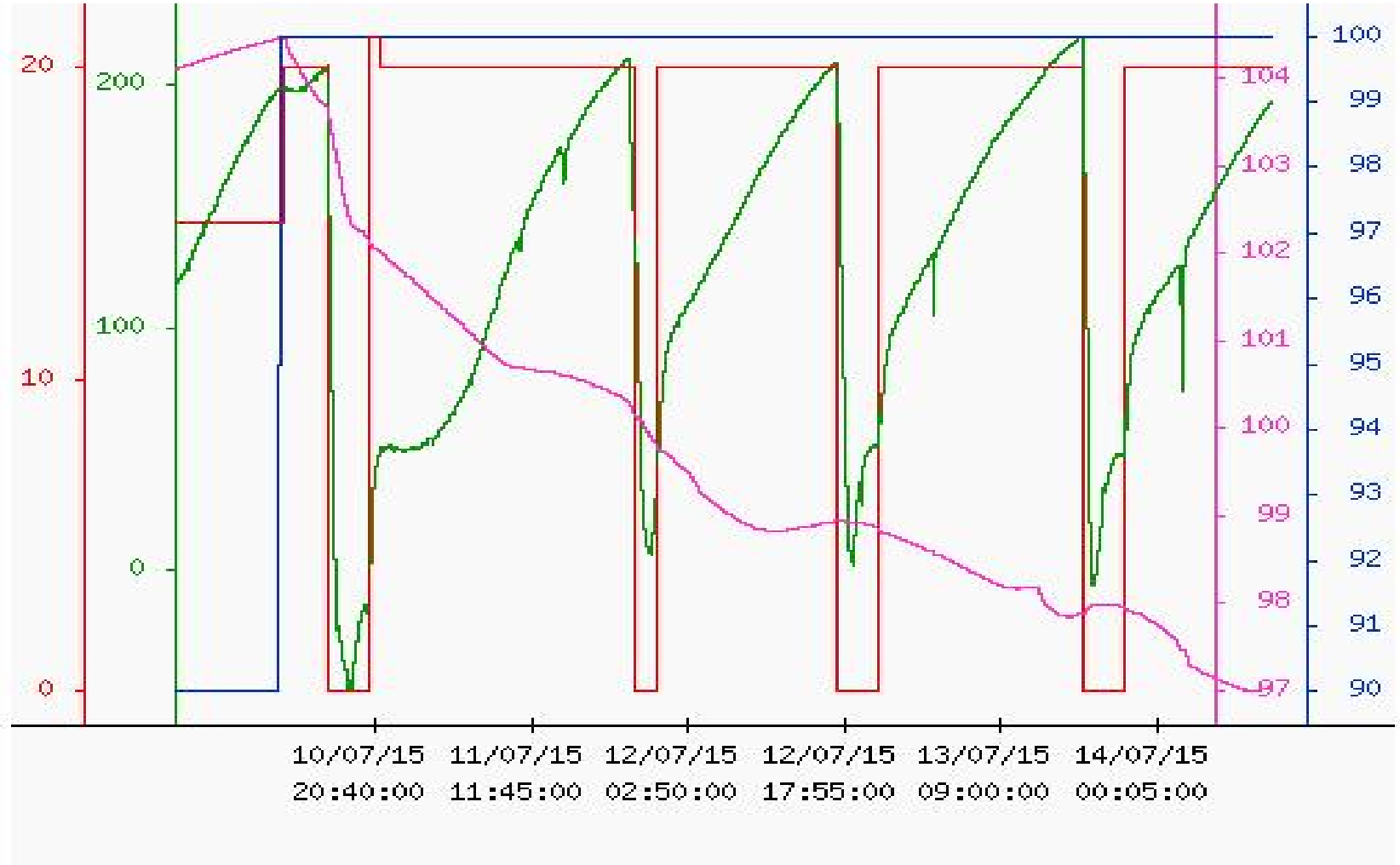


From: 01/07/2015 10:54:53 To: 14/07/2015 10:54:53 Common axis: Update graph



SNDR_BLOWER_SPEED	CURRENT SNDR PD BLOWER SPEED
SNDR_LIQUID_LVL	CURRENT SNDR LIQUID LEVEL
SNDR_ORP	CURRENT SNDR ORP VALUE
SNDR_pH	CURRENT SNDR pH VALUE

From: 01/07/2015 10:54:53 To: 14/07/2015 10:54:53 Common axis: Update graph



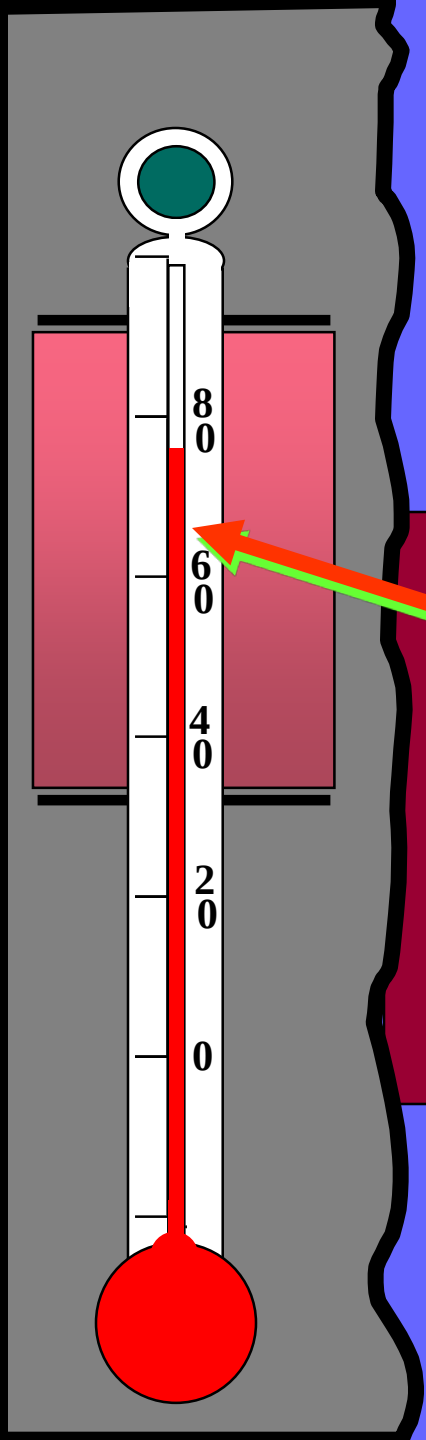
SNDR_BLOWER_SPEED	CURRENT SNDR PD BLOWER SPEED
SNDR_ORP	CURRENT SNDR ORP VALUE
SNDR_PMP_SPEED	CURRENT SNDR JET PUMP SPEED
SNDR_TEMP	CURRENT SNDR TEMPERATURE

SNDR Temperature

- Nitrifying and denitrifying bacteria are highly temperature dependent
- Ideal range is ~90 to 100 F >105 too extreme
- Outside Air is added to aid in temperature control

Conclusions

- Reduce nutrient recycle ($NH4^{+}$)
- Better cake quality
- Lower dewatering costs
- Better air quality in dewatering room
- Reduce volume of solids for T&D



ThermAer

Autothermal Thermophilic Aerobic Digestion

Biosolids Treatment

Kevin Staton
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