THE SECOND GENERATION ATAD: AN OVERVIEW

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WHAT IS AN ATAD?

- ATAD STANDS FOR
  - Autothermal
  - Thermophilic
  - Aerobic
  - Digestion
WHAT DOES THAT MEAN?

- Autothermal – the sludge is self heating from the heat given off by digestion
- Thermophilic – The sludge temperature is above 110 degrees F (Actually it will be between 140 and 150 degrees F, or 60 – 65 degrees C)
WHAT DOES THAT MEAN?

- Aerobic – the sludge is in an oxidizing state. There may be dissolved oxygen at some times
- Digestion – the process destroys solids
HOW MUCH HEAT IS IN SLUDGE?

- AUTOTHERMAL means that the sludge is self-heating.
- Digesting one pound of volatile solids releases, in theory, 9000 BTU
- One BTU raises the temperature of one pound of water one degree F
HOW MUCH IS THAT IN PRACTICAL TERMS?

- 2000 Lbs of sludge at 75% VS has 1500 Lbs of volatile solids
- If you destroy 50% of that, 750 Lbs are destroyed
- $750 \times 9,000 = 6,750,000$ BTU
- If the sludge is 5% TS, then the volume is 4800 gallons (40,000 Lbs)
- Temperature rise $= \frac{6,750,000}{40,000} = 168$ degrees F  PRETTY HOT!
SO WHY DON’T NORMAL AEROBIC DIGESTER GET HOT?

- Because they are open to the air and the air is an enormous heat sink and...
- Because there is a high flow of air taking the heat away
- Actually, they do, sometimes, and it often isn’t pretty
LIKE THIS
HOW DO WE KEEP FROM LOSING THE HEAT?

- Cover the tank
- Insulate the walls
- Use a volumetrically-efficient aeration system
COVERED TANK

2/8/05—Looking SE @ the aluminum cover on the east half of ATAD tank #2.
ANOTHER COVERED TANK
ANAEROBIC/ATAD CONVERSION
INSULATED WALLS

3/18/05--Looking NE @ the continued Thermax insulation installation along the east wall of the northern pump gallery.
EFFICIENT AERATION
AERATION SYSTEM
THREE RIVERS, MI

1/29/02 ATAD tank 24" air header w/ stn. stl. support sys

4/19/02 ATAD/24" air jet manifold in action at ATAD tank
WHAT’S SO GOOD ABOUT THERMOPHILIC OPERATON?

- The high temperatures kill pathogens. The bacterial kill rate is related to the temperature.
- The bugs work a lot faster, meaning the detention time can be shorter for good volatile solids reduction.
Time & Temperature

Time, Hours

Temperature

122 127 133 138 144 149 154 160 165 171 176 181
SYSTEM COMPONENTS

- ATAD REACTORS
- SNDR REACTOR
- STORAGE TANKS
- ODOR CONTROL
JET AIR HEADER

- Made of Fiberglas
- Provides mixing and aeration
- Outlet velocity 30 fps

1/4/05--Looking E @ the fiberglass drop line down to the jet aeration piping in ATAD tank #2
JET MOTIVE PUMP

- Provides motive power for jet aeration system
- Provides mixing as well
- Turnover time is about 35 minutes
PUMP WITH ORP PROBE
TANK COVERS

- Covered to retain heat and to contain odors
- Can be poured in place concrete, Concrete planks or Flat Panel Aluminum, or Combination
11/4/04--Looking W @ placement adjustment of a section of the 8" precast concrete deck for ATAD tank #2.
2/8/05--Looking SE @ the aluminum cover on the east half of ATAD tank #2.
FOAM CONTROL/TRANSFER PUMP

- Provides foam control and sludge transfer from reactor
- Piping is HOT and will be insulated
ANOTHER FOAM CONTROL PUMP
3/3/05--Looking S @ insulation installation around the 10" foam control piping for ATAD tank #1.
SPLASHCONE

- Sprays sludge down on foam layer
3/21/05--Looking NE @ the continued insulation installation along the east wall at the north end of the northern pump gallery.
AIR SUPPLY

- Normally dedicated PD blowers
- Can be from central air supply by motor-operated valves
- Flow controlled to maintain ORP
PD BLOWERS IN SOUND
REDUCING ENCLOSURES – DELPHOS OH
How is the ATAD Reactor Controlled?

- By ORP and Temperature

  The controller varies blower air and pump speed to control ORP
  - Feeding ATAD drops ORP: air and pump speed increase
  - When demand is satisfied ORP increases, air and pump speed decrease
SNDR REACTOR

- Stands for “Simultaneous Nitrification/Denitrification Reactor
- Removes 50% of ammonia from off gas
- Provides an additional 15% TS reduction
- Reduces ammonia and biopolymers by 65%.
- Reduces dewatering polymer and coagulant demand
- Heat loss by radiator and heat exchanger
3/4/05--Looking ESE @ the 6", 4" and cooling finned foam control piping for ATAD tank #3.
RADIATOR - DELPHOS
3/11/05--Looking N @ the progress in the northern pump gallery.
3/24/05--Looking N @ the first coat of paint applied to the heat exchanger in the northern pump gallery.
CONTROL FOR SNDR

- **Monitors**
  - ORP
  - Temperature
  - pH

- **Controls**
  - Air flow (time)
  - Flow to radiator
  - Flow to heat exchanger
  - Intent is to maintain tank temperature at 94°-96° F AND pH BETWEEN 6.5 AND 6.9
NITRIFICATION/DENITRIFICATION
BY PH CONTROL

pH/ORP vs Time

Time

9:36 AM  12:00 PM  2:24 PM  4:48 PM  7:12 PM  9:36 PM  12:00 AM  2:24 AM  4:48 AM  7:12 AM  9:36 AM

pH/ ORP (mv)

6.3  6.4  6.5  6.6  6.7  6.8  6.9

-350  -300  -250  -200  -150  -100  -50

0  50

0  50

-100  -150  -200  -250  -300  -350
Sludge feed can be continuous if there are 2 ATAD reactors. Only one reactor is fed in a day. Feeding alternates.

Sludge transfers to SNDR are batch transfers, done once a day.
WHY ONCE A DAY?

- To conform with the EPA regulation that “every particle” has to meet the required time and temperature
WHAT ARE THE CONTROL SETTINGS ANYWAY?

- SOLIDS RESIDENCE TIME (SRT)
  - The SRT will be 10-14 days.
  - The SRT is controlled by wasting and by tank level

- ORP
  - The program will attempt to maintain the ORP at a setpoint between +50 and -100 mV, depending upon experience.
  - Pumps will change speed and air flow will change to maintain setpoint
WHAT ABOUT ODOR CONTROL?

- The ATAD generates a lot of ammonia in the off-gas (about 900 ppm)
- Plus some reduced sulfur compounds from time to time
- 3-stage biofilter deodorizes off-gas
3 STAGES OF ODOR REMOVAL

1. Foul air is pulled from ATAD reactors to the SNDR. The foam control sprays absorb ammonia from off gas.

2. Spray water chamber at biofilter absorbs more ammonia. Most of ammonia is removed in stages 1 and 2.

3. Biofilter provides growth media for nitrifiers to consume ammonia.
TYPICAL FOUL AIR FLOW DIAGRAM

- BIO FILTER
- ATAD 1
- ATAD 2
- SNDR
BIOFILTER AIR DUCT

3/1/05--Looking SE @ 10" foam contol piping being installed just off the north edge of ATAD tank #1.
3/14/05--Looking NW @ the placement of the iron-based lava rock media in the soaker hose section of the biofilter.
SHREDDED TREE ROOTS

3/14/05—Looking NW @ the introduction of the root wood media in the soaker hose section of the biofilter.
SOAKER HOSES AND COVER ON TOP

3/16/05 - Looking SW @ the soaker hoses and start of cover installation at the east end of the biofilter.
BIOFILTER FAN PULLS FOUL AIR THROUGH FILTER

3/22/05--Looking NW @ the strobic fan as placed atop the biofilter cover.
PERFORMANCE AT INSTALLATIONS
STALEY STARCH, W.LAYFAYETTE IN

- First Plant
- 15 Dry Tons/day (TPD)
- Industrial
- Invented here because they were drowning in biosolids
BEFORE AND AFTER

- Dewatering 24 Hrs/day
- 12-14% solids
- Land applied after relicquefacation
- Odor Complaints
- Angry Neighbors
- Holding up plant production

- Dewater 3 days wk, 8 hrs day
- 18% cake solids
- Mixed with horse stall waste
- Everyone is happy
THREE RIVERS MICHIGAN

- 2.5 MGD Design
- Odor Complaints
- Failing Digesters
- Septage overloaded plant
INNOVATIONS

- New foam control scheme
- Treats septage primary and TWAS
THE RESULTS

- 45% TS Reduction
- Feed sludge thinner than design
- Hydraulic loading rate more than design
- Accepts 25,000 gpd septage at 1.5 MGD flow
- No problems
YORKVILLE ILLINOIS

- 2. MGD
- Plant expansion
- Tight Site
- Wanted to Reduce Biosolids Production
INNOVATIONS

- New foam control scheme
- Heat exchanger to cool down sludge
- First SNDR tank
THE RESULTS?

- 50% TS Reduction
- SNDR reduced polymer and chemical dose
- Cake solids 28% with 100% WAS feedstock
- Cake certified as compost
BOWLING GREEN OHIO

- 5 MGD Flow
- Plant expansion
- Stinky aerobic digesters
- High power cost
- Capacity is 15,800 Lbs/day
WHY ATAD?

- Potential for cost savings
- Biggest reduction – aeration power reduced from 900 Hp to 450 Hp
INNOVATIONS

- Passive radiator to cool SNDR
- Continuous feed-2 reactors
- Air from common header with aeration tanks
- Open storage tanks
THE RESULTS

- Up to 65% TS reduction
- 75% VS reduction
- 32% cake solids
- Polymer dose of 7 Lbs active/dt with centrifuge
- Biosolids cake now sent to soil blender
- Costs reduced $390,000/yr compared to aerobic digestion
ATAD Reactors Process Indicators

AMMONIA, TOO – 65% REDUCTION

COD Concentration (mg/lt)

Ammonia/Ammonium as N (mg/lt)

Feed Tank 1 Tank 2 Tank 3 Tank 4

Soluble COD

Ammonia/Ammonium

AMMONIA, TOO

AMMONIA, TOO

–

–

65%

65%

REDUCTION

REDUCTION
MORE GOOD STUFF

- COD and NH3 reduction reduces polymer dose and allows for settling
- Supernating for volume reduction possible
- With powdered bentonite
- Without powdered bentonite
MOREHEAD, KY

- Retrofit of anaerobic digesters
- Capacity 6,600 Lbs day
MORE PICTURES
THE RESULTS

- 60% reduction in sludge cake to fields
- Cake solids went from 15% to 21%
- Elimination of anaerobic digester recycle caused aeration tank blower to be oversized (OOPS!)
- Maintains temperature with only 2% feed solids
DELPHOS OH

- Part of new plant design
- Digests MBR sludge, which is well-oxidized
- Capacity is 8,800 Lbs/day
INNOVATIONS

- Treats gravity belt thickened MBR WAS, a low volatile waste
THE RESULTS

- 63% VS Reduction
- 22% cake solids with belt press
- $170,000 savings/yr in dewatering/disposal costs (sludge is given away)
Heart of the Valley, Wisconsin

- Treats Actiflo primary sludge and Biostyr WAS
- Capacity 21,800 Lbs/day
INNOVATIONS

- Treats Actiflow primary waste and Biostyr secondary waste
THE RESULTS

- 63% VS reduction
- 56% TS reduction
- No odors
- Good supernating
- Liquid land application
MARSHALL MINNESOTA

- Anaerobic digester retrofit
- Capacity 12,000 Lbs/day
- Plant flow 2 MGD, heavy industrial waste from ADM
- Primary and TWAS
WHY AN ATAD?

- Anaerobic digester covers failed after 11 years: $1 million to replace. Other equipment in need of replacement.
- ATAD produced fewer biosolids for equivalent costs
EQUIPMENT LAYOUT
INNOVATIONS

- Liquid storage in covered tanks (4 MG volume)
- Good supernatating without chemical addition
THE RESULTS

- 50% TS reduction
- 65% VS reduction
- Digested biosolids decant to 5% + TS
- Anaerobic sludge only decanted to 2.5%
- 67% reduction in land application cost
- Supernatant ammonia only 56 mg/L
- Reactor Temp: 155F  21 minutes pathogen kill time
CONCLUSIONS

- ATAD is cost effective
- 50-65% TS reduction
- 55-75% VS reduction
- Good supernating
- Good cake solids
- Low polymer dose
- Non-farm market for end product