Benefits of Covered Aerated Static Pile Composting with Positive Aeration

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Benefits of positive aeration design

1. Subjective benefits of positive aeration
   - ❖ Permits use of efficient covered aerated static pile composting technology
   - ❖ Simpler to design and control
   - ❖ Biofilters not required for emissions control
2. Objective benefits of positive aeration
   - ❖ Reduced energy demand
   - ❖ Uniform air distribution in air plenums

Simplicity of Design

- Dedicated blower for each pile
- Eliminates control valves and manifolds
- Easily automated
- Lower cost
  1. No biofilter required
  2. Lower cost of materials, i.e., less piping and less corrosion protection

Overall Aeration Efficiency

- Positive aeration requires 60 to 100 percent less energy than negative aeration
- The specific volume of the gases is higher with negative aeration than with positive aeration. The volume of gas to be compressed is also higher due to the moisture concentration. These factors alone cause more than a 60 percent loss in efficiency
- No headlosses from biofilter

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Air Distribution

- It is essential to take uniform headloss at the orifices to obtain proper air distribution form the aeration plenum (can not rely on the mix to do this; some times the entire length of aeration plenum may not be covered)
- Design of hydraulic diffusers (Perry's Handbook of Chemical Engineering,)
- On-Farm composting Handbook "Rules of Thumb"
  1. Sum x-sectional area of orifices equal to x-sectional area of the aeration plenum
  2. Headloss in orifices 10X headlosses in aeration plenum

Aeration System Calculations

1. Design targets
- 3-5 Hp for 100ft to 175 ft aeration plenum
- 700-1,000 CFH/ton of dry compostables
- Total aerations system pressure losses, including compost mix and cover 8 to 11-inches H_2O
2. Air plenum headloss calculations
- Closure algorithm (Haug, R. T. ,1993)
- Perry's Handbook of Chemical Engineering
- MOR, Inc Excel Spreadsheet (iterative process)

Aeration Plenum Design

- Input
  1. Plenum air flow, acfm
  2. Plenum diameter, in
  3. Air temperature, ^{o}F
  4. Plenum length, ft
  5. Orifice diameter, in
  6. Orifice spacing, in

- Output
  1. Velocity in plenum, ft/sec
  2. Velocity through orifices, ft/sec
  3. Delta P through aeration plenum, orifices and pile, inch H_2O
  4. Mal-distribution, %
  5. Blower Hp required

MOR, Inc. Air Plenum Calculations

DESIGN
OF AERATION SYSTEM

INPUT DATA

Total Rqrd Flow Per Dry Ton Acfhr	Dry Tons/ Pile	Rqrd Total Flow ACFM	No Pipes #	Pipe Dia Ft	Press Psia	Temp oF	Length Ft	Dia Hole In	Holes In Each Pipe #
1500	31.8	795	3	0.500	13	100	160	0.1875	480

OUTPUT DATA

Rqrd Flow In Each Pipe ACFM	Area Ratio	Vel Down Pipe Ft/sec	Vel Thru Holes Ft/sec	Delta P Down Pipe In H20	Delta P Thru Holes In Pipe In H20	Delta P Thru Pile & Thru Holes In Pipe In H20	Delta P Thru pile + Head Comp Must Develop In H20	Delta P Ratio	% Mal-Distribution
265.1	0.47	22.51	50.51	0.26	1.50	4.50	4.76	5.72	9.2

Note: Delta P Ratio should be about 10 or larger to give 5% mal-distribution or better

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Aeration Plenum/Orifice Construction

Air distribution testing (smoke tests)

Air distribution tests should be preformed at commissioning:

- At top of air plenum
- Above base layer
- On top of the pile surface

Air Plenum/Testing

CVWRF encased air plenum

Air plenum smoke testing

Emissions Control Factors

- ePTFE micropore covers
  1. VOC capture efficiencies ,85 to 95 percent
  2. Ammonia capture efficiencies , 70 to 85 percent
  3. Odor (D/T) , 75 to 90 percent reduction in emissions
- Biofilter
  1. VOC, ammonia , and odor reduction all over 90 percent for well designed/maintained biofilters
  2. High ammonia concentrations, especially associated with anaerobically digested biosolids and green wastes with low C:N ratio, may effect biofilter performance
  3. Biofilters must have good moisture control to achieve optimum removal rates

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Emissions Control

38ft X 175ft ePTFE micropore cover , Salt Lake City, Utah

175ft diameter X 8ft deep Biofilter, Bakersfield, California

Positive vs. Negative Aeration

- Less system corrosion
- Lower leachate generation ((Nicoletti and Taylor, 2005)
- Less degradation of woodchip layer above aeration plenums causing an increase in blower Hp requirements (Paul and Geesing, 2009)
- Forced air exists the compost mix over the entire surface area surface, pilot study in Tenino, WS 2007

Closing comments

Positive aeration provides better:

- Air flow
- Air distribution in the pile
- Lower system pressure losses
- Less energy consumption
- Better temperature control, especially when over -heating is a concern

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