Lessons Learned in Aerated Static Pile (ASP) Composting

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ASP Lessons Learned Overview

- ASP History (Beltsville Method) and definition
- Pile porosity, moisture and height must be consistent
- Within a large compost pile the moisture loss = energy loss = total decomposition
- Air flow direction as a tool to manage moisture
- Air duct sizes and blowers must match feedstock volatility (one size does not fit all)
- Turning and rewetting systems must be considered for energetic feedstock mixtures

What is an ASP?

Definitions

- Aerated Static Piles are forced aeration composting systems for carefully constructed and blended piles of organic residuals.
- They provide adequate oxygen and control of pile temperature by adjusting the amount and direction of airflow

- Control of air flow is done by using:
  - Suction and/or pressure blowers; and
  - On/off timers; and/or
  - Temperature feedback
  - Zone dampers; and/or
  - Bidirectional dampers

The Role of ASP's in a Compost Process

Desired Role	Process Consequence
• Contain and treat initial odorants (VOC's) during the first 7 to 10 days • Provide temperature control to meet sanitation requirements • Significantly reduce oxygen demand for any following processes	• Media dries as energy is released as water vapor • Compost process slows as moisture is lost • Settling can reduce pile porosity and limit airflow • Surface precipitation can create veins of saturation • Odors can develop in saturated areas

Different Approaches to ASP Systems

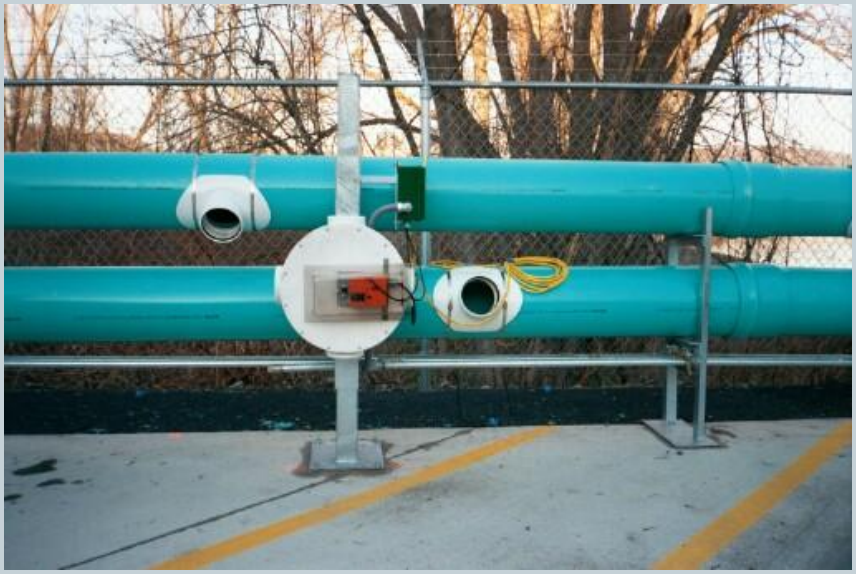
Aeration direction	Consequences
• Positive (pressure) aeration →	• Less power and leachate, but dries out pile quickly • Large temperature gradients within the pile • Requires a biofilter surface layer or membrane cover
• Negative (suction) aeration →	• 1/3rd more power for the same air flow rate, • More leachate and condensate • Less temperature gradients • Requires fixed biofilter

Auto-Reversing Air Flow

Alternating positive and negative aeration

4 Way Rotary Damper

- Retains moisture
- Controls temperature gradients with high/low sensors
- Requires both surface biofilter layer and fixed biofilter on exhaust



GMT facility in Chenango, NY

Alternating Direction ASP

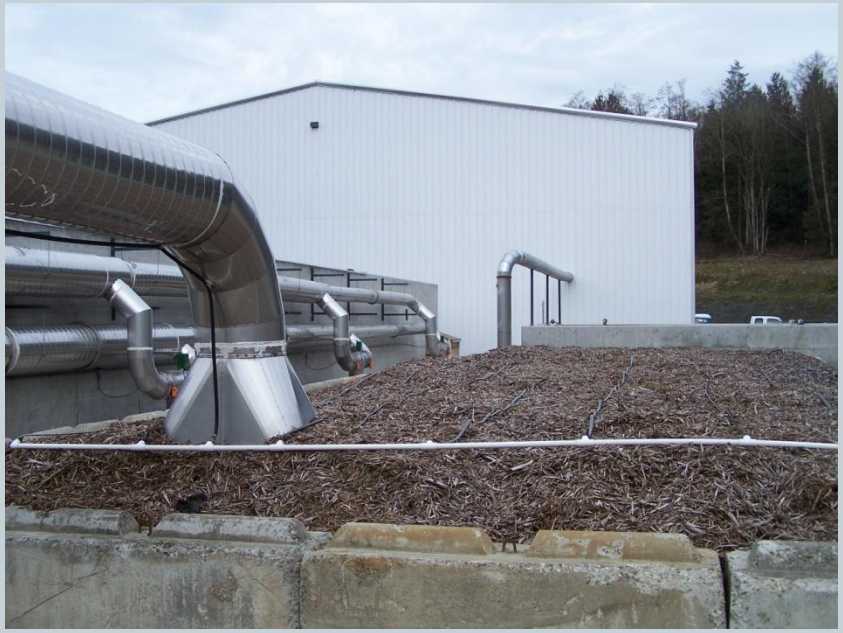
Positive w/Biofilter layer

Perforated trench covers at 7” pressure

Lenz Enterprises, Stanwood, Washington

Negative with Biofilter

Pulled from pile at 10” suction

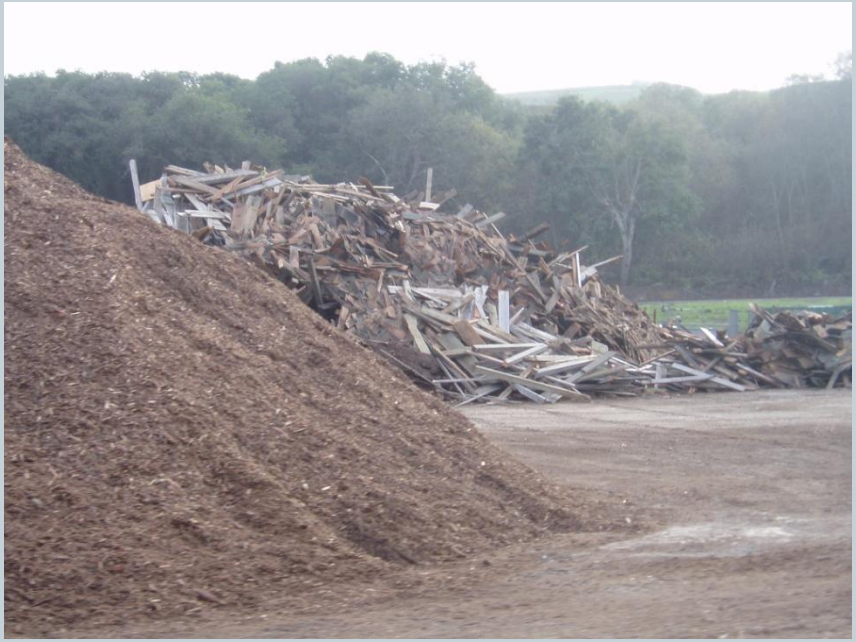


Proper Pile Mixture & Preparation

Carefully & Completely Mix

- Dry, fine and coarse materials must be added to wet, dense feedstocks
- Up to 2/3rds of the mix might be bulking agents
- Bulk density below 800 lbs./cubic yard is best
- Higher initial moisture levels are targeted 60% to 65%
- Blended <u>thoroughly</u>

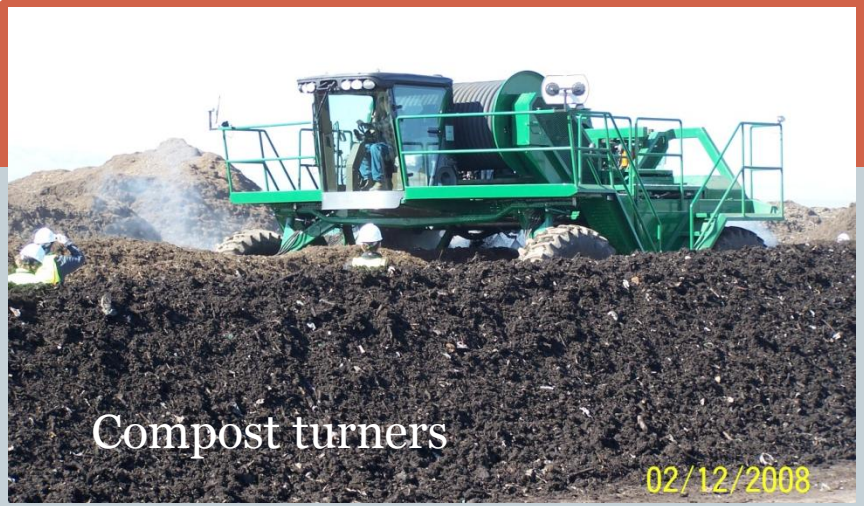
Bulking Agents



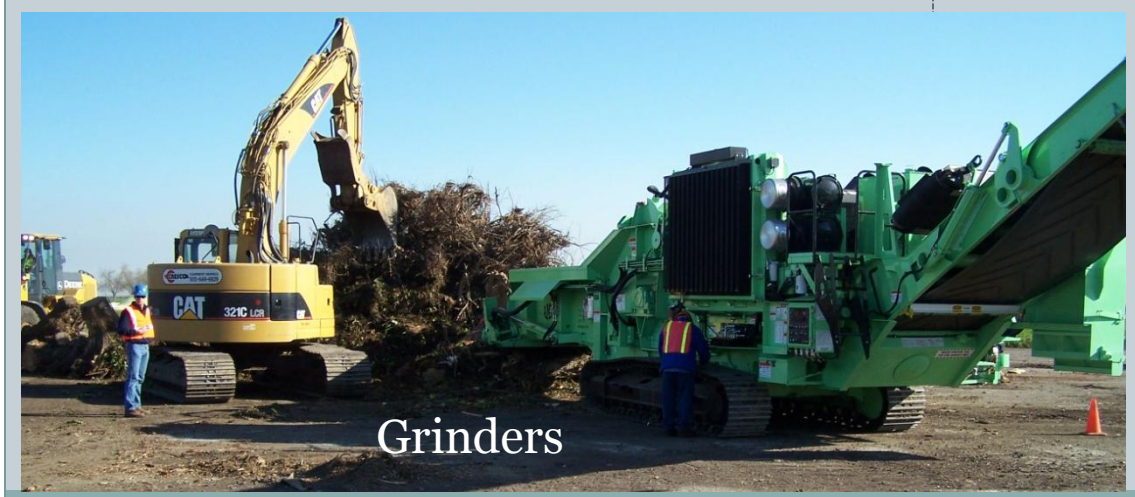
Vision Recycling, Santa Cruz, CA

Mixers

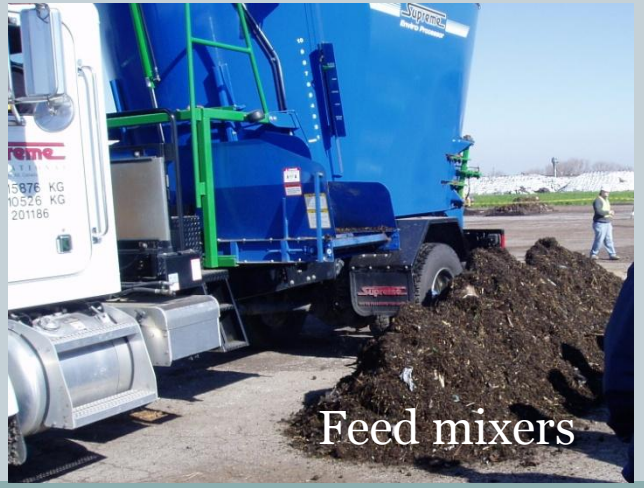
Manure spreaders



Compost turners



Grinders

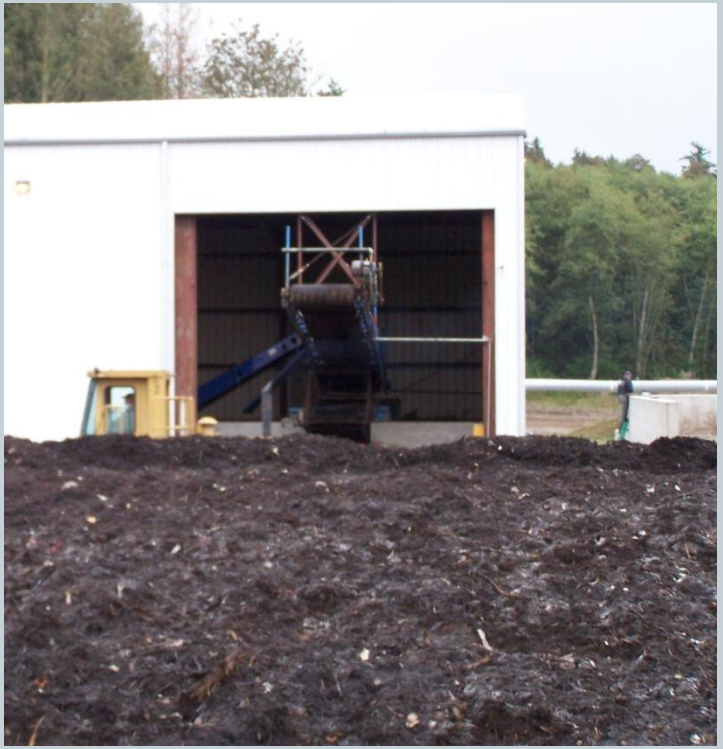


Feed mixers

Moisture Additions and Replacement

Over head watering prior to turning

Conveyor spray bars



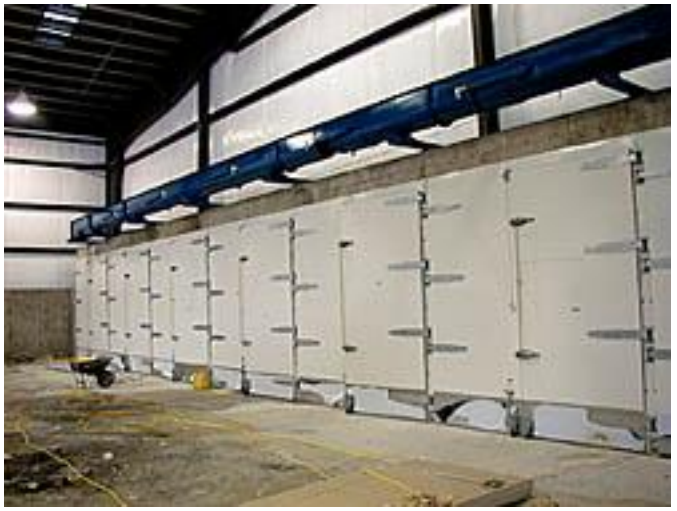
High Tech or Low Tech?

Whether in-vessel or in-open pile, aerated static piles can be expensive or cheap, but either needs to be filled carefully and evenly to reduce short circuiting of air flow.

Consistent porosity -

Consistent moisture -

No packing in or driving on pile edges -



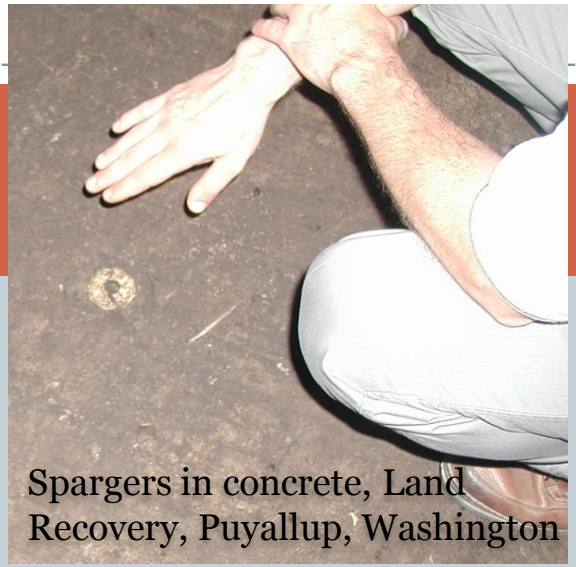
West Yellowstone Compost Facility

Cold Creek Compost, Ukiah, CA

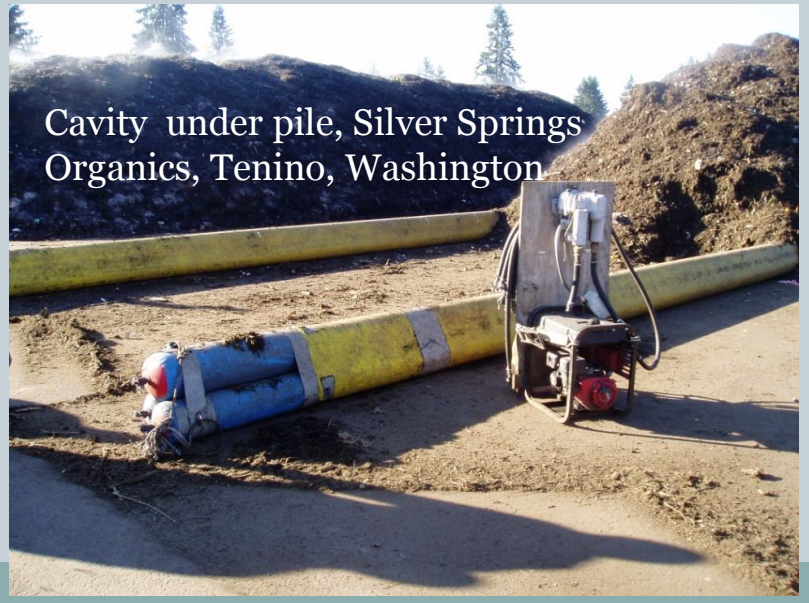
ASP Air Distribution Systems

Pipes, trenches, spargers, cavities

- Above ground perforated pipes
- Trenches with perforated covers
- Spargers up through concrete from pipe manifolds
- Under-pile cavity forming system



Spargers in concrete, Land Recovery, Puyallup, Washington



Cavity under pile, Silver Springs Organics, Tenino, Washington

Covers used in the first weeks of composting reduce compost emissions

- Lifecycle VOC emissions from green waste composting in windrows were measured at less than one pound of VOCs per ton of compost feedstock
- 70-80% of the generation of VOC from Green Waste Windrows occurred in the first 2 weeks
- VOC emissions doubled by adding Food Waste
- Using compost as a cover reduced emissions by 75% compared to uncovered pile

- San Diego State University - pseudo compost covers report http://www.ciwmb.ca. gov/publications/organics/44207009.pdf

Primary Types of Compost Covers

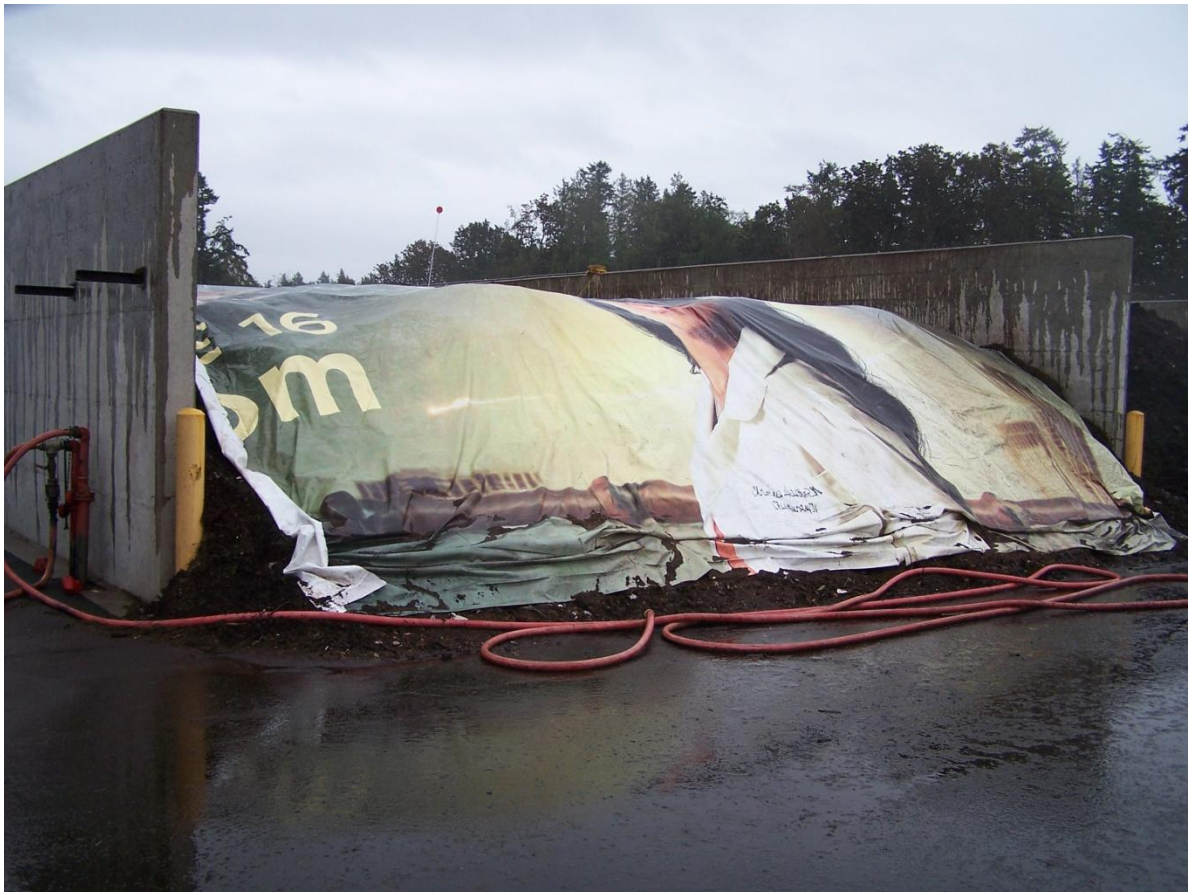
- Impermiable
- Microporous Membrane
- Spun or open weave fabrics
- Covers can help control moisture levels

Covering piles

Covering piles reduced the temperature variability

Condensate forms in the top layer just below the cover

Oxygen levels stayed high and drying still occurred through the rest of the pile



Lenz Enterprises covered piles trials

Large volumes of air are needed to maximize Volatile Solids (VS) reduction!

- Determining the Degree of Aerobiosis of Composting Materials
  - Maintaining oxygen concentrations above 13% as air left the pile reduced anaerobic pockets
  - Oxygen consumption rates of over 4.5 to 8.4 mg O2/g vs*hr were observed and these batches reduced VS at a significantly higher rate than those below 13%
    - Klauss, Papadimitriu in ORBIT Bioprocessing of Solid waste and sludge Vol 2 No.1, 2002

- Air flow rates for a 3 meter high pile should be 35-40 $m^3/hr/m^2$ of floor area during the high oxygen demand period of composting over the first 3 to 5 days. This provides adequate cooling to <65° C and keeps oxygen levels above 13% for a green waste/food waste blend. This will then maximize VS reduction and dry the pile.

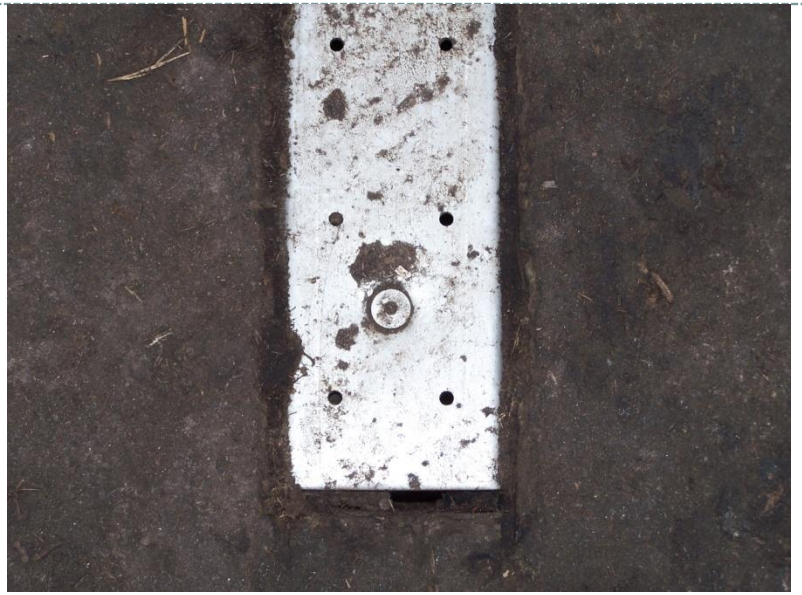
Not enough air flow? Assisting trench covers

Drill out larger holes in plates, or add more holes

Decrease mix bulk density or pile height

Place coarse woody material over the trench covers

Or design the system for higher pressures and more air flow.



Lenz Enterprises, Stanwood WA

Port Angeles WWTP WA

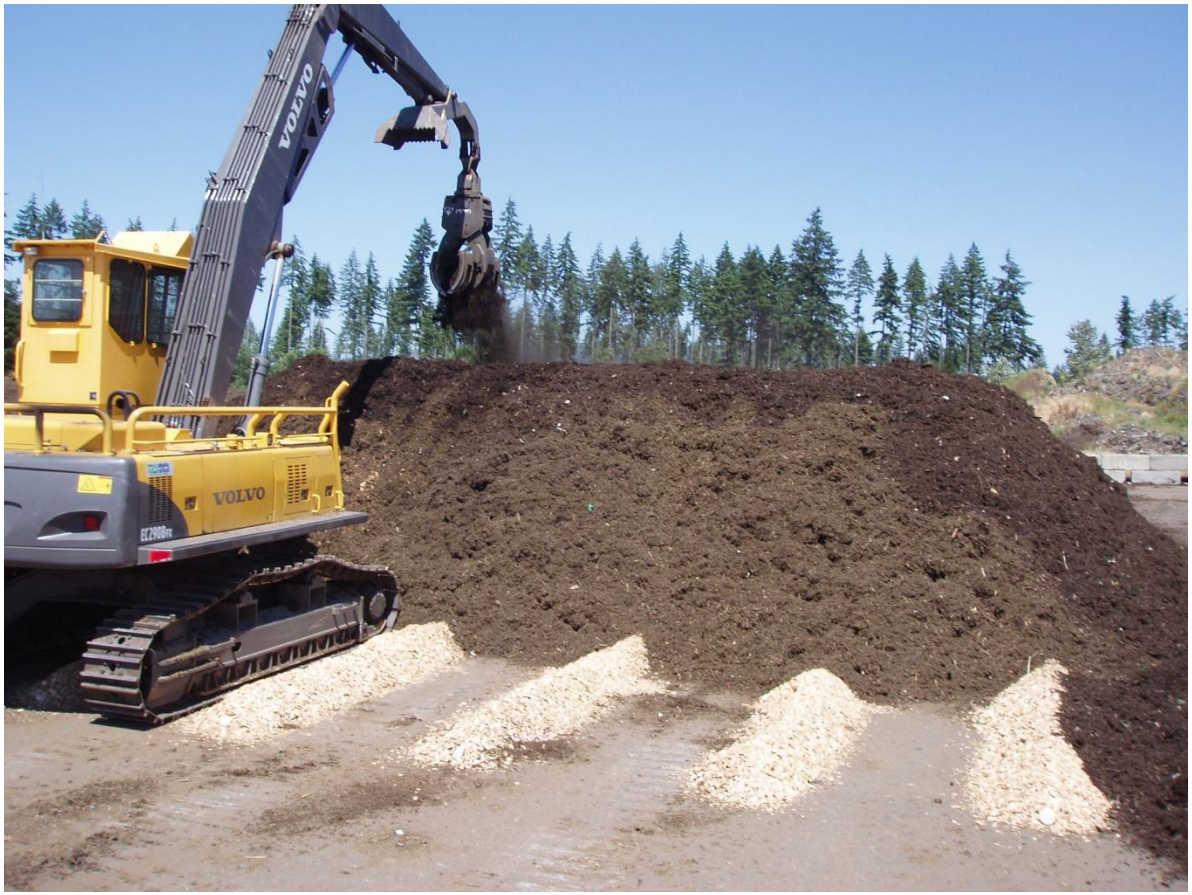
Assisting Above Ground Pipe Systems

Similar techniques as trench aeration

Positive air flow during pile loading reduces clogging

Notice darker material on surface – finished coarse compost as a biofilter layer

Dedicated smaller single blowers per pile can improve efficiency



Positive Aeration
North Mason Fiber,
Silverdale WA

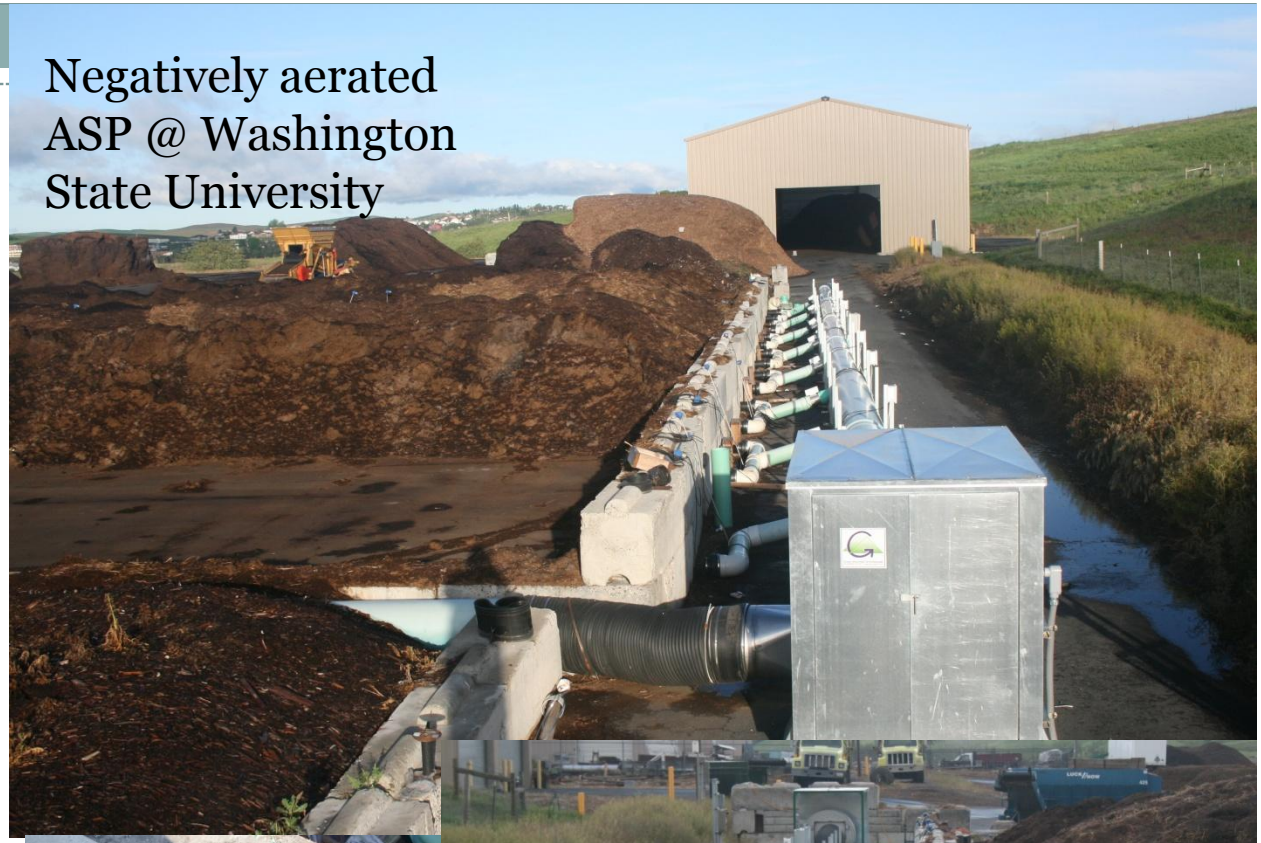
Assisting Above Ground Pipe Systems

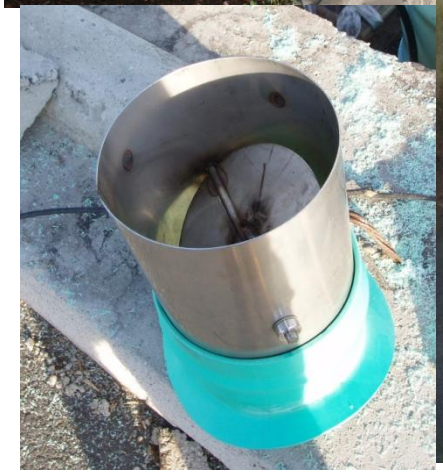
Keep pile pipe lengths relative to diameter or hole spacing engineered for even flow, pre-perforated pipe does not work for long pipe runs

Step down manifold diameters to maintain air velocity

Keep pipe velocity below 15 m/s

Seals are important for zone dampers



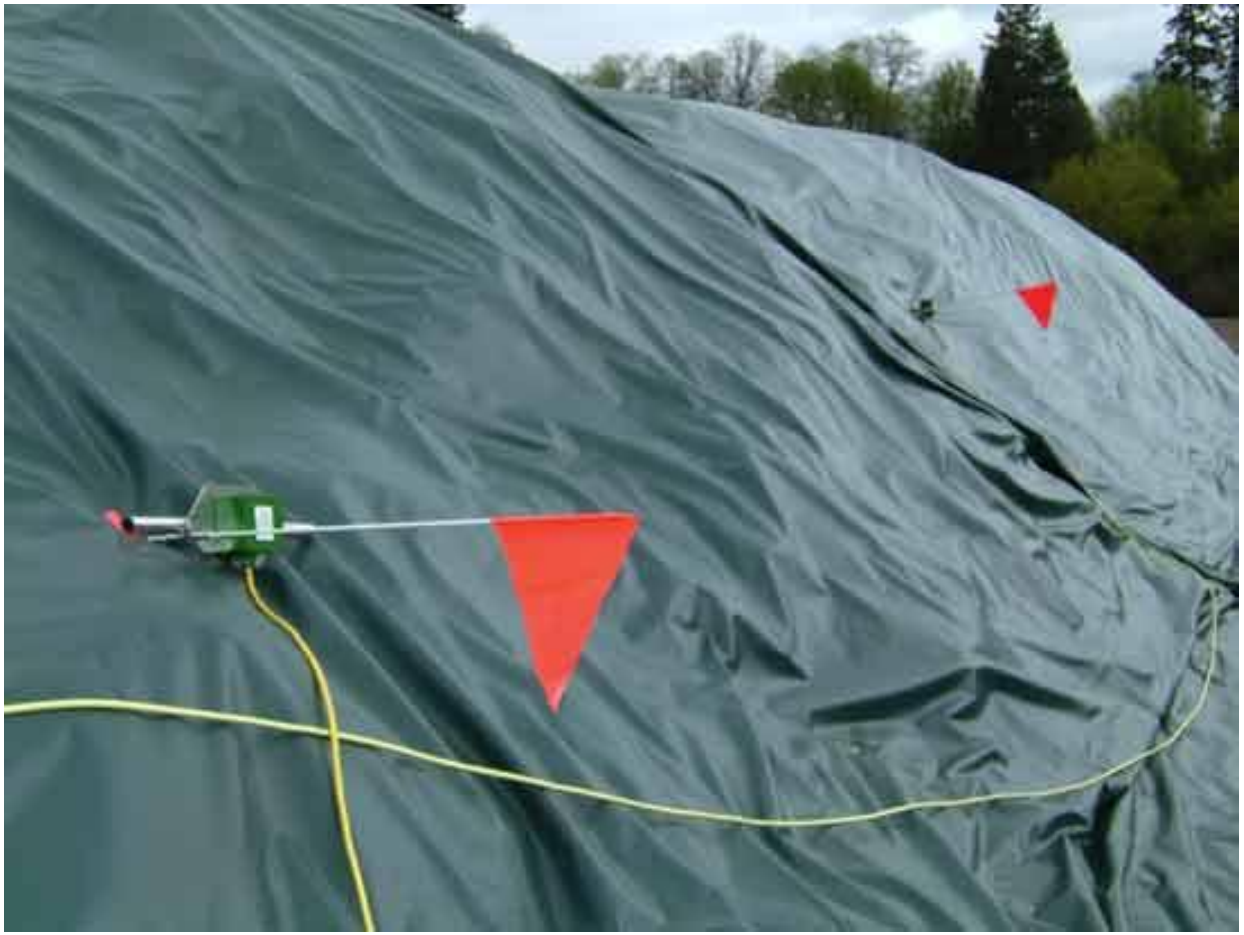


Probe locations

Where you monitor oxygen or temperature is important to the control of air flow

Multiple sensors on a probe allow for determining when to reverse airflow

Checking the representation of probe placement is important as well



Lowering pile height

Temperature control is easier the lower you get

A single direction air flow can reach process temperature extremes (>65°C) in 1.2 meters (4 feet)

Reversing air flow allows for a 2.5 meter (8 feet) pile to be effectively cooled

Turning and rewetting

It is essential to allow adequate moisture to be replaced to continue rapid decomposition

Rewetting during turning is the best way to provide uniform rewetting

Spray bar at end of discharge conveyor, fed by a hose reel, Land Recovery, Puyallup WA

Turned windrow pile stabilization

After well controlled ASP for 10 to 14 days, biological oxygen demand is reduced enough to allow compost to be placed into a windrow system. Turning at least every week for 2-4 weeks maintains enough porosity and speeds the stabilization process.

Lenz Enterprises finished material heading to screener after 45 days

Extended Pile Stabilization

This works even for extended trapezoidal pile systems. The air flow continues through large particle redistribution. Even without forced aeration

Lenz Enterprises' turned extended stabilization bed achieved 340 tons per day capacity on less than 3 acres after 7 -10 days of ASP

Extended Pile Stabilization

However, further use of forced aeration provides significantly more drying and cooling making stable material in 21 days ready for curing

Compost Factory, Land Recovery

Finished Compost - Stable and cured in 34 days

Compost Factory, Land Recovery

ASP Lessons Learned when handling food wastes

- Intensively manage the mixing, moisture and porosity in the first few hours after receipt of organic wastes.
- Place the mix in an ASP and cover it with a biofiltration layer (or selective membrane) immediately, and aerate at a very high rate of air flow for the first 3 to 5 days alternating air flow direction to keep pile temps below 45 degrees C to assure pH levels rise above 6.5
- Then control the pile temperatures between 55 degrees C and below 65 degrees C throughout the pile using alternating air flow during the 3 day sanitation period and lower it again to around 45 degrees
- After 10 to 14 days, tear the ASP down, re-water and turn using windrow turners to further stabilize and homogenize the pile.

Suggested Reading

- Sundberg, C. & Jönsson, H. 2008. Higher pH and faster decomposition in biowaste composting by increased aeration. Waste Management, 28(3): 518-526.
- Beck-Friis, Smårs, S., Jönsson, H., Eklind, Y. & Kirchmann, H. 2003. Composting of source-separated organic household waste at different oxygen levels: Gaining an understanding of the emission dynamics. Compost Science & Utilization, 11(1): 41-50.