ENGINEERED
COMPOST SYSTEMS

The Benefits of Low Headspace In-Vessel Composting

Low headspace in-vessel composting systems have many advantages over other compost systems. The main advantage is process control—when you can control the composting environment, then operational issues like odors, moisture loss or gain, pathogen reduction, vector attraction, surface water, and seasonal variations—become very manageable.

By low headspace in-vessel composting we mean composting inside a vessel that is sufficiently full so there is very little air volume between the compost and the vessel's ceiling (typically less than 3 feet). The opposite of low headspace systems are high and open headspace systems. Examples of high headspace systems are aerated static piles (ASP), windrows, and, agitated bays enclosed in buildings. Examples of open headspace systems are the same as above and are outside, open and/or without walls (not enclosed in buildings).

Engineered Compost Systems (ECS) has extensive experience with the design, manufacturing, and installation of equipment, aeration controls and monitoring systems for composting with all three types of systems (low, high and open). Based on our experience, low headspace in-vessel systems offer numerous advantages, such as increased process-efficiency and often decreased capital and operational costs, when compared to high and/or open headspace facilities. Some of these advantages include:

Improved Working Conditions
Low headspace in-vessel systems reduce worker exposure to pathogens and odors found in biosolids, MSW and food wastes. ECS systems pre-process and convey potentially pathogenic feedstocks directly into low headspace vessels. The raw compost achieves pathogen and vector attraction reduction (PFRP and VAR) inside the vessels without worker exposure and without contaminating other compost or equipment.

Alternatively, high headspace composting (in buildings) exposes workers to prolonged contact with process air that is typically contaminated with odiferous compounds, fungal spores and other potential health threats. Also these spaces tend to have very high humidity that cause problems with building corrosion, visibility and poor worker comfort during hot weather. Typically, it is <u>not</u> economically feasible to provide sufficient air changes in a large building to completely mitigate these concerns. High worker turnover, losses in productivity, and high maintenance costs are associated with exposure to such environments

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Reduced Air Handling / Biofiltration Needs
The air handling needs of a low headspace in-vessel system are a small fraction of what is required to ventilate a high headspace system. The required air handling volume in an ECS low headspace in-vessel system is set by compost processing needs, whereas in a high headspace system the total air handling volume is largely determined by the need to ventilate the building. By separating building and process air, the process air characteristics (re-circulation rate, temperature, RH, Oxygen level) can be much more closely controlled. Thus the composting environment can be better managed to more efficiently meet compost process goal.

The reduced building ventilation requirements also saves energy required to heat and move make-up and exhaust air, as well as reducing biofiltration requirements.

Superior Odor Control
The oxygen demands of bacteria do not require that the process air is continuously oxygen saturated (21%). Therefore the process air can be recycled as a partial flow of fresh make-up air is introduced as needed. The sealed low headspace vessels typically recycle 70 to 90% of the process air. The exhaust air volume is directed to the biofilter for odor control.

Reducing the amount of exhaust process air translates in a reduction of the amount of odor-laden air sent to the biofilter. The result is smaller biofilters, processing smaller volumes air, creating a smaller risk of odor release. It is the perfect solution for facilities with neighbors near by.

Another odor control advantage is the vessel itself. The ECS low headspace composting vessels are completely sealed after loading, and are not opened again until the primary composting is completed and the potential for odor is minimized (Generally, a 16-21 day retention time is recommended.) In contrast, high headspace facilities in buildings have numerous openings (doors) that must be regularly accessed to introduce feedstocks and/or remove compost. These openings provide portals for the release of fugitive odors. And, of course, any odor release in an open headspace system cannot be contained.

Moisture Control
For many facilities, especially those in dry and hot climates, controlling moisture loss is a time consuming and costly process. Managing material drying, or the resulting slowing of bio-stabilization, requires considerable labor and water to control in both high and open headspace systems.

To minimize and control moisture loss, the ECS low headspace in-vessel aeration system features reversing aeration and recycling of process. The aeration direction control is based on measured vertical temperature stratification. This controlled reversing transports much less of the moisture out of the compost mass. The reversing aeration also causes the previous contact

face (part of pile first contacted by the airflow) to become re-saturated when aeration direction changes. The recycled process air is typically saturated and relatively warm. This further reduces drying at the contact face.

With single direction aeration systems these moisture control advantages are largely lost. Aeration systems without the ability to reverse aeration and recycle process air must use cooler and dryer fresh air causing moisture transport from the system. This is true for any type of system (low, high or open headspace) if a single direction aeration system is used.

Regulatory Compliance

The USEPA Process to Further Reduce Pathogens (PFRP) states:
"Using either the in-vessel composting method or the static aerated pile composting method, the temperature of the biosolids is maintained at 55°C or higher for 3 consecutive days. Using the windrow composting method, the temperature of the biosolids is maintained at 55°C or higher for 15 days or longer. During the period when the compost is maintained at 55°CC or higher, the windrow is turned a minimum of five times."

The clear intent of this regulation is to expose all of the material in the pile to a temperature of 55°C or higher for 3 consecutive days. In the windrow method this done by repeated mixing the cooler material at the outside of the pile into the +55°C center. In the in-vessel and static aerated pile this can only be accomplished by insulating the composting mass.

Much of the research that led to the promulgation of this rule covering the static pile PFRP was based on the "Beltsville Method." This method uses insulation both under and over the pile at a thickness, determined by local climatic conditions, to ensure the entire pile volume meets design temperatures. Generally 8 to 16 inches (depending on ambient conditions) of insulating finished compost is necessary. This insulating layer can add up to 30% to the material-handling requirements.

The added time and expense of turning windrows or insulating static piles is unnecessary with ECS low headspace systems. The insulated vessels and reversing aeration easily maintains interior design temperatures for regulatory compliance. This feature is especially important for facilities in cold weather climates.

Modern compost facilities are in need of better process control to contain odors, comply with environmental regulations, maintain worker safety and comfort, and increase facility throughput on smaller sized facilities. Low headspace in-vessel composting systems are proving they can meet those needs.