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Cornell Waste Management Institute



Compost Facilities: Off-Site Air Emissions and Health

<http://cwmi.css.cornell.edu/compostairemissions.pdf>

Summary of the literature by:

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Summary of Articles on Compost Air Emissions and Health

This summary is has been compiled to help address concerns regarding the potential of air emissions from large-scale composting facilities to impact the health of neighbors. I have attempted to summarize and provide citations to all of the relevant journal articles and published governmental reports. Much of the available literature addresses on-site investigations that are relevant to worker health. Some of the literature on worker health is summarized here because of its relevance to neighbor impacts. However, no attempt has been made to comprehensively address worker health related to air emissions at compost facilities. A chapter in the up-dated On-Farm Composting Handbook (expected publication in 2007) will address worker health considerations. This summary does not include a comprehensive review of odor or volatile organic compound studies.

An abridged version of this literature summary that includes only those articles that directly address health impacts is available at: cwmi.css.cornell.edu/composthealth.pdf. The summaries are arranged in chronologic order of publication date, starting with the most recent. Within each year, articles are arranged alphabetically by author. The choice to place the summaries in chronologic order is based on the fact that much of the relevant literature is very recent and thus earlier articles (generally those prior to 2000) that draw conclusions based on the literature that was then available are out of date.

Please let CWMI know if there are other articles that should be included. At the end of the paper is an alphabetical list of references cited.

General Observations from the Literature

- There has been a significant contribution to the literature in the past decade, in part due to studies supported by the European Commission. (The literature summary below is organized by date of publication, with more recent publications at the beginning.)

BIOAEROSOLS

- A number of studies show that concentrations of bioaerosols downwind of outdoor composting facilities are elevated at times to distances on the order of 200-500 meters (650-1640 feet).
- Many of the bioaerosols are produced by the composting process. Data are not sufficient to determine whether the type and concentration of bioaerosols emitted are related to compost feedstock.
- Bioaerosols are particles of microbial, plant or animal origin and may be called organic dust. This can include live or dead bacteria, fungi, viruses, allergens, bacterial endotoxins (components of cell membranes of Gram-negative bacteria), antigens (molecules that can induce an immune response), toxins (toxins produced by microorganisms), mycotoxins (toxins produced by fungi), glucans (components of cell walls of many molds), pollen, plant fibers, etc.
- Microorganisms are frequently adsorbed onto dust particles.

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- Many bioaerosols are known to cause symptoms and/or illness, including a wide range of adverse health effects and infection. Individuals may become sensitized to some bioaerosols through repeated exposure.
- There are no ambient or occupational exposure limits for bioaerosols in the U.S.
- Validated standard methods are not yet available for measuring the various bioaerosols.
- All monitoring methods underestimate bioaerosol concentrations. Use of culture techniques will underestimate potential health risks since non-viable, non-culturable microorganisms as well as non-living constituents can contribute to health risks. Direct spore counts can provide a somewhat better estimate of exposure for irritation and allergic reactions, but cannot determine viability and thus potential for infection; but this method still underestimates exposure to particulates and pieces of bacteria (endotoxin), spores and fungal hyphae which can also produce irritation, allergy, and toxic reactions. Also, direct spore counts cannot distinguish between some species (such as *Penicillium* and *Aspergillus*), making exposure indeterminant. DNA analysis methods using PCR technology are being developed for more and more species, but are still limited in what types can be identified.
- Variation in exposure to bioaerosols from composting facilities is high even over short time periods. Intermittent releases and changes in wind complicate air monitoring since sampling other than for short time intervals can be difficult.
- The relative abundance of *Aspergillus fumigatus* and other microbes varies seasonally in air emissions from composting facilities. *A. fumigatus* is ubiquitous in both outdoor and indoor (particularly where there are pets) air.
- Measuring *A. fumigatus* is not a good indicator for other bioaerosols.
- Concentrations of bioaerosols in enclosed composting facilities are significantly elevated.

HEALTH

- An association was found in residents between distance to an outdoor composting facility and respiratory symptoms and general health complaints, but not allergies or infectious disease.
- Self-reported symptoms were not correlated with *A. fumigatus* levels in the air in the vicinity of a large open-air yard waste composting facility.
- Compost workers show a response to elevated exposure to bioaerosols despite the fact that there is a “healthy worker” effect (compost workers’ general health apart from potential compost-related illness is better than average people). Acute and chronic respiratory health effects, mucosal membrane irritation, skin diseases and inflammatory markers were elevated in workers.
- Short-term exposure to air in an enclosed composting facility resulted in measurable systemic changes in healthy subjects.
- Occupational exposure to bioaerosols may be reduced through a combination of engineering controls, work practices (and other administrative controls), and personal protective equipment.

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COMPOST MANAGEMENT

- Agitation of the compost (such as turning and screening) produces emissions. Minimizing agitation, application of water to minimize dust, monitoring wind to avoid agitation when winds are likely to blow towards neighbors can help minimize impacts.
- Frequency of turning (unless at least daily) has little impact on keeping piles aerated and increased turning can increase bulk density and thus reduce air flow through the compost pile.
- Good management of composting can help minimize odor impacts, however, odors are generated even at well-managed compost facilities. Compounds causing odors are not generally present off-site at concentrations high enough to cause illness, however excessive odors can result in symptoms such as nausea.
- Odors are minimized when there is adequate oxygen and oxygen is best controlled through ensuring free air space by using amendments like wood chips that improve porosity.
- A blanket of finished compost on top of unfinished piles can reduce odor and VOC (volatile organic compound) emissions. There are no data to demonstrate whether it will reduce bioaerosol emissions.
- Leachate is particularly odorous thus measures to prevent leachate from collecting at compost sites are important.
- Compost is most odorous and more VOCs are emitted in first several weeks of material handling.
- There is the potential to move odors off-site by transport of odorous material in tire treads.
- Wood chips release VOCs during composting. The chipping operation itself also releases VOCs.