Health & Safety Issues
Mid-Atlantic Better Composting School

Dr. Jennifer G. Becker

Dept. of Environmental Science & Technology
College of Agriculture and Natural Resources
University of Maryland, College Park

TOPICS

I. Motivation

II. Microbiological risks

III. Chemical risks

IV. Compost fires

V. Injury risks

MOTIVATION

- Safety is good business
  - -allows workers to concentrate and do good work
  - -avoids expensive workers compensation premiums and equipment damage
  - -improves morale
  - -avoids unnecessary pain, illness, and/or lost wages
- OSHA standards apply to composting and mulching industry
  - -Agriculture
  - -Fertilizers, mixing only (SIC code 2875)

MICROBIOLOGICAL RISKS

- High concentrations of bacteria & fungi key to successful composting
- Most human pathogens like fecal coliforms should be killed off by high temperatures
  - *Pathogen* = organism that causes disease through *infection*-the invasion and growth of microorganisms in tissue
  - Inadequate composting can lead to survival of pathogens in cooler layers of compost

  Example: *E. coli* O157:H7 can survive for several days in soil
- Prions are not inactivated by heat generated during composting

Guidelines for Achieving Thermal Inactivation of Pathogens

- taken from "the 503 rule" [Federal Register 58(32):9248-9415, Standards for the Use or Disposal of Sewage Sludge])
- based on inactivation of indicator organisms (fecal coliforms and *Salmonella*)

Class A (unrestricted) Biosolids Pathogen Criteria:

1000 MPN per g of fecal coliforms

OR

3 MPN per 4 g of *Salmonella*

- Analyze at time of disposal or distribution (allow time to obtain results [up to 2 weeks for commercial labs])

Class A (unrestricted) Biosolids Process Criteria:

For in-vessel or static aerated piles:

- Maintain 55˚C (131˚F) or higher for 3 consecutive days

For windrows:

- Maintain 55˚C (131˚F) or higher for at least 15 days
- Windrow must be turned ≥ 5 times during this period after being at 55˚C for 3 d

Static piles and Windrows:

- Measure daily at "toes" and at 10 to 15 ft intervals-use a variety of depths
- Not regulated for other organics
- Early, frequent measurements help determine whether self-heating is occurring

BACTERIAL PATHOGENS

- May be present in sewage sludge or feedstocks of animal origin
- Bacteria ssociated with gastrointestinal illnesses (stomach bugs):
  - -*Escherichia coli* (*E. coli*) - Many animal hosts
    Enterohemorrhagic O157:H7 and related strains are of greatest concern
  - -*Salmonella* strains - Animal and poultry hosts
  - -*Campylobacter* strains - Cattle and sheep
- *Listeria monocytogenes* - Animals, birds, and soil, causes encephalitis
- *Leptospira interrogans* - Weil's Disease
  Spread by contamination with rat urine. Causes human infections via skin abrasions and mucous membranes

OTHER PATHOGENS IN ANIMAL PRODUCTS/SLUDGE

Helminths and Protozoa (Parasites):

Giardia lamblia - Animals - Giardiasis

Cryptosporidium parvum cysts - Animals, especially calves

Round worm (*Ascaris*) eggs - Swine

Viruses:

Rotavirus - groups A and B - bovine, swine

Hepatitus E - swine and rats

Myxovirus - swine and poultry

Prions

PATHOGENS

http://www.cdfa.ca.gov/ahfss/ah/Scrapie_info.htm

- Small, abnormally-folded, infectious proteins
  -may be found in animal carcasses and meat processing wastes
- Some are associated with transmissible spongiform encephalopathy (TSE) diseases
  -Chronic Wasting Disease (CWD) - deer, elk, moose
  -BSE ("Mad Cow Disease") - cattle
  -Scrapie - sheep
  -variant Creutzfeldt-Jakob disease - humans
- Composting is not appropriate for disposal of animal carcasses or products in which TSE is known or suspected to be present

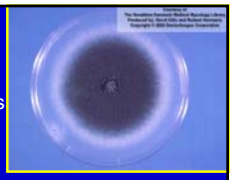
TOXIC AND ALLERGENIC MICROORGANISMS

- Most microbes in finished compost also found in "normal" outdoor air and materials
- We all inhale these "normal" microorganisms-usually without ill effects
  - At high concentrations, repeated exposure to some of these microorganisms can cause harmful effects

Toxin: A substance that disturbs a normal bodily function

Allergen: Triggers an immunological response that causes body to be sensitized or to over-react to the substance

Aspergillus fumigatus and related strains



- tolerate high temperatures (125˚F)
- allergenic fungi - cause aspergillosis
  symptoms range in severity:
  mucous membrane irritation, asthma, severe lung damage
  (Allergic Bronchopulmonary Aspergillosis)
- opportunistic pathogen
  -Most individuals can inhale several hundred *Aspergillus fumigatus* spores per day without infection
  -Can cause severe and sometimes fatal infection in certain individuals
    -prior infection with tuberculosis
    -immunocompromised individuals

Endotoxin

- Component of cell wall of certain bacteria
- Widespread in the environment (and in house dust)

Health Effects

Endotoxin Concentration (ng/m^3)	Condition
20-50	mucous membrane irritation
100-200	acute broncho constriction
1000-2000	organic dust toxic syndrome (acute flu-like symptoms)

- 236 to 374 ng/m^3 measured in enclosed facility during compost screening
- Long-term exposure may lead to:
  -chronic bronchitis and pulmonary disease & reduced lung function
  -**reduced** risk of lung cancer

MICROBIOLOGICAL RISKS

- Two main routes of exposure to compost microorganisms

  ingestion - main route of infection - can be controlled by good hygiene

  inhalation of bioaerosols - unlikely to cause infection, major route of exposure to allergens and toxins

- Compost microorganisms can be aerosolized during shredding, turning, & screening
- Control of bioaerosol inhalation is complex

PREVENTIVE MEASURES - INFECTION

- Practice good hygiene
  - -Wash hands with an antibacterial soap under running water prior to:
    - -eating, drinking, or smoking
    - -entering any offices or other 'clean' rooms
  - -Wear gloves for handling feedstocks/unfinished compost
  - -Never eat, drink, or smoke on site, except in 'clean' areas
  - -Immediately wash and disinfect any cuts or skin abrasions & cover with waterproof dressings
  - -Change from work clothes before leaving the site & clean work clothes on regular basis
- Control rat populations and other vermin

PREVENTIVE MEASURES - ALLERGANS AND TOXINS

- Minimize the production of dust by:
  - -Controlling moisture:
    - -by avoiding over-drying during pile/windrow teardown
    - -during screening (40-60% ideal)
  - -Keeping hard surfaces damp and clean
  - -Avoiding dry sweeping and use of compressed air to clean equipment

- Wear dust mask or half-mask respirator (requires fit test & training)
- Use filters or air conditioning in cabs of front-end loaders etc. and keep windows closed

CHEMICAL RISKS

- Little information on fate of individual chemicals in compost operations
- Pesticide concentrations in finished compost are generally low
  - -Organochlorine insecticides (including chlordane and other banned chemicals) most common
  - -Organophosphates, carbamate insecticides, and most herbicides are rarely detected
- Fate of most pesticides in compost similar to that in soil
- Early research suggests antibiotics and hormones are transformed during compost process
- Land application of PCBs and heavy metals in compost may be limited as for sewage sludge

PREVENTIVE MEASURES - PESTICIDES AND OTHER CHEMICALS

- Avoid composting feedstocks containing high concentrations of pesticides and other harmful chemicals
- Follow recommended composting procedures to maximize pesticide breakdown
- Follow good hygiene practices

COMPOST FIRES

- Seldom a problem outdoors
- Unless piles:
  - -become too dry (~25-45% moisture)
  - -are too large (over 12 ft high)
- Piles that are too large and dry can spontaneously combust

PREVENTIVE MEASURES

- Follow good composting guidelines
  - -Maintain appropriate moisture levels and pile sizes
  - -Monitor temperature and turn piles between 140-150˚F
- Maintain adequate water supply and delivery system
- Smoke only in designated areas

EXAMPLES OF INJURY RISKS AT COMPOSTING SITES

- Musculoskeletal injury from manual handling of material

- Falls from ladders and on spilled materials
- Trauma or death due to contact with moving parts
- Injury due to ejection of foreign matter during windrow turning
- Hearing loss due to noisy machinery

SEVERE INJURIES INVOLVING MACHINERY MOST OFTEN DUE TO:

- absence or inadequacy of guards
- removal of guards to clear blockages or maintenance
- failure to isolate machine adequately when clearing blockages or maintenance (lockout)
- falling during cleaning and maintenance

PREVENTIVE MEASURES - INJURY RISKS

- Become familiar with, and follow, OSHA requirements
- Ensure equipment is isolated from energy source and inoperative before being serviced (lockout/tagout)
- Guard moving parts on screeners, turners, tractors, tub grinders, mixers, shredders etc.
- Provide railings and steps for all raised platforms
- Keep aisle and passage ways clear

PREVENTIVE MEASURES - INJURY RISKS

- Maintain a hazard communications program
  - -List of chemicals
    - →provide Material Safety Data Sheets
  - -Label hazardous materials
- Use/provide appropriate personal protective equipment
  - -Possibly hard hats, gloves, hearing protection, eyewear, and respiratory protection

- OSHA standards most frequently cited during last year:
  - -Abrasive wheel machinery
  - -Mechanical power-transmission apparatus
  - -Hazard communication
  - -Guarding floor and wall openings and holes
  - -General requirements for all machines
- The top two in $$$ fined were:
  - -Control of hazardous energy (lockout/tagout)
  - -Mechanical power-transmission apparatus

QUESTIONS?

Jennifer G. Becker
Dept. of Environmental Science & Technology
University of Maryland
301-405-1179
jgbecker@umd.edu