Worker Safety and Health at Composting and Anaerobic Digestion Facilities

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I love that NEW COW SMELL.
Topics

Types of hazards
Hierarchy of controls for hazard elimination/reduction
Hazard analysis: HAZOP, JHA

Anaerobic Digestion and Composting
• Overview of process/flow
• Types of hazards and sources of injuries/illnesses
• Unit operations: hazards & control measures
Consider any and all types of hazards and combinations

CHEMICAL HAZARDS

- adverse health effects
  - acute
  - chronic
- reactivity, fire, explosion
Newly-constructed biogas plant in southwestern Germany
Explosion, Dec. 2007
Consider any and all types of hazards and combinations

BIOLOGICAL HAZARDS

• disease; infection
• allergy
• inflammation
Consider any and all types of hazards and combinations

ERGONOMIC HAZARDS

• strains
• sprains
• over-exertions (acute or cumulative)
Consider any and all types of hazards and combinations

OCCUPATIONAL STRESS

- shiftwork, scheduling, mandatory overtime
- quality control pressures
- meeting goals and deadlines
- job responsibilities
- technostress
Consider any and all types of hazards and combinations

PHYSICAL HAZARDS

• Radiation – ionizing, non-ionizing
• Thermal – heat stress, cold stress
• EMF – electromagnetic fields
• Vibration
• Noise
Consider any and all types of hazards and combinations

TRAUMA

• Slips and falls
• Impact
• Compression
• Cuts
• Amputation
Workplace Health and Safety Program

Consider any and all types of hazards and combinations

VIOLENCE

- Verbal harassment
- Threats
- Physical assaults

- Vandalism
- Arson
- Sabotage
Hierarchy of Controls
(some examples)

- Source Reduction
  - Hazard substitution
  - Process change
- Engineering Controls
  - Enclose process
  - Mechanize process
  - Barriers / isolate hazard
  - Local exhaust ventilation
  - General dilution ventilation
- Administrative Controls
  - Housekeeping
  - Work practices; SJOPs
  - Sampling, testing, monitoring
  - Preventive maintenance
  - Training
- PPE (respirators, clothing, gloves)

Best
Useful hazard analysis techniques

- Process failure analysis – such as HAZOP; risk mapping

- Job hazard analysis – this can be used as the basis for standard job operating procedures
Confined Space
An example of combined hazards

Asphyxiating atmosphere/oxygen deficiency

Explosive atmosphere: gases or dusts

Toxic atmosphere

Mechanical hazard, needing lockout/tagout, line-breaking, or other procedures

Engulfment: drowning, buried alive
ANAEROBIC DIGESTERS
Operations and Maintenance
Unit Operations

Step 1: manure collection

Step 2: addition of other digester feedstocks

Step 3: anaerobic digester

Step 4: solids separation/dewatering
  - Step 4a: solids storage
  - Step 4b: liquid storage

Step 5: biogas distribution system
  - Step 5a: disposal by combustion (gas flare)
  - Step 5b: electricity and heat generation
Confined Spaces

- raw manure tank
- feedstock tank
- effluent tank
- agitator pits
- digester

These are confined spaces by definition as per 29 CFR 1910.146. 
(Note: this OSHA regulation does not apply to agriculture.)

ANSI/ASABE S607 Oct2010 Ventilating Manure Storages to Reduce Entry Risk
RECOMMENDATIONS BY USDHHS/CDC/NIOSH: Manure pits on farms should be treated like any other type of confined space.

- all manure pits should be ventilated,
- the atmosphere within the pit should be tested before entry,
- a standby person should be in constant contact and ready to lift the worker to safety with mechanical lifting equipment (winch, hoist, or pulley), and
- anyone entering a manure pit should wear a safety belt or harness with a lifeline tied to the mechanical lifting device.
Ventilation of Confined Spaces

Ventilate the manure pit as per ANSI/ASABE S607

Source:
Testing a potentially hazardous atmosphere
Tank covers
PREVENTIVE MEASURES

Make covers of a sturdy material to support weight of workers standing or walking across tops of tanks.

- If more than one person stands on the hatch cover at any one time, then the weight of multiple people would dictate the strength needed.

- If a pump is hoisted from a tank and allowed to rest on an adjacent hatch cover, perhaps alongside the operator of the winch, these weights should also be taken into account.
Figure 6
Biogas piping – no flash arrestor (notice scorching)
Flare
Generator
Noise; electrical hazards; oil on floor.
COMPOSTING
What is being composted?

Feedstocks: (receiving, tipping floor)
- Yard wastes: leaves, grass, brush, trimmings
- Food wastes
- Agricultural wastes: plants, animals, manure, bedding
- Industrial wastes: paper, food wastes, ?? ???
- Sewage sludge (biosolids)

Bulking agent: wood chips, sawdust, other
Accidents and Trauma Risks

Engulfment
In buildings or from windrows, mists from evaporating moisture might visually obscure workers – run over

Brush chipper accidents
Conveyor belt accidents
Grinders, turners, and mixers
Power take-offs from tractors
Shedding parts; flying debris

Equipment hazards - operations

- Is this equipment manufactured with any guards or interlocks?
- Could a temporary injury happen from using this equipment?
- Could a permanent injury or fatality happen from using this equipment?
- While operating this equipment, something goes terribly wrong. How would you stop this equipment from operating or moving immediately?
Equipment hazards - maintenance

• What sort of maintenance does this equipment typically need?
• To do maintenance, does this equipment (or a portion thereof) need to be locked-out, blocked, chocked, etc.?
• What if the item(s) you described in the previous question were not done? Could an injury or fatality result?
Wood Chipper
Tub grinder

Trommel screen

Figure 4.3
Turning windrows using a bucket loader.

Figure 4.4
Tractor-assisted windrow turners.
Elevating-face conveyor is adapted with permission from Scat Engineering. Rotary drum turner is adapted with permission from Wildcat Manufacturing.
Working under Power Lines

Be aware of overhead power lines and the possibility of electrical shock.

The elevated part of the vehicle should be kept a distance of at least 10 feet (3 m) from the power lines to prevent the equipment from becoming energized and shocking the operator.

Check this during the day – lines can expand and sag in hot weather.
Loud equipment...

wood chipping
shredding
grounding
turning piles

...reported as exceeding 90 dBA.

Shredders reported as high as 98 dBA.

*How could noise exposure be reduced?*

Compost Fires

Need a supply of water for firefighting. A common cause is spontaneous combustion. Find the hot spot - uncover it and apply water to it.
Figure 2.2
Natural (passive) air movement in a composting windrow or pile.
Routes of exposure for chemicals and biological agents

Inhalation

Skin/eye contact or absorption

Injection (through the skin, including cuts, jabs, and high-pressure injection injuries)

Ingestion (hand-to-mouth transfer, dust lands on lips, hold objects in mouth)
Biological exposures

- **Bacteria**: infectious risk in initial phase of composting; may not be significant risk in final processing if system operates to kill pathogens (possible exception of *C. botulinum*).
- **Fungi**: allergens and toxic products; acute or chronic effects in susceptible people
- **Viruses**: poor survivability in sewage sludge compost (inactivated)
- **Protistans** (protozoal parasites)
- **Animals**: worm cysts
- **Prions**

Hygiene Practices

• Hygiene facilities: change rooms, showers, clean-up, lunchroom

• Shower at work and change into clean clothes and shoes. Reserve footgear for use at worksite.

• Wash hands with soap and water before eating or smoking or whenever hands come into contact with compost or feed stocks.

• Wash hands before and after using the bathroom.

Hygiene Practices

• Do not wear work clothes home or outside the work environment.
• Remove excess contaminants from footgear prior to entering a vehicle or a building.
• Thoroughly but gently flush eyes with water if contaminants contact the eyes.
• Care for cuts and abrasions promptly. Keep wounds covered with clean, dry bandages.

Hazard Reduction

Enclosed cabs with air filtration on equipment to reduce...

...inhalation

...eye exposure

...impact injuries
Hazard reduction -- PPE

- Respiratory protection for all the dust-generating tasks (particulates); minimum N-95
- Unvented goggles; can add faceshield if impact possible
- Gloves and steel-toed workshoes; for wet feedstocks use heavy duty rubber gloves and boots
- Use protective clothing; moisture-proof for wet feedstocks
- Hardhat
- Hearing protection

Hazard reduction -- PPE

Remove contaminated clothing at end of shift. Avoid laundering work clothes at home. If they are cleaned at home, place them in a bag and leave them bagged until they are actually to be placed in the washing machine. Wash separately from other clothing using the hot water cycle. Use chlorine bleach if appropriate for the fabric.

“The sooner you think of those leaves as compost, the sooner I can watch this game in peace.”
“Mrs. Dillof ... Mr. Dillof?”