Exercise: Measuring Bulk Density and Free Air Space

Bulk Density Procedure

1. Weigh empty bucket. Record weight
2. Fill bucket 1/3 full of material (compost or feedstock)
3. Drop bucket at 6” height on firm surface 10 times
4. Fill bucket 2/3 full of same material
5. Drop bucket at 6” height on firm surface 10 times
6. Fill bucket to 5-gallon line and repeat dropping
7. Refill to 5-gallon line. Do not drop
8. Weight bucket with material

Material Measured	Answer
1. Weight of empty bucket	
2. Weight of bucket with material	
3. Weight of material (line 2 – line 1)	
4. Convert to lb/yd^3 (line 3 x 40)	

5 gallons = 0.67 ft^3 = 1/40th of 1 yd^3, so lbs of material in a 5-gallon bucket multiplied by 40 equals approximate number of lbs in a cubic yard

Free Air Space Procedure

Use the same bucket from the bulk density exercise with the material inside.

1. Place bucket on ground
2. Fill bucket with water completely without overflowing
3. Weigh the filled bucket

Material Measured	Answer
1. Weight of bucket with material	
2. Weight of bucket with material + water	
3. Weight of water (line 2 – line 1)	
4. % free air space (line 3 x 2.4)	

5 gallons of water = 42 lb = 100% porosity, so 100 ÷ 42 x weight of water = % FAS

Key Composting Components

1. Feedstocks
2. Moisture
3. Aeration
4. Shape and Size
5. Temperature
6. Time

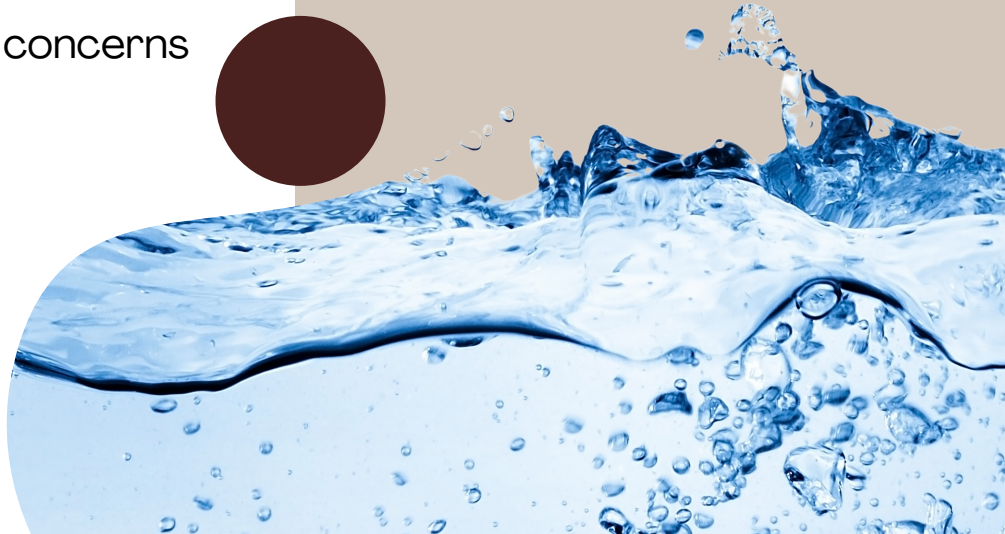
Adapted from Compost Research & Education Foundation

Moisture

Microbes live on surface of particles and require water film to move

Optimum moisture = 45-60%

- > 65% = anaerobic
- < 40% = fungus dominates, difficult to rewet
- < 30% = dust concerns



Pile Shape and Size

Large pile:

- Retains temperature
- More compact
- Less airflow

Small pile:

- More airflow
- Less temperature retention

Pile size should match equipment

Temperature

High temperatures = faster breakdown (140 - 150°F)

Above 160°F = lose microbial diversity and composting slows

Most weed seeds and pathogens killed at 131°F or higher

- Aerated static pile & in-vessel = 131°F+ for 3 days
- Turned windrow = 131°F+ for 15+ days with 5 turnings

Adapted from Compost Research & Education Foundation

Aeration

Oxygen consumption increases with temperature

Below 10% oxygen, switch to anaerobic and produces odors

Static

- Suction = negative pressure
- Blowing = positive pressure

Windrow

In-vessel

When is it done?

- Temp <10°F warmer than ambient
- About 1/3 original size
- Can't recognize original materials
- Dark color
- Earthy smell

Time

Mesophilic phase:

- 2-14 days

Thermophilic phase:

- 3 wks to several months

Curing and maturation:

- 1 to several months

Exercise: Building a Compost Pile

1. Each group assigned one pre-determined compost recipe
2. Form small compost cage
3. Acquire and combine feedstocks using a 5-gal bucket: 1 bucket = 1 part
4. Fill cage to just below the top

Recipe Assessment

1. How does the pile look?
2. How does the pile feel?
3. Is the pile too wet or too dry?
4. Will air be able to flow through the pile with the porosity?

Exercise: Measuring Compost Moisture

Squeeze Test Procedure

1. Grab handful of compost material
2. Squeeze hard
3. Release grip
4. Assess using following table

Description	Moisture Content
Water flows out while squeezing	>65%
Some water drips while squeezing	60-65%
Material leaves a wet sheen on hand, but no water drips	55-60%
Material feels moist; no drips or sheen on hand; when bounce ball, stays intact	50-55%
Ball sticks together but when bounced it breaks apart	45-50%
Cannot form a ball with material	40-45%
Material feels dry and dusty, leaving a dusty feeling on your hand when discarded	<40%

Koster Tester Procedure

1. Weigh empty Koster tester basket and record weight
2. Add compost to basket until scale reads 100 grams
3. Place basket with sample on drying unit and dry for approximately 20 minutes
4. Remove and weigh the basket and record the weight.
5. Place the backet on the drying unit for an additional 5 minutes.
6. Remove and weigh the basket and record the weight.
7. Repeat steps 5 and 6 until decreases in weight do not exceed one gram.
8. Calculate the dry matter % with the following equation:

$$\frac{\text{Final weight of basket and compost} - \text{ weight of empty basket}}{\text{Intial weight of basket and compost} - \text{weight of empty basket}} \times 100$$

Compost Uses - Soil

Improve Soil Health

"The capacity of soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health" -Doran and Parkin, 1994

Compost improves:

1. Soil Structure
2. Aeration
3. Water permeability
4. Plant root penetration
5. Seeding emergence

Compost reduces:

1. Crusting
2. Clod formation

Long-term Benefits

- Plant nutrients available 2-5 years
- Non-nutritive effects 1-6 years or longer
- Plant available phosphorus
- Organic nitrogen increase
- Increase in plant micronutrients
- Soil organic carbon compounds present for many years

Adapted from Cole Smith, UCANR

Compost Uses - Bedding

Advantages

- Economical on-farm bedding source
- Non-abrasive to cows standing and resting
- Less wear on equipment
- Good cow comfort
- Composting kills bacteria
- Can be used deep-bedded or on top of mattresses
- When well managed, no impact on SCC

Disadvantages

- Organic material - provides medium for bacterial growth
- Additional equipment and labor required to compost
- May require greater care in parlor prep
- May need to prioritize between field application and bedding

On-Farm Composting according to CalRecycle and Water Quality Control Board

Status	Feedstock	Quantity on site	Notes
Excluded/Exempt	Ag materials ONLY	25,000cy	Sell/give away up to 1000cy/year

OR …If you want to use imported feedstocks (green materials, food materials, other manure)

Excluded/Exempt	Ag materials Green materials Food material	100cy total at any time	(sales unclear)

Even Excluded/Exempt operations must:

- *Maintain records of materials, quantities*
- *Prevent threat to public health & safety (vermin, odors, etc.)*
- *Prevent contamination of ground, surface waters (100ft setbacks from streams & wells, minimize ponding, leaching, erosion, stormwaters)*
- *Update Nutrient Management Plan to reflect composting activities, application of compost to pasture, etc.*

If you "advance" beyond Excluded thresholds…

Status	Feedstock	Quantity on site	Notes
Notification Tier	Ag materials ONLY	25,000cy	Sell/give away up to 5000cy/year One annual inspection
Notification Tier	Ag materials Green materials	Green materials **MAY** be limited to 12,500cy/year Total materials limited to 25,000cy	Sell/give away up to 1000cy/year One annual inspection
Notification Tier	Ag materials Green materials	Green materials **ARE** limited to 12,500cy/year Total materials limited to 25,000cy	Sell/give away up to 5000cy/year Four annual inspections

Notification Tier requires (in addition to above):

- *File with Local Enforcement Agency (LEA) - usually County EHS*
- *Create "Odor Impact Minimization Plan"*
- *1-4 inspections per year by LEA*
- *Annual filing and fees to LEA ($500 - $2500/year)*