

## 23.0 Appendix D: Bulk Density and Free Air Space Determination

### To Determine Compost Mix Bulk Density and Free Air Space

The procedures for measuring pile bulk density simulate the compaction of materials that you would expect under normal composting operations. Dropping the bucket 10 times from a given height helps to keep the measuring process consistent.

#### Volume of a Bucket

To determine the volume of a plastic bucket for the bulk density and free air space tests, complete the following four steps:

1. Weigh the empty bucket and record its weight (kg).
2. Fill the bucket to the top with water, weigh and record the weight (lb).
3. Subtract the weight of the bucket to determine the weight of water.
4. Divide the weight of water by 1000 to determine the volume of the bucket ( $m^3$ ).

#### Bulk Density

To determine the bulk density (unit weight) of an individual feedstock or a compost mix, complete the following seven steps:

1. Weigh an empty 20lt bucket and record the weight; then
2. Fill the bucket 1/3 full with your mix of materials;
3. Raise the bucket approximately 150mm above a firm surface and let it drop 10 times. This will compact the material to reflect actual field conditions;
4. Next, place additional mix in the bucket to fill it 2/3 full then repeat Step 3;
5. Then, fill the bucket to the top with material and repeat Step 3;
6. Finally, fill the bucket to the top (water level) and weigh it to determine the weight of the bucket plus the compacted mix of materials;
7. Subtract the weight of empty bucket from the total weight and record the weight of the compacted materials;
8. The target range for the weight of the compacted material is 7 – 11 kg

Note 1: A cubic metre is a common unit of measure when dealing with compost. One cubic metre equals a volume that measures 1m x 1m x 1m

Note 2: There is 1000lts. Therefore, there are 50 buckets in one cubic metre.

Given the results of Step 8, above, the target range for bulk density is between 400 – 500 kg's/cubic metre.

#### Free Air Space

Use the same full bucket from the bulk density test to complete the free air space test. This test uses water to approximate the amount of voids (free air space) in a bucket full of compost materials as an indirect measure of porosity.

Complete the following five steps:

1. Place the bucket of material on level ground;
2. Fill the bucket with water completely without overflowing;
3. Weigh the filled bucket. Use caution – the bucket will be heavy;
4. Record the weight and calculate the volume of water in the bucket.
5. Calculate the percentage of voids.

The target range for free air space for compost piles is 35% to 60%

#### Example

Part 1 – Determine the Bulk Density of a Sample of Raw Feedstocks.

1. Your bucket holds 20kg of water and therefore it has a volume of 20lt .
2. You complete the eight steps to determine the bulk density of your mix, and the net weight of materials is 9.9kg .
3. The bulk density of this material is  $9.9\text{kg} \times 50 = 495\text{kg}/\text{m}^3$  . This material is within the desired range.

Part 2 – Determine the Free Air Space of this mix.

4. You complete the five steps to determine the free air space of your mix, and the weight of your mix plus water 17kg .
5. You calculate the weight of the water by subtracting the weight of the mix:  $17\text{kg} - 9.9\text{kg} = 7.1\text{kg} = 7.1\text{lt}$  of water.
6. You divide the volume of water by the total volume of your bucket to determine the Free Air Space:  $(7.1/20 = 0.355 \times 100 = 35.5\%$  FAS.
7. This is an acceptable FAS, albeit somewhat toward the low end of the range.
8. In this example, additional bulking agent (comprised of coarse woody material) could be added to increase the free air space to enhance the porosity for aeration.
9. Adding dry bulking material is also commonly done to adjust the moisture content of wet feedstocks, such as food waste or wet (sloppy) animal manure.

### Smoke Test

A smoke test is an easy way to confirm that the mix has a suitable porosity for uniform airflow. Aeration of the Aerated Static Pile is possible when the airflow is pressurized and confined to the base of the pile. Air leaks (i.e., short circuiting) reduce the effectiveness of the aeration system and therefore compromises the composting process. Smoke generators are an easy and inexpensive way to visually check for air leaks in your new compost system.

This following test can be accomplished by one person; however it is a much easier process with two or more people.

### Test Procedure

1. Be sure that the bin is filled to capacity when running this test to provide sufficient back pressure to reveal all significant leaks;
2. Set the timer so that the blower runs continuously;
3. Open the valve to the bin being tested, to the full open position. Close all other valves;
4. Place a smoke generator on a pie tin (or alternate non-flammable surface), light the fuse and hold it next to the air inlet on the side of the blower (duration about 30-seconds).
5. The smoke will be pulled into the blower and distributed through the aeration system.
6. If there are leaks in the system, concentrated smoke will pour out of these openings;
7. If there are no significant leaks, the smoke will emerge in a diffused manner on the surface of the ASP. This is what we hope to see.
8. If the system does have significant leaks, these can be closed by placing additional finished compost on top of the ASP.

#### Take Necessary Precautions

If you are conducting the test in a populated area, be sure to notify everyone that you will be creating a considerable amount of smoke and to not be concerned. If you are in a highly populated area (e.g., public horse venue, university, prison, etc.) be sure to notify the authorities (including the local fire department) that you will be conducting the test at a specific time. Provide the MSDS Sheet that is included with the smoke emitters to these same authorities before conducting the test.

#### Safety Note

The smoke is not harmful or malodorous. What odour you will detect is faintly similar to burning paper. Over exposure could be caused if the smoke generator is ignited in a confined area and a person remains in that area for 10-minutes or longer.

Over exposure could result in throat irritation and mucus membrane congestion requiring medical treatment. Should this occur, remove the individual to fresh air and if breathing is difficult, get medical attention immediately. The smoke is non-hazardous and safe when used outdoors as directed.

Link: The Material Safety Data Sheet (MSDS) <https://www2.itap.purdue.edu/msds/docs/7967.pdf>