The Theory and Operation of Composting

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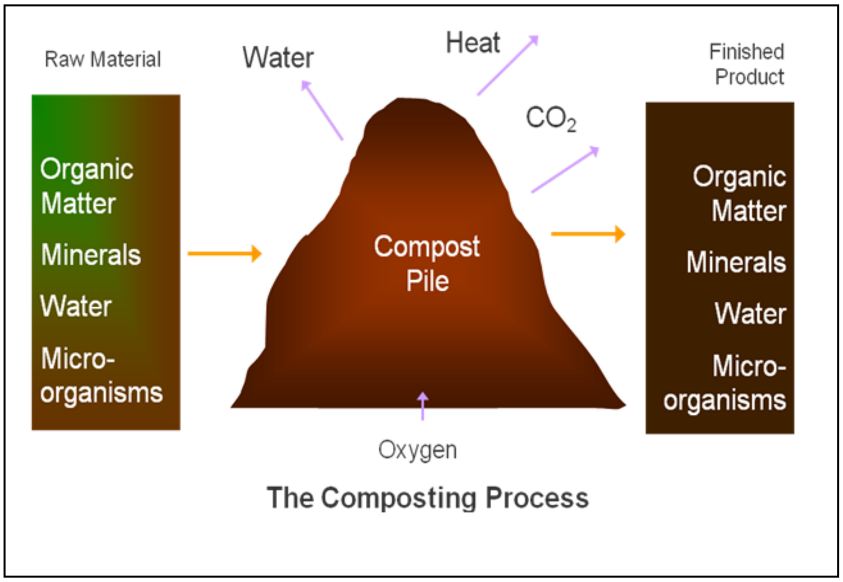
COMPOSTING THEORY

Composting is a natural biological process, where aerobic microorganisms (primarily bacteria and fungi) decompose organic waste to produce a stable organic product that can enhance the quality of the soil by providing organic matter, nutrients and beneficial microorganisms.



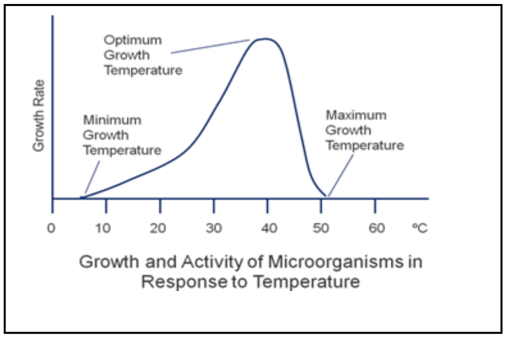
The Composting Process

Human-controlled composting optimizes the conditions needed for the natural decomposition process. By creating these ideal conditions, a much faster and efficient decomposition of the organic waste and stabilization of the final product can be achieved.

In order to enhance the composting process, the following criteria are very important:

Temperature

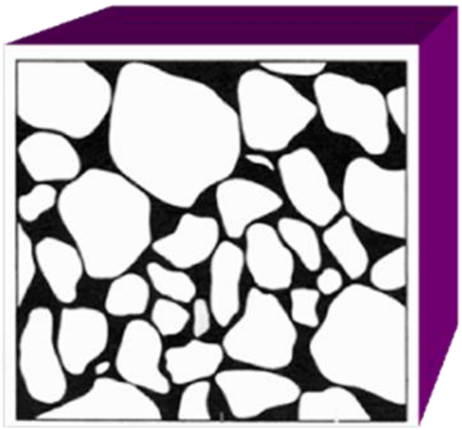
The optimal temperature for composting is between 55 and 65 degrees C. This temperature is created by the microorganisms themselves and is important for killing potentially pathogenic organisms and weed seeds. At temperatures below 55 C, the process is slower and may not result in proper sterilization of the product. At temperatures higher than 65 C, some of the beneficial microorganisms are killed which also slows the process. The temperature can be controlled by moisture, aeration and by mixing.



Growth and Activity of Microorganisms in Response to Temperature

Air-Filled Porosity

Air-filled porosity is the volume of air inside a volume of compost. The organic waste must allow the passage of air through the material because composting is an aerobic process, where the microorganisms require oxygen to decompose the material. The air-filled porosity should be between 35 and 45% of the volume of the material. Air-filled porosity is usually not measured directly, but inferred from measuring bulk density and moisture content.

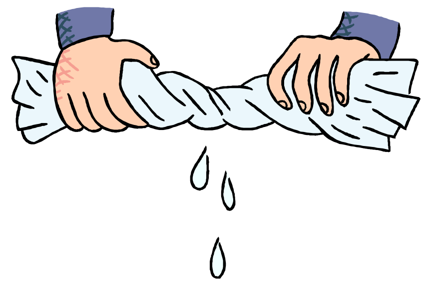


Bulk Density

The bulk density is the weight of the composting material per volume, usually expressed in kilograms per cubic meter. The composting material should have a bulk density of between 600 and 700 kg per cubic meter. Material having a bulk density lower than this is likely too dry, or the particles are too large to compost properly. Material having a higher bulk density is likely too wet, or has particles that are too small to allow oxygen to enter the material.

Moisture Content

The moisture content of the composting material must be between 45 and 65% moisture content. The bacteria and fungi that do the composting live in a water layer around the organic particles. If the moisture content is below 45%, there is not enough water around the particles for the microorganisms to live, and if the moisture content is greater than 65%, the pores between the particles are filled with water, and the microorganisms cannot obtain enough oxygen. The rule of thumb is that if you can squeeze water out of the material, its likely more than 70% moisture content and is too wet.



Mixing

Mixing the composting material is very important to ensure that all of the material reaches temperatures required for pathogen kill. It also breaks preferential air pathways that may develop and slow the composting process.

COMPOSTING TECHNOLOGIES

Composting technologies can be separated into the following categories:

Static pile composting

Static pile composting is the simplest type of composting process, but is also the slowest process with the least likelihood of adequate and consistent temperatures for pathogen kill. The finished product may also be of inconsistent quality. The moisture content, porosity of the mix, and pile height and width become very important to make this type of composting process work successfully. The time required for composting and the lack of control makes this technology not practical for most applications.

Aerated static pile composting

Aerated static pile composting uses forced aeration to speed up the composting process by ensuring adequate oxygen throughout the pile. Preferential air pathways may develop, especially if the material is more dense or has a higher moisture content. At least one mix is required in an aerated static pile composting process to ensure pathogen kill on the edges of the pile. This technology speeds up the process substantially over static pile composting and is used by many technology providers.

Turned windrow composting

Turned windrow composting uses a specialized turning machine to mix and provide aeration into a pile of composting material. Turning frequency ranges from daily to weekly depending on the season, the material being composted, moisture content and porosity of the compost, and the stage of composting. The size of the windrow depends usually on the size of the compost turner. If the material is not porous enough, oxygen concentrations can be minimal at a depth of 0.5 to 1 m within one hour of turning. This makes turned windrow composting slower than aerated pile composting. Turned windrow composting produces an excellent quality compost. Turned windrow composting is the most commonly used composting method because of the lower capital cost of these systems. The major disadvantages are the amount of space required and the lack of odor control capability with this technology.

Turned and aerated composting

The highest quality product can be achieved in the shortest amount of time using a combination of aeration and turning. The forced aeration ensures that the oxygen concentrations remain high enough for optimal composting conditions. The multiple turning of the compost ensures that preferential air pathways do not develop and that all of the composting material has reached temperatures required for pathogen kill. A rotating drum and an agitated bed composting systems are two examples of this technology.