australian organics recycling association

COMPOST PROCESS FACT SHEET

What is composting?

Composting is mainly a natural process where microorganisms break down most naturally occurring organic materials, such as food scraps and garden waste, under controlled conditions of air flow, temperature and moisture.

The composting process requires oxygen and water to take place (known as an aerobic process – without oxygen, the process becomes anaerobic). This process produces a stabilised, pasteurised organic material called compost, while also releasing heat, carbon dioxide and water vapour. While temperature is not essential for all composting, it is necessary for destroying animal and plant pathogens, and any plant structures such as seeds, spores, tubers or cuttings that can give rise to a new plant.

Composting mimics the natural decomposition of organic matter in ecosystems, where plant and animal residues break down, cycle through the soil, and contribute to new growth. Through harnessing and accelerating natural decomposition pathways, composting extends beyond waste management to provide circular solutions.

AS4454: Composts, soil conditioners and mulches

The Australian Standard AS4454 Composts, soil conditioners and mulches provides a framework for defining and classifying compost, soil conditioners and mulches based on their composition, processing and intended use. While voluntary, it is referenced in all regulatory composting guidelines to establish minimum requirements for production, characterisation and quality testing.

The importance of composting

A crucial part of the recycling industry, composting generates economic value from organic waste, creates jobs in collection, processing and distribution, and supports other key industries including agriculture, horticulture, landscaping and construction.

Socially, it supports community-led initiatives and raises awareness of waste reduction and the circular economy. Environmentally, composting diverts organic waste from landfills, reducing greenhouse gas emissions while improving soil health across all its applications.

Ideal Conditions for Composting

A range of factors support the growth of aerobic decomposer microorganisms, which drive the composting process.

AERATION (CIRCULATION OF OXYGEN)

Aeration is essential to provide the oxygen needed for microorganisms to break down organic matter aerobically.

MOISTURE

Must be sufficient (typically 40-60%) to sustain biological activity without compromising aeration. As a final product, a minimum of 25% moisture is required under AS4454.

PARTICLE SIZE AND BULK DENSITY

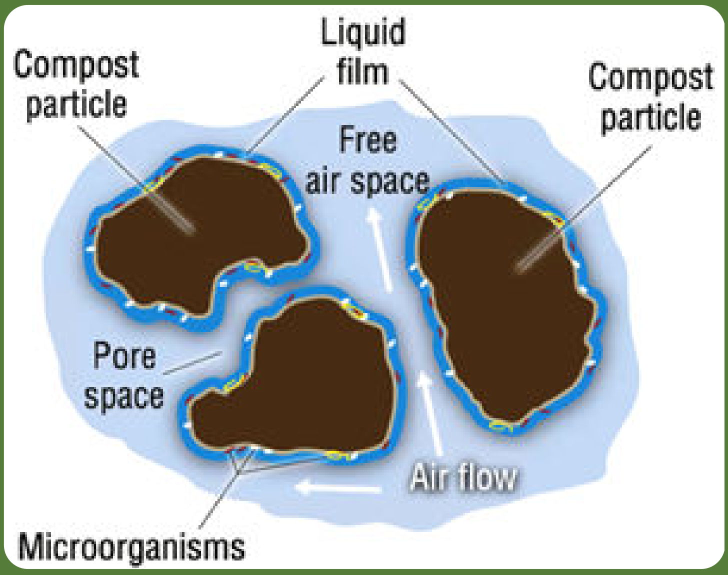
Particle size and density influence aeration and microbe access to organic matter, oxygen and water. While all organic materials can be composted, the quality of the feedstock directly influences the quality of the end product. For example, a wet feedstock may benefit from dry materials to maintain optimal aeration and moisture levels.

CARBON TO NITROGEN (C:N) RATIO

Organic material must have the right supply of carbon and nitrogen, as microorganisms consume the waste for both energy and growth. A well-balanced feedstock blend is essential for the speed of composting, and as such, composters make recipes that blend high nitrogen feedstocks (e.g. meat and fish residues) with high carbon feedstocks (e.g. wood and hay).

TEMPERATURE

Both a cause and an effect of composting. Microbial activity generates heat, which, in turn, creates the ideal conditions for different microorganisms to thrive. Temperature is a key indicator of composting progress, essential for pasteurisation and later maturation.



Particle environment within compost pile
(Rynk et al., The Composting Handbook, 2022)

Stages

Composting is a continuous process that relies on microorganisms that are naturally present on the surface of organic matter and the environment. It is complex and dynamic, with decomposer microorganisms (mainly bacteria and fungi) thriving and then dying as conditions such as food availability, temperature and aeration change. As this process progresses, the organic matter breaks down and transforms into compost.

The composting time from start to finish is varied. The closer to ideal conditions at the start of the process, the quicker the organic material will convert to compost. As a result, different technologies control these conditions and the speed of the processes.

Generally, at least 6–14 weeks are required in the pasteurisation and composting phases. The operation of a commercial composting facility involves more steps.

Feedstock preparation: Screening, grinding and blending

Before composting begins, feedstock is received and sorted to remove contaminants and ensure it is in the right form and proportion. Ideally, materials are mixed to achieve the proper moisture content, carbon to nitrogen ratio, particle size and bulk density for efficient decomposition.

For commercial composters processing food and garden organics (FOGO), decontamination is essential for quality compost. These operations rely on systems ranging from picking lines to specialised sorting equipment with high-precision sensors, cameras, lasers and artificial intelligence that detects and removes plastics, metals, glass and other contaminants.

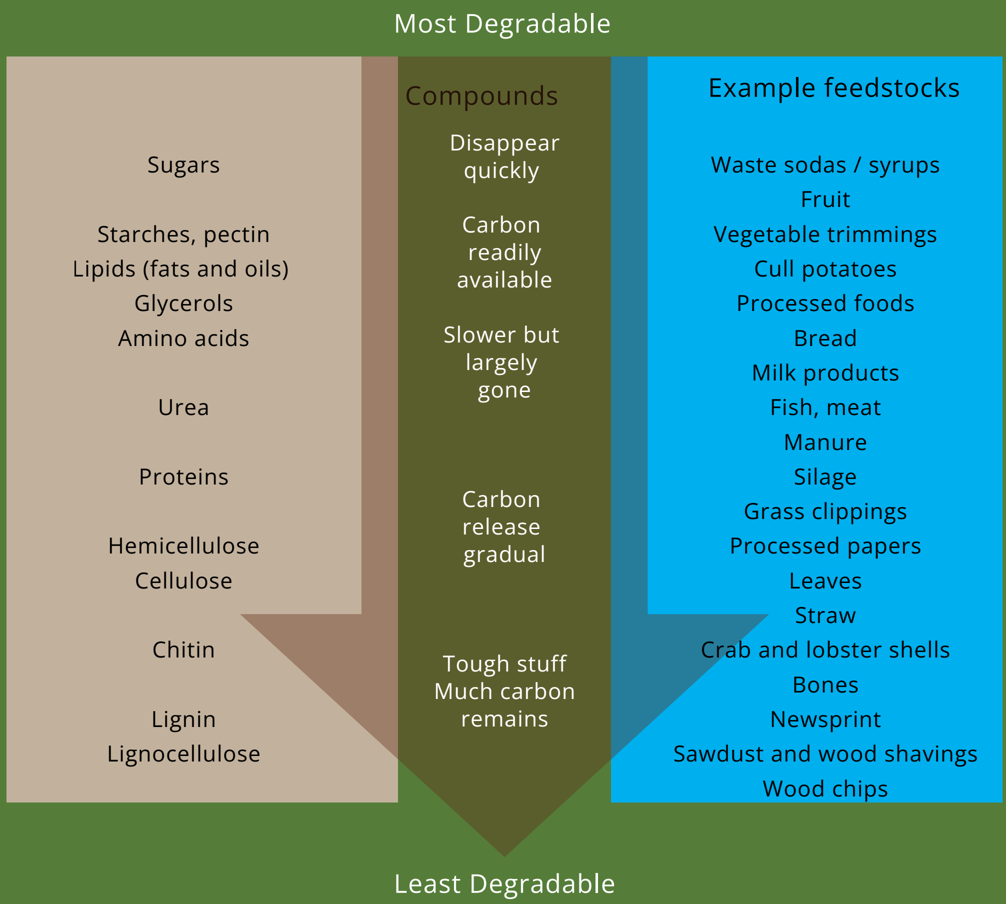
Oversized materials are also separated, usually using screens, before being ground alongside wood or green waste to achieve the optimal particle size and improve bulk density.

Pasteurisation, composting and maturation

Once organic material is aggregated according to the chosen composting technology, the technical composting process begins and typically progresses through (1) pasteurisation, (2) active composting and (3) maturation. There is no clear line between these three phases.

Composting starts as soon as moist organic materials are piled together in a balanced carbon-to-nitrogen ratio (C:N). Microbial activity rapidly breaks down easily degradable compounds such as sugars, starches and proteins.

As microbial colonies grow, they consume oxygen and generate heat, causing temperatures to rise quickly. Under optimal conditions, the pile can reach 55–72°C, a range that can be maintained for weeks. If the moisture is high and flow of oxygen is insufficient, the organic matter can shift from aerobic decomposition into anaerobic decomposition, which can generate unwanted odorous compounds.



Organic compounds and feedstocks from most degradable to least degradable
(Adapted from Rynk et al., The Composting Handbook, 2022)

Pasteurisation

Pasteurisation is achieved when organic materials are exposed to a temperature for long enough to significantly reduce the number of plant and animal pathogens as well as plant propagules (e.g. seeds).

To meet AS4454, pasteurisation requires at least three turns with internal temperatures of 55°C or above for at least three consecutive days before the next turn. For higher-risk feedstocks – such as animal manure, food waste, or grease trap waste – the requirement extends to five turns with internal temperatures of 55°C or above for at least three consecutive days in between each turn (at least 15 days).

This process eliminates pathogens and weeds, resulting in a pasteurised product which is not yet compost. At this stage, the material is still immature and biologically unstable, meaning it may harm plants if applied to soil directly.

Active Composting

To progress from pasteurisation to compost, microbial decomposition must continue. This requires maintaining the following conditions that support microbial activity:

- Oxygen supply through passive or forced aeration
- Moisture control by adding or withholding water
- Even decomposition through turning or mixing the pile.
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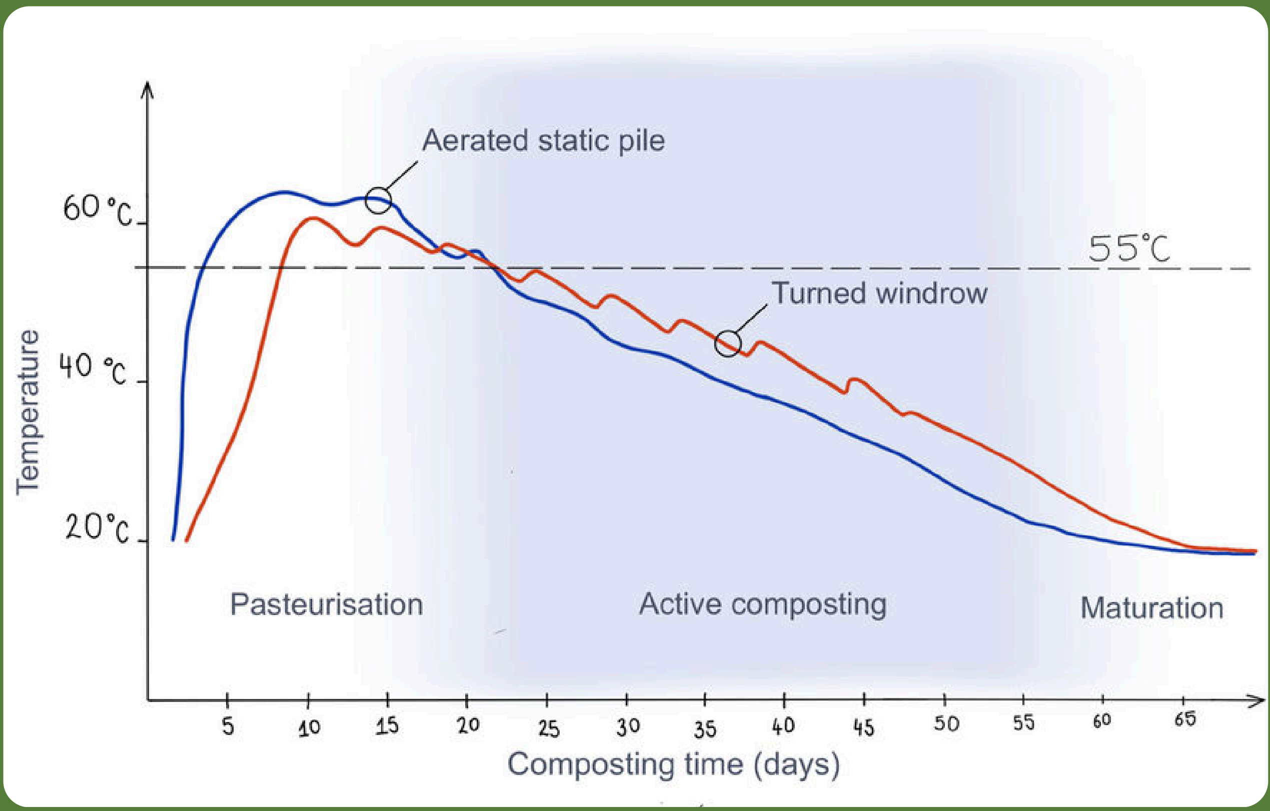
As the readily degradable food sources are consumed, microbial activity slows, and the pile's temperature starts to decline. More complex materials like woody debris become the dominant food source, and microbes adapt to breaking these down over a longer period of time.

Maturation

As microbial activity continues to decline, the temperature of the pile gradually approaches ambient levels. This signals the transition to a stable, mature compost. Maturity is assessed by measuring stability indicators such as carbon dioxide release, oxygen consumption and temperature trends.

Higher values indicate ongoing decomposition, while lower values reflect a mature compost.



Aerated static pile and turned windrow process timeline (RMCG, 2025)

Product preparation: Screening and testing

Once composting is complete, the material is screened and tested to ensure it meets quality standards such as AS4454. Screening removes oversized particles and contaminants, producing a uniform final product.

Any coarse material can be reintroduced to the start of the composting process for further breakdown.

Technologies

Technologies used in composting are broadly separated into open windrow composting (OWC) and in-vessel composting (IVC).

The technology used can be linked to the siting of the facility. For example, in areas with housing close to the composting facility, enclosed systems such as in-vessel composting tend to be used. In more open, regional areas, open windrow processes are more likely.

Other waste treatment technologies exist including anaerobic fermentation.

Open windrow composting

Many composting operations use open-windrowcomposting methods such as passively aerated static piles and turned windrows (long piles of material arranged in rows). These methods are common due to their minimal site alteration and low engineering and capital investment requirements. They are used on farms and can also be scaled up with technologies like mobile aerated floors.

Broadly, they share the following characteristics:

- Aeration – can be achieved passively with frequent turning, or through passive or forced aeration delivered through pipes or flooring at the base of a static pile.

- Feedstock – blending must consider bulk density, especially when relying on passive aeration, to ensure that there is sufficient free air space for oxygen distribution. While all feedstocks can be processed, these methods are best suited for lower risk feedstock (e.g. plant material, manure) with lower moisture content to simplify operations and minimise odour issues.

- Size – windrows that rely on passive aeration should provide a gradient of oxygen from the surface to the centre in between turnings. If low oxygen concentrations are achieved before the centre, anaerobic conditions will likely release odours when turned. For mechanically turned windrows, the height should accommodate the windrow turner's clearance.

- Temperature – as heat is produced in the composting process, if the windrows or piles are too small, they may lose heat quickly and fail to reach pasteurisation temperatures. Temperature probes are usually used to accurately monitor the pile temperature.

- Machinery – typically involves loaders, excavators and windrow turners for pile management. Mobile aerated floors support passive and forced aeration, while covers can help reduce odours and protect piles from rainfall. Probes are commonly used to monitor temperature and moisture levels throughout the process.

In-vessel composting

There are a variety of contained, in-vessel composting systems with different combinations of vessels, aeration devices and turning mechanisms. These can be fully or partly enclosed and typically feature more advanced technology and automation with smaller footprints.

Broadly, they share the following characteristics:

- Forced aeration – can involve blowing air through the pile or sucking ambient air inwards through the pile. The latter ensures that odours can be managed by passing through a scrubber or bio-filter.
- Agitation – devices that mix or turn the organic material are embedded or mounted onto the vessel.
- Process control – tends to be more rigorous with probes measuring parameters like moisture, oxygen, carbon dioxide and temperature, allowing for greater control and efficiency.
- Short retention time – with optimised conditions, composting progresses faster. Typically, pasteurisation and early compost occur in-vessel, while maturation is completed in windrows.
- Process isolation – protects the process from the weather as well as the surrounding environment from the composting process. This enables the processing of more challenging feedstocks, reduces required separation distances, and minimises issues like odour complaints.

Community gardens

Community gardens mostly use passively aerated static piles or rotating containers to produce compost. The breakdown follows a similar pathway to a composting facility but the piles rarely achieve the increase in temperature required for pasteurisation. Community composters must remove certain weeds or diseased plants to reduce the risk of plant and animal diseases, and plant propagules remaining in the compost.

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