GUIDE - MANAGEMENT & OPERATION

Composting Facility

Adapted to the context of First Nations in Quebec

April 2024 edition

Note: Those sections are under revision:
Compost Distribution
Compost Quality Control

FNQLSDI
First Nations of Quebec and Labrador Sustainable Development Institute

GUIDE FOR THE MANAGEMENT AND OPERATION OF A COMPOSTING FACILITY ADAPTED TO THE CONTEXT OF FIRST NATIONS IN QUEBEC

General information

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Presentation of the Guide

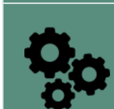
This guide is designed for the First Nations in Quebec. It is intended for waste management managers and workers who wish to understand the operation and implications of the composting service. It is also a reference tool for the operation of a facility. It addresses centralized composting activities on a First Nations community scale. It therefore takes this into account, among other things, in the possible size of the facility and the legal specificities on reserve. However, this makes this guide less suitable for home or bin composting (on an individual or family scale).

The guide presents the stages of the composting service and the main actions to be carried out, from collection to compost use. It also defines more precisely the basic principles of the process that allow organic materials to turn into compost and the operations that need to be carried out. Health and safety, quality control and data monitoring are also covered by providing additional recommendations regarding management and operation. The human resources and training needs are presented at the end of the document. The guide also includes printable practical information sheets.

This document is therefore designed to cover general concepts associated with the management and operation of a facility and can be used regardless of the compost processing method. However, it is recommended that you undergo comprehensive training or consult additional documents that provide more explanations on the operation of the processing technique used in order to properly operate the composting platform. Moreover, this guide does not address the planning aspect of the service implementation, but rather its management once implemented. It therefore does not cover site planning or the detailed processing methods. Other resources are available to guide your community through this stage, many of which are listed in *Appendix 1*. Among these is a review of composting technologies that was conducted by the FNQLSDI in 2018. The FNQLSDI also offers its services to support the First Nations in their process of implementing new waste management services such as a composting platform.

How to Use this Guide

This guide can be consulted in its entirety or in part depending on your needs. Several references between sections indicate where to find additional information on the topic being discussed. References in italics have hyperlinks to go directly to the section mentioned (click on the *italic text*). A glossary is available at the beginning of the document to define specific concepts and words used in composting. The guide also includes various pictograms and boxes to make it easier to read. They include the following:

	Tips and advice
	Definitions
	Useful resources
	Additional information
	Instructions
	Operation recommendations (different icons for each subject) Accompanied by a green box
	Steps of the composting service (different icons for each stage)

Presentation of the FNQLSDI

The First Nations of Quebec and Labrador Sustainable Development Institute (FNQLSDI) was created in 2000 by the Chiefs of the Assembly of First Nations Quebec-Labrador (AFNQL). Its mission is to offer First Nations a dynamic service hub, supporting their actions towards maintaining healthy territories and resources, developing sustainable communities and promoting the recognition of their rights.

The FNQLSDI offers diverse services to the 43 communities of the First Nations in Quebec and Labrador. These services respect the priorities, needs and vision identified by the communities themselves.

The FNQLSDI is mainly active in the following fields:

- Center of expertise in consultation;
- Center of Expertise on Impact and Benefit Agreements;
- Climate change and renewable energy;
- Conservation;
- Waste management;
- Mines and site restoration;
- Strategic planning and comprehensive community planning.

Table of contents

Glossary

Forced aeration: Use of fans to move the air through the composted materials[1].

Passive aeration: The natural movement of air in a pile or windrow caused by convection and which supplies air. No action is taken[2].

Aerobic: A situation or process that takes place in the presence of air and oxygen.

Pathogen: Organism that can cause infections or diseases such as viruses, fungi and parasites[3].

Bulking agent: Materials mixed with organic material in order to create a mixture that is conducive to composting. Bulking agents allow for adjusting the carbon to nitrogen (C:N) ratio and the moisture content. They increase the porosity and improve the aeration of the mixture[4]. These are dry brown materials that are rigid and made up of large particles such as wood chips, dead leaves or cardboard.

Anaerobic: A situation or process that takes place in the absence of air and oxygen.

Windrow: Pile of compost in the shape of an elongated triangular pyramid.

Turned windrow/pile: Composting method where the air circulation is done mechanically by stirring (mixing, turning) the materials regularly.

Bacteria: Living organism made up of a single cell. Bacteria are found everywhere in the environment. They can play beneficial roles, for example by assisting in the decomposition of materials in the composting process.

Stirring: The act of turning and mixing the composted material in a pile, windrow or in-vessel system. Turning is done to increase porosity, introduce oxygen, redistribute moisture or make the material more homogeneous[5].

Compost: Stable, humus-like material resulting from the controlled decomposition of organic materials in the presence of oxygen. Can be incorporated into soil for plant growth or to improve soil properties.

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[1] Fortin A., Hénault-Éthier L. 2009. Guide technique pour le compostage sur site en ICI. https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/Guide_technique_compost_ici.pdf
[2] Alberta Environment and Parks. 2018. Compost Facility Operator Study Guide. https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/co
[3] Idem
[4] Recyc-Québec. Lexique. Page viewed on March 29, 2021. https://www.recyc-quebec.gouv.qc.ca/haut-de-page/lexique
[5] Alberta Environment and Parks. 2018. Compost Facility Operator Study Guide. https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/com

Active composting: Period of active composting when the organic material reaches temperatures of 55°C or above. This period varies depending on the composting technology used but is characterized by frequent aeration and high microbial activity. Requires closer monitoring than the curing phase[6].

In-vessel composting: Composting method where the materials are completely encapsulated during the process[7], for example in a rotating drum or a container.

Composting: Controlled process of biological decomposition during which organic materials are degraded into a soil that is very rich in nutrients.

Contaminant: Element or substance which should not be found in the compost and which can affect its quality such as plastic, glass or a chemical product.

Foreign bodies: Materials which should not be in the compost and which can affect its quality. This is a contaminant in solid form such as plastic, glass, or metal.

Feedstock: Organic materials that are accepted at the composting site and included in the composting process[8]. The collected materials and the bulking agents are the main feedstock.

Leachate: Liquid that has passed through waste or compost. The liquid becomes loaded with compounds that can pollute groundwater.

Brown material: Organic material featuring a large amount of carbon. It is often drier and made up of wood and dead plants (e.g., dead leaves, paper, cardboard, coffee grounds, bread, pasta and rice).

Compostable material: Organic material that can be composted depending on the composting methods.

Organic material: Material formed by living beings (humans, animals, plants, insects, fish, algae, etc.) that can decompose.

Waste: Material that is no longer of value to its owner and which they are getting rid of. It can be reused, recycled, recovered, or eliminated. Composting is a form of recovery.

Green material: Organic material having a large amount of nitrogen. It is often moister and made up of fruits, vegetables or live plants.

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[6] Fortin A., Hénault-Éthier L. 2009. Guide technique pour le compostage sur site en ICI. https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/Guide_technique_compost_ici.pdf
[7] Alberta Environment and Parks. 2018. Compost Facility Operator Study Guide. https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/com
[8] Recyc-Québec. Lexique. Page viewed on March 29, 2021. https://www.recyc-quebec.gouv.qc.ca/haut-de-page/lexique

Curing: Phase following active composting, during which organic material that is more difficult to break down decomposes. There is less microorganism activity, temperatures are lower, and aeration is less frequent. Requires less monitoring than active composting.

Microorganism: A living organism so small that it cannot be seen with the naked eye. Among other things, it can be a bacterium, a fungus, an alga or a virus[9]. Microorganisms play an important role in breaking down organic matter.

Phytotoxic: Substance which has a toxic effect on plants. Immature or oxygen-free compost can be phytotoxic if it contains acids or alcohols which can harm sensitive seeds and plants[10].

Aerated static pile: A composting method where air circulation in the pile is done mechanically by blowing or sucking air with fans. Little or no mechanical mixing (turning, stirring) is carried out.

Static pile: A composting method that does not involve turning the piles or windrows of compost or does not use mechanical means to introduce oxygen.

Porosity: A measurement of the free space between each particle of compost, including the space filled with water[11].

Turning: The action of mixing, agitating, or stirring the composted material in a pile, windrow or in-vessel (closed) system. Turnings are done to increase porosity, introduce oxygen, redistribute moisture, or make the material more homogeneous[12].

Screening: The process of separating particles based on their size using a sieve. Oversized contaminants and particles are removed from the compost to improve its consistency and quality[13].

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[9] Idem
[10] Alberta Environment and Parks. 2018. Compost Facility Operator Study Guide. https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/com
[11] Alberta Environment and Parks. 2018. Compost Facility Operator Study Guide. https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/com
[12] Idem
[13] Idem

1. Introduction

1.1. Benefits of Composting

Recovering organic materials by creating new resources rather than waste

Reducing the amount of waste produced by around 30%

Safeguarding natural environments

Less waste allows landfill sites to be filled less quickly, extending their lifespan. If fewer new sites are built, natural environments will be safeguarded.

Saving money

The band council will pay less to transport and bury waste at the landfill site by locally recovering its organic materials, which represents about 30% of the waste bin in First Nations communities.

Reducing pollution

Of the air: In the landfill, organic materials that decompose without oxygen produce greenhouse gases that contribute to climate change. One of the main ones is methane, a gas 25 times more powerful than CO_2 in terms of its effect on climate change.

Of water and soil: As it decomposes in landfills, organic material produces liquid, which becomes contaminated as it flows into other landfill waste. This liquid, called leachate, is harmful to soils and groundwater if not properly treated.

Improving the health of soils and plants

By returning it to Mother Earth, compost increases soil fertility since it is loaded with nutrients for plants. It is therefore an ecological alternative to chemical fertilizers. It also improves soil structure to better retain and drain water, aerate the soil and retain nutrients.

1.2. What is Composting?

Composting is a biological decomposition process during which organic material such as food waste, leaves and garden waste are transformed into a soil that is very rich in nutrients called compost.

Composting simply mimics the biological decomposition process found in nature, but in a controlled environment. By monitoring and controlling certain parameters, we can produce compost more quickly and ensure that it can be safely used.

Figure 1: Composting cycle

Organisms and microorganisms break down organic material under specific conditions of temperature, moisture, nutrients, and oxygen ratio. Some have a chemical effect on materials, while others physically break down materials by digging, eating, digesting, and stirring them. They include things such as bacteria, fungi, earthworms, insects, and mites.

Organic Materials

Organic material is formed by living things (humans, animals, plants, insects, fish, algae, etc.). The organic materials that can be used for composting vary depending on the composting method and facility. We therefore use the term compostable material to designate organic material that can be composted for a specific facility.

1.3. Compostable Materials

Compostable materials are organic materials that can be composted depending on the composting methods. Generally, home composting (one or a few households) will only be done with organic plant-based material (e.g., vegetables, leaves). Animal-based organic materials (meats, dairy products) are often excluded, as these materials are more difficult to manage in small-scale systems. They can attract animals, produce more odours, and contain pathogens that cannot always be eliminated with small amounts of compost. Larger facilities, at the scale of a First Nation community, municipality or grouping, can however be designed to process all these wastes.

Materials **generally accepted** for **all composting methods**:

- Leftover fruits and vegetables (raw, cooked, rotten)
- Leftover rice, bread, pasta, legumes (no sauce, grease, or oil)
- Coffee, tea and herbal tea filters and residues
- Eggshells
- Shredded newspaper (better to recycle)
- Paper, cardboard, and paper towels soiled with food
- Dead plants, twigs, straw
- Dead leaves, cut grass
- Wood chips and sawdust
- Hair

Materials **generally accepted** by facilities at a First Nation community, municipality or group scale:

- Meat, fish, seafood
- Dairy products
- Fat and oil

Materials **sometimes accepted** by facilities at a First Nation community, municipality or group scale:

- Wastewater sludge
- Animal feces

2. The Steps of the Composting Service

The composting service involves 10 main steps. These steps are described in this section, along with the main actions to be performed. However, some aspects of the operation are detailed in the next sections of the guide. Such is the case for the management of the active composting and curing steps, found in section *3*. Operations that are not associated with a particular step, but rather refer to the entire process are also covered in Sections *5* and *6: Health and Safety* and *Data Monitoring*. *Compost Quality Control* is also a separate section.

Steps of the composting service
Step 1: Collection
Step 2: Feedstock inspection
Step 3: Feedstock preparation
Step 4: Active composting
Step 5: Curing
Step 6: Assessing stability and maturity
Step 7: Screening
Step 8: Storing
Step 9: Distribution
Step 10: Using the compost

Step 1: Collection

The collection of organic materials sorted directly by the participants (at the source) can be carried out in two ways:

- **Voluntary contribution**: Organic materials are brought by participants to the composting site or to collection points.
- **Curbside collection**: Organic materials are collected directly from each participating residence and establishment.

The logistics and equipment options are very diverse. Collection can be done simply by using, for example, small collection containers (e.g., 5-gallon buckets) which are manually emptied into a trailer or pick-up truck. Collection can also be similar to waste and recycling collection with a standard collection truck that can collect materials in larger containers (e.g., 120 L wheeled bins). There are also compartmentalized trucks that can reduce transport costs by collecting two types of waste at the same time (e.g., organic materials and waste).

Figure 2: Pick-up collecting 5-gallon buckets

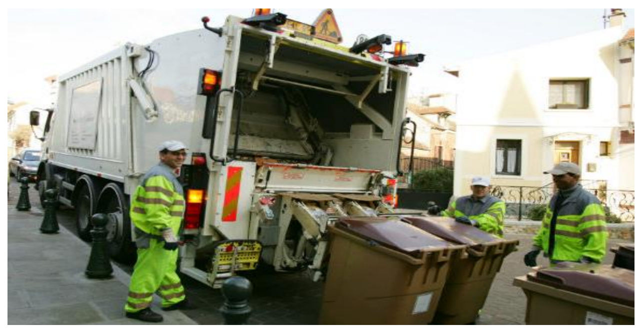


Figure 3: Standard truck collecting 240 L bins

For a strong participation of the members of your community, the curbside collection must:

- Respect the established schedule
- Have a regular frequency
    - Equal to or higher than the waste collection
    - Minimum of once a week in the summer season

Collection Frequency

Reduce the frequency of garbage collection and replace these days with organic material collection. For example, collect waste once every 2 weeks instead of once a week and collect organic materials once a week. This saves collection costs and encourages participation. Materials that produce odours are more likely to be disposed of where they are collected faster.

Communication

Information, awareness and education for community members are essential to the success of the organic material collection and more broadly the composting process. Not only does their participation affects the quantities of materials collected, but it also affects their quality. The quality of materials will in turn have a direct impact on the work of the operators in terms of managing the process. For example, if materials are too wet because liquids (rejected material) have been placed in the bins, the operator will have to adjust their recipe to rebalance the moisture. The quality of the compost produced is also impacted, for example with contaminants such as small pieces of plastic, which could still be found in the compost at the end of the process.

The key information to communicate

- The objectives of the program and the anticipated results, followed by the evaluation of these objectives achievement
- The benefits of composting
- The environmental impacts of organic materials eliminated with waste
- The materials accepted and refused by the collection service
- Instructions for sorting materials and collection logistics
- The composting technology used
- The final product and its use

The means of communication

- Information toolkit (e.g., leaflet, calendar, checklist)
- Promotional materials (e.g., clothing, sticker)
- Information telephone line (e.g., human resource to answer questions)
- Training
- Media (e.g., posters, interviews, newsletter)
- Special activity (e.g., open house day, contest, distribution of compost)

Figure 4: Awareness activity in Listuguj

Step 2: Feedstock Inspection

When the collected material arrives at the composting facility, it must be inspected for:

- Elements that cannot be composted such as metal, glass, plastic, sharp objects and rocks.
- Items that could negatively impact the quality of the finished compost such as batteries and pesticide containers.

Even if the finished compost is inspected with screening, the earlier these materials are removed from the process, the less likely they are to break down into pieces and further contaminate the compost. Inspection can be performed by sorting the material manually or by using mechanical tools.

Step 3: Feedstock Preparation

The collected materials are prepared to provide the best conditions for composting. Depending on the composting methods, they can be:

- **Crushed** to reduce particle size and volume
- **Mixed** to create a mixture of homogeneous materials
- **Combined with bulking agents**, to add carbon to the mixture, balance its moisture, increase its porosity and improve its aeration. Examples: sawdust, straw, dead leaves

Figure 5: Various brown materials, Kahnawà:ke composting facility

Figure 6: Mixer grinder

Choosing Bulking Agents

What materials to use?

- Leaves and dead plants, straw, hay
- Sawdust, bark, wood pellets and chips
- Shredded branches, twigs
- Shredded cardboard and paper

What characteristics to foster?

- Low moisture
- Low density
- Biodegradable organic materials
- Non-toxic (no stains, glues, solvents, treated wood, etc.)
- Easily available at low cost
- Resistance to compression and structure (if need be)

When is structure important?

Since bulking agents are used among other things to structure the pile and allow air to pass through, the structure and size must be taken into account when choosing the material. Material that will keep its shape when wet and break down more slowly will give more room for air. Wood chips and twigs are a good example. Conversely, shredded cardboard and paper offer little structure.

The importance of structure varies depending on the composting method used. It is mainly useful for piles or windrows. A system with very frequent aeration such as that of an in-vessel composting system (e.g., rotating drum, container) will rather prioritize materials that degrade quickly and absorb liquids well. Cardboard and paper would therefore be a good option. It is also possible to mix several materials depending on the supply opportunities.

Where to find the materials?

- Create agreements with institutions and businesses in your community or region.
- Collect the leaves in the fall and save them to add to the mix later.
- Encourage members of your community to bring their wood and yard waste.

Step 4: Active Composting

Once the materials are prepared, they are placed in a pile, windrow, bay or in-vessel system. The materials then begin to decompose and enter the active phase of composting. This is the time when easily degradable organic materials like fruit break down quickly.

Figure 5: Turned windrow system

By creating the right conditions, decomposer organisms become more active. Like us, they need water, food (carbon and nitrogen) and air. Their activity produces heat and increases the temperature of the compost. It can go from ambient levels to a temperature of 55 to 65°C. Regular monitoring of materials is very important during this period to ensure that the process goes smoothly. This helps to avoid potential inconveniences like creating odours and slowing down the process.

To monitor the process, parameters such as temperature and moisture must be checked and recorded. The frequency at which the parameters must be checked varies depending on the composting method, the season and even the operator's experience (often at least once a week). The actions to be taken are decided according to the values obtained. For example, if the compost is too dry, water can be added to it. *Section 3: Management of Active Composting and Curing* outlines the parameters to monitor and what to do based on the results.

Figure 8: Aerated static windrow system

Figure 9: In-vessel rotating drum composter

The basic action consists of stirring or aerating the compost, depending on the composting method. It is carried out on a regular basis. For example, a rotating drum rotates several times a day and a windrow should be turned about once a week. Then, if the parameters still need adjustment, other actions can be taken such as adjusting the mixture of bulking agents and collected materials or adding water.

Composting Techniques at a Glance

Several types of facilities and methods can be used depending on the quantities of materials to be processed, their nature, the space available on the site, its location, the budget, and several other criteria. Compost can be processed outdoors, sheltered by canvas or a roof, or processed in a closed building with odour treatment (negative air pressure). It can be placed in piles, windrows (long piles), bays or rows. It can also be in a closed in-vessel system that can look like a large container, sometimes in the form of a cylinder.

Oxygen is integrated by passive aeration, forced aeration or mechanical agitation, or by using a combination of these methods:

- **Passive aeration** consists of not taking any particular action. The pile ventilates by itself with an air suction effect. Warmer temperatures in the centre of the pile cause the air to rise upwards. This creates a current in the centre which draws in the cool air from the sides. It must be accompanied by another technique for effective composting.

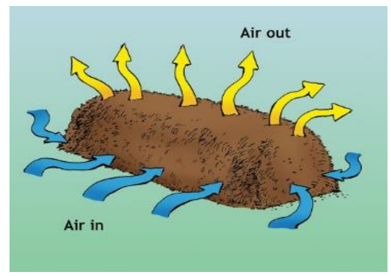


Figure 6: Passive aeration

- **Mechanical agitation** of the compost pile involves turning or stirring the compost using a front loader or specialized machinery (figure 7).
- **Forced aeration** allows air to be blown or drawn into the compost pile, most often through perforated pipes connected to fans (figure 8).

The FNQLSDI completed a review of the different processing technologies in 2018. In addition to providing a description of the methods, it offers a comparison on several aspects such as the needs in terms of equipment and infrastructure, land area, labour, etc. Several other documents are also available for more information on these techniques. The most relevant are presented in *Appendix 1* among the useful references for starting a composting service.

Step 5: Curing

After having broken down the organic material which degrades easily, the microorganisms take care of the more complex ones like paper, wood and plants. The process is slower, and the temperature drops below 40°C to room temperature at the end of the process. Indeed, it is the drop in temperature that indicates that the materials have finished their active phase. Be careful, the other parameters (moisture, oxygen, structure) must be in good condition to ensure that the temperature drops for this reason rather than due to another problem.

The materials are put into curing piles, windrows, or bays. Monitoring the process to ensure good composting conditions is the same as for active composting, but certain interventions such as aeration are less frequent since decomposer organisms are less active.

Figure 8: Windrow curing

Figure 7: Bay curing

Duration of the Composting Process

The time it takes for feedstock to become finished compost varies depending on several factors. Together, the active phase and the curing phase can last from about 6 weeks up to 1.5 years. Here are the main factors:

The composting method:	The speed varies depending on the operations carried out and the conditions in which the organic materials are processed (e.g., aeration frequency, exposure to bad weather). Usually, slower methods have other advantages such as their simplicity and low cost.
The climatic conditions:	If composting takes place outdoors, cold winter temperatures can slow down and even stop the process during this time.
The operator's level of control and management:	The more optimal composting conditions are maintained (oxygen, water, carbon to nitrogen ratio), the faster the process.
The types of feedstock and their degree of preparation:	Materials which have been pre-processed, for example by mixing or grinding, are more homogeneous or made up of smaller pieces. This speeds up the process.

Step 6: Assessing Stability and Maturity

The progress of the composting process is measured with two main indicators: stability and maturity.

Stability: Compost is stable when its active phase is over. It continues to decompose, but more slowly, as the activity of microorganisms slows down. There is therefore less need for oxygen in the pile and the temperatures are lower.

Maturity: Compost is mature when it is ready to use. When the compost reaches maturity, it is already stable. However, stable compost may not yet be mature if it is in its curing phase. In addition to being stable, mature compost no longer has a substance that could be harmful to plant growth, referred to as phytotoxic.

The finished compost should also have the following characteristics:

- Brown soil appearance
- Pleasant earthy smell
- The starting materials are unidentifiable

Figure 9: Mature compost

When should Evaluation be done?

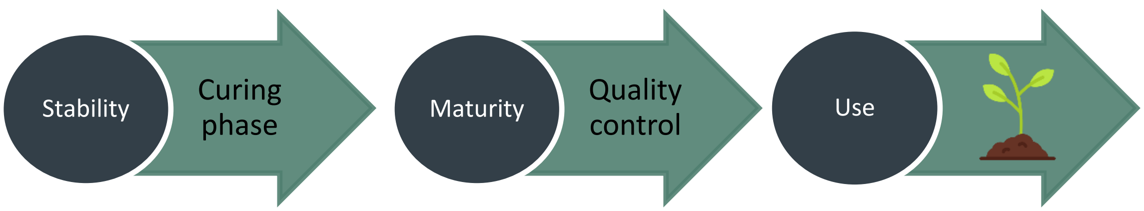
Stability

- Before starting the curing phase

Maturity (including stability)

- Before storing the compost
- Before performing the quality control (see section *4*)

Compost quality control (section *4*) done according to provincial regulations includes tests to assess the stability of the compost (note: government documents[14] use the term "maturity", but the two terms are confounded). Some of these tests must be done in a laboratory. Before performing them, it is preferable to do the simple tests on site to avoid paying to repeat these expensive tests if they are negative.



How to Evaluate these Indicators?

There are several techniques for assessing stability and maturity. Among other things, it is possible to have samples tested in a laboratory, to perform germination, odour or temperature tests. There are also kits sold on the market which indicate the level of maturity of the compost (Solvita test).

[14] Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC), 2015. Guide sur le recyclage des matières résiduelles fertilisantes : Critères de référence et normes réglementaires – Édition 2015. Québec. http://www.environnement.gouv.qc.ca/matieres/mat_res/fertilisantes/critere/guide-mrf.pdf

The most common laboratory stability tests are presented in table 9 under *Section 4: Compost Quality Control*. These are respirometry (O^2 uptake rate) and CO^2 evolution rate tests. Some tests to be performed on site are presented below:

Stability

- A sample of moist compost placed in a sealed plastic bag should give off a slight earthy odour when opened after a week of storage at temperatures between 20 and 30°C.
- The compost remains at room temperature after several days when placed in a well insulated container (flask). Instructions for this test, known as the Dewar Self-Heating Test, are provided in *Appendix 2*.

Maturity

- The temperature inside a pile in good condition (approximately 50% moisture and oxygen concentration greater than 5% in the centre of the pile) remains at or near-room temperature for several days.

Stability and maturity (process progress)

For more precision, the Solvita test is often used on composting sites. This is a kit that allows operators to easily determine the maturity of the compost. The test involves putting a sample in an incubation jar with probes that measure emissions of ammonia or carbon dioxide. Results are ready in four hours. You do not need to be a chemist to perform this test. Simply compare the results with a colour chart provided with the kit. For more information on the product or to order it, visit the company's website[15].

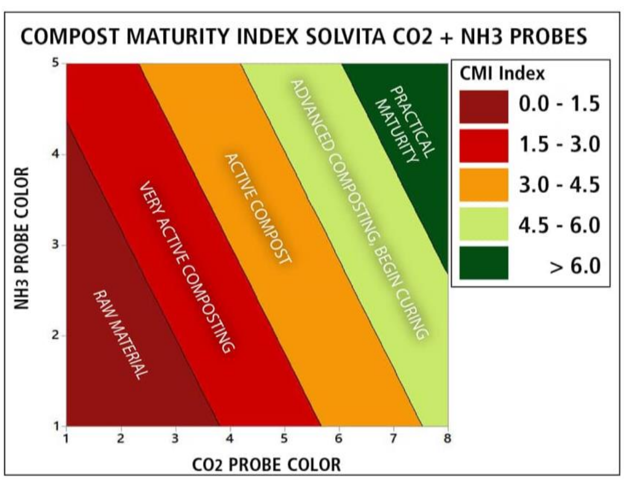


Figure 11: Solvita test maturity index

Figure 10: Solvita test kit

15 Solvita® (2021) CMI Calculator, Compost Maturity test. Page viewed on January 7, 2021. https://solvita.com/cmi-calculator/.

Step 7: Screening

Screening is usually done when the compost has matured but can also be done after the active phase of composting. Screening the **finished compost** improves the quality of the product for its users, because it becomes less compacted, more uniform and without clusters. It is also easier to screen since it has less moisture than compost that is still being processed. Screening **after the active phase** offers the advantage of making the maturing compost uniform, which speeds up the process. The compost can be screened at both these times if desired.

The material is passed through a sieve with a mesh of about 1 cm to remove excessively large materials. The mesh should be larger when used after the active phase. This removes:

- Organic materials that have not finished decomposing.
    - ➢ They can be put back into active composting.

- Unwanted materials that are not suitable for composting (contaminants). They can negatively affect the quality of the compost and present risks to health and the environment (e.g., glass, metal).
    - ➢ They are disposed to the appropriate places (e.g., waste, ecocenter).

Figure 13: Rotary sieve

Figure 17: Manual sieve

Figure 12: Mechanical sieve

Step 8: Storing

Storing the finished compost is the final step in the composting process. It can be stored in bulk or in bags. In bulk, it is preferable to protect it from bad weather with tarpaulins (breathable membranes) for example. This prevents weeds from growing on it or odours from forming. Monitoring stored pile parameters is recommended to limit the risk of fire. These parameters are mainly temperature and moisture. Refer to section *5.2.1: Fire Prevention*.

Figure 14: Mature compost pile

Step 9: Compost Distribution - Under Revision -

*The following section (Compost Distribution) is currently under revision. Some information may differ from current regulatory requirements. For more information, please contact the team at wm_gmr@iddpnql.ca.

Compost can be distributed for free or sold inside or even outside your community. Legal obligations vary depending on the type of distribution (sale or donation) and its location. The regulatory framework is shared by the provincial and federal governments. Verification of the compost quality is governed by provincial regulations. The nature of its distribution (free or sold) is regulated by the provincial government, while a federal law governs its sale. This therefore leads to a legal void with regard to quality control and free distribution. However, it is recommended that you follow provincial regulations and standards to ensure that its use is safe for the members of your community and for the environment.

Table 1 presents a summary of the requirements to be met depending on the type of compost distribution. These requirements are then described below for each of the elements described; the product sheet, project notice and labelling. Quality testing is explained in detail in section *4: Compost Quality Control.*

Table 1: Requirements to be met depending on compost distribution

Compost distribution	C-P-O-E classification quality test	Product sheet	Project notice	Labelling
Free distribution on-reserve	Recommended	Recommended	Not required	Not required
Sold on-reserve	Mandatory	Recommended (if sold in bulk)	Not required	Mandatory (if sold in bags)
Free distribution outside the community (Quebec)	Mandatory	Mandatory	Mandatory	Not required
Sold off-reserve (in bulk)	Mandatory	Mandatory	Mandatory	Not required
Sold off-reserve (in bags)	Mandatory	Not required	Not required	Mandatory

Product Sheet

A description of the compost must be given to its users. It must contain the following elements:

- The quality of the compost (results of laboratory analyses)
- Compliance with standards (C-P-O-E classification)
- Recommendations for use
- Warnings

General use recommendations for members may be determined based on advice provided by the Compost Council of Canada[16]. Refer to step 10 focused on using the compost. For more specific uses, evaluation by an agronomist is recommended. A template for the product sheet is provided in *Appendix 3*.

Instructions for Use

Although the product sheet is not mandatory when the compost is distributed in your community, producing one with instructions at the very least would help ensure proper use.

[16] Compost Council of Canada. 2019. Page viewed online on October 22, 2020. http://www.compost.org/

Project Notice

A project notice must be submitted to the MELCC each year for the compost distribution. In this notice, the results of the compost quality analyses are required, among other things, to ensure compliance with the regulations[17].

Since this is a notice and not a request, the compost can be distributed without waiting for confirmation or instructions from the MELCC. Administrative checks may be made on the documents received and the activities in the field. If the compost does not comply with the regulations, requests for corrections will be made. The project notice form is provided on request by the regional offices of the MELCC.

Labelling

If the product is sold in bags, it must have a label that meets federal Fertilizer Act and Regulations requirements[18]. The label should include the following information. Refer to the web page for specifications.

- Product name
- Net weight
- Name and address of the registration holder or party responsible for the packaging
- Batch number
- Guaranteed analysis (nutrient content)
- Instructions
- Warnings (if applicable)

Useful Resource

Regulation of compost under the Fertilizers Act and Regulations

Webpage: https://www.inspection.gc.ca/plant-health/fertilizers/trade-memoranda/t-4-120/eng/1307910204607/1307910352783)

[17] Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC), 2015. Guide sur le recyclage des matières résiduelles fertilisantes : Critères de référence et normes réglementaires – Édition 2015. Québec. http://www.environnement.gouv.qc.ca/matieres/mat_res/fertilisantes/critere/guide-mrf.pdf

[18] Government of Canada. 2018. T-4-120 – Regulation of compost under the Fertilizers Act and Regulations. Page viewed online on September 14, 2020. https://www.inspection.gc.ca/plant-health/fertilizers/trade-memoranda/t-4-120/eng/1307910204607/1307910352783

Step 10: Using the Compost

The finished compost can be used as an organic amendment. This means that it can be added and mixed with the earth to help the soil and plants be healthier. Be careful; it should not be used alone (without soil) to grow plants, because it is too strong and may damage them.

Figure 15: Community garden

According to the Compost Council of Canada[19], the following are instructions for using compost depending on its use. For specific use, professional consultation is recommended.

Maintaining flower beds: Add about 1.25 cm (1/2") of compost as a top layer in the fall or spring. If adding mulch, apply compost first, then cover with mulch. If last year's mulch is still in place, remove it, add a layer of compost, then reapply the mulch, watering until the entire root zone is saturated.

Planting flower beds or lawns: Add 5 cm (2") of compost and mix to a depth of at least 30 cm. Although compost is beneficial any time it is added to the soil, for the best results, add your compost about four weeks before planting. This will give the compost a little more time to increase the number of beneficial organisms in your soil, which will stimulate plant growth.

Planting vegetable gardens: Apply about 2 cm (¾") of compost as a top layer, before or after planting. Again, for the best results, apply the compost at least 4 weeks before planting. You can also put some compost in the hole you make when you plant your seedlings.

Planting trees: Dig a hole about 5 times the diameter of the tree's root ball. Before planting, mix 1 part of compost with 6 parts of original soil and mix well outside the hole. Place the tree in the hole and use the compost-soil mixture as backfill around the root ball. Water abundantly.

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[19] Compost Council of Canada. 2019. Compost directions for use. Page viewed online on October 22, 2020. http://www.compost.org/compost_directions/.

3. Management of Active Composting and Curing

The process during which organic material is transformed into compost is mainly carried out during steps 4 and 5 of the composting service. Presented in section *2*, they are detailed here to address the basic principles of the composting process and the operations that need to be carried out. Additional recommendations to ensure the health and safety of workers are also presented in section *6*.

First, the 5 main conditions to be met for the process to be successful are presented: carbon to nitrogen ratio, temperature, oxygen, moisture and porosity. Each is broken down into *how does it work*, *what to do*, and *how to do it* to monitor and maintain these conditions. They are then summarized in *monitoring parameters*, while indicating frequencies and monitoring methods. Finally, the tables in the *Troubleshooting* section indicate the actions to be taken depending on the state of the parameters. Practical information for the composting site in this section is also available in *Appendix 4* in a printable version.

3.1 Parameters to be Satisfied

3.1.1 Carbon to Nitrogen Ratio (C:N)

How does it work?

Carbon and nitrogen are some of the basic nutrients for composting. Bacteria need the combination of the two to break down material efficiently. Carbon provides energy to bacteria, and then this energy is used to “eat” the nitrogen. A bacterium needs 30 times more carbon than nitrogen to thrive. This represents a carbon to nitrogen ratio of 30:1. It is possible to calculate the ratio of composted materials with theoretical values or laboratory testing. Fortunately, you do not need to know the exact ratio. You just need to strike a good balance between materials that are richer in carbon and those that are richer in nitrogen.

Materials rich in **nitrogen**, also called **green** materials

- Waterlogged, moist, soft
- Examples: Food scraps (fruit, vegetables, meat), weeds and fresh grass
- In too large a quantity, they will rot and give off odours.

Materials rich in **carbon**, also called **brown** materials

- Dry, rigid
- Examples: Dead leaves, straw, sawdust, cardboard
- In too large a quantity, they slow down the process

Carbon and Nitrogen

They are among the main components of all known life on Earth. Everything that lives or has ever lived contains it.

What to do?

The organic material from collection is mainly made up of food wastes, which are green material (nitrogenous). It is therefore required to add brown materials (carbonaceous) to have enough carbon in the recipe. Brown material, also called a bulking agent, also helps other composting conditions to be met by absorbing moisture and allowing air to flow into a pile. Finding the right ratio of brown materials to add is a trial-and-error process. The materials collected have a different composition from one place to another and change over the course of the year according to the seasons and the consumption habits of the population. In general, 30% to 50% of the weight of the collection waste must be added in brown materials (also varies depending on the composting method). At a glance, we can therefore start the "recipe" with a ratio in these proportions and make adjustments according to the observations of the monitoring parameters (moisture, temperature, porosity, etc.).

Add brown materials with a ratio of approximately 30% to 50% of the weight of the collection.

How to do it?

Creating the recipe for bulking agents (brown materials) and collected materials is done mainly at the material preparation stage, before the composting process begins.

It can also be modified during active composting and curing. It is not necessary to monitor the ratio by doing a test, since the other parameters will give clues as to whether the recipe needs to be adjusted. For example, too much moisture or too high a density could be resolved by adding bulking agents. Refer to section *3.3: Troubleshooting*.

Calculating Feedstock Recipe

Quantities can be measured by weight by weighing the materials using a scale, or by volume with the equipment used to transport the materials and mix them (e.g., buckets, excavator).

An Excel spreadsheet or web page can be programmed to do the calculation automatically by entering the quantities of materials collected. A calculator can be used as well.

Materials

- Calculators
- Spreadsheet

  OR
- Excel spreadsheet or web page

Procedure

1. Define the desired proportion of bulking agents (%)
2. Evaluate the quantity of collected materials to introduce (by weight or by volume)
3. Use the following formula to calculate the amount of bulking agents to add:

$$\text{Bulking agents} = \text{Desired proportion (\%)} \times \text{Collected materials}$$

Example

Desired proportion of bulking agents: 30% (0.3)
Quantity of collected materials: 10 kg
Quantity of bulking agents to be added = 0.3 x 10 kg = 3 kg

3.1.2. Temperature

How does it work?

Much like when we get hot while exercising, heat is produced when microorganisms work to break down organic materials. Microorganisms are responsible for the rise and fall of temperature in the process. The more active and numerous they are, the higher the temperature. This is why the temperature is at its highest during the active phase of composting, then drops as the curing phase progresses. A finished compost then returns to room temperature. The temperature therefore allows to monitor the progress of the composting process. It is also a good indicator to check if everything is going well or if there is a need for adjustment.

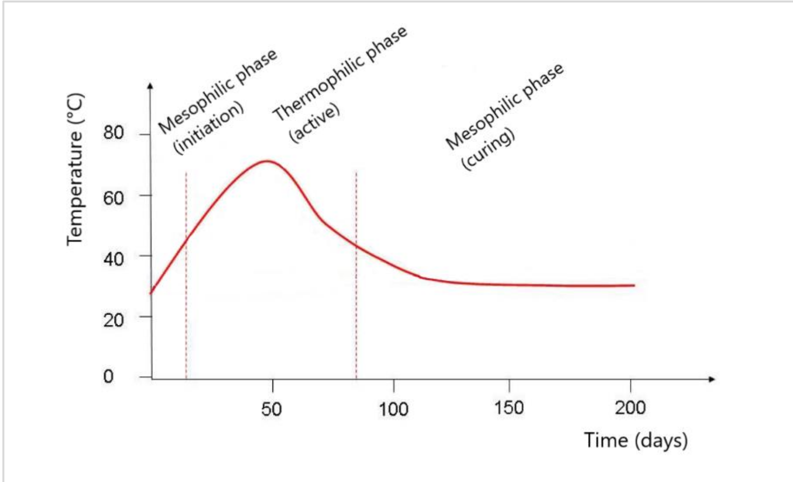


Figure 16: Temperature evolution in the thermophilic composting process

As the temperature rises, different bacteria are at work. They are classified into two categories: mesophiles and thermophiles. The temperature categories also have the same names. Thus, average temperatures between 10 and 40°C are called mesophilic and high temperatures above 40°C are called thermophilic (Table 2).

Table 2: Temperature categories of composting

Temperatures	Fahrenheit	Celsius
Mesophilic (medium):	Between 50 and 105°F	Between 10 and 40°C
Thermophilic (high): • Destroys pathogens • Destroys weed seeds	Over 105°F • 131°F • 145°F	Over 40°C • Starting from 55°C • Starting from 63°C

What to do?

If animal wastes are processed by the composting platform, it is necessary to reach thermophilic temperatures during the active phase. These temperatures can destroy pathogens in meats, dairy products and plants starting from 55°C, in addition to destroying weed seeds starting from 63°C. However, a temperature higher than 70°C causes certain decomposers to die, which slows down the composting process.

Pathogens

Organisms that can cause infections or diseases such as viruses, fungi and parasites.

Since the temperature depends on the activity of decomposers, the ideal conditions for their wellness must be ensured by providing them with a good carbon to nitrogen ratio, water and oxygen (detailed in the following sections). When the desired temperature is reached, stirring the material will lower or stabilize it so that it does not rise too high and slow down the process.

Keep the temperature between 55 and 65°C during the active phase.

How to do it?

Taking the temperature regularly (once or several times a week) and recording the results allow you to monitor the progress of the process. Take the temperature at several places, **at the centre** of the pile, windrow or in-vessel system.

Use an analogue or digital thermometer fitted with a stainless-steel probe approximately 1.2 to 1.8 m long and 6 to 10 mm in diameter. The probe allows you to measure the temperature near the centre of the compost pile. It is also possible to put a protector on the probe to prevent it from bending when pushing it through harder material.

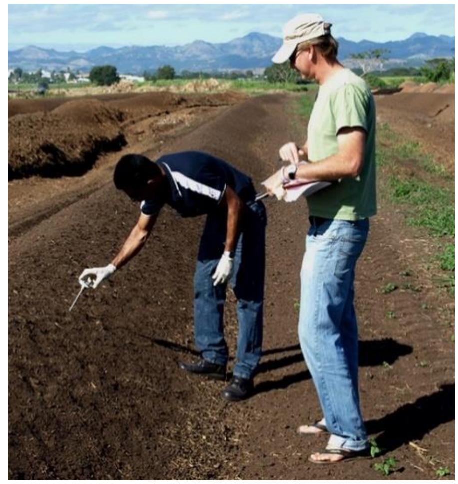


Figure 17: Temperature measurement

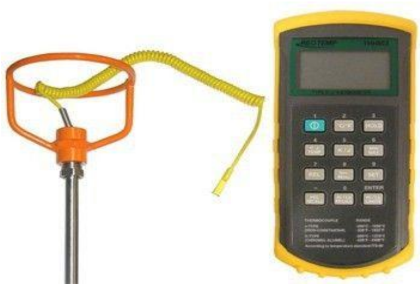


Figure 19: Digital thermometer with probe

Figure 18: Analogue thermometer with probe

Reducing Pathogens

According to the recommendations of the Canadian Council of Ministers of the Environment (CCME)[20], here is the procedure for eliminating pathogens during the composting process.

In-vessel composting: The materials must be kept at a minimum temperature of 55°C for at least **3 consecutive days**.

Aerated static pile composting: The material must be kept at a minimum temperature of 55°C for at least **3 consecutive days**. It is best to cover the piles with a layer of insulating material, such as mature compost or wood chips, so that the outer layers can reach the desired temperature. It is also recommended to redo the windrows (stir the materials) after at least 3 days at high temperature and repeat another 3-day sequence thereafter to ensure that all the materials have heated up.

Turned windrow composting: The materials must be kept at a minimum temperature of 55°C for at least **15 days** and be turned at least 5 times during the period of high temperature. A minimum of 3 days between turnings is necessary for the centre of the windrows to heat up long enough.[21]

[20] Canadian Council of Ministers of the Environment. 2005. Guidelines for Compost Quality. https://www.topspray.com/wp-content/uploads/2020/06/compostgdlns_1340_e-1.pdf

[21] Alberta Environment and Parks. 2018. Compost Facility Operator Study Guide. https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/co

3.1.3. Oxygen and Aeration

How does it work?

Microorganisms need oxygen to survive and to break down organic materials. The oxygen demand is higher during the active phase of composting since the microorganisms are more active, then decreases during the curing phase. Aeration also helps manage or eliminate potential odours, which are in part associated with lack of oxygen during material decomposition.

What to do?

Frequently aerating the materials allows for providing them with oxygen, in addition to reducing heat and removing moisture.

- Stir or aerate the materials regularly.
- Maintain an oxygen level of 12 to 18% optimally, minimum of 5%.

How to do it?

The method used to provide oxygen to the compost depends on the composting technique used. It can be done by forced aeration, where fans blow or pull air through grids or perforated pipes passing through the compost. Compost can also be mixed, for example by turning piles or windrows with an excavator or specialized machinery.

When to Stir or Aerate Materials?

Many observations provide clues as to when the compost needs to be stirred or aerated. The main indicator is temperature. When it starts to go down, this can mean that the microorganisms are lacking oxygen and that it is time to stir.

More directly, a tool called an oximeter can measure the oxygen level in the compost. Oxygen should be introduced when the rate gets close to the minimum value (5%). However, this tool is not mandatory. It is also quite expensive (around $2,000).

Figure 20: Oximeter

Here are some guidelines for determining when a pile should be stirred:

- Temperatures are above 65% and below the desired temperature depending on the phase of composting.
- After heavy rains to redistribute the moisture absorbed by the materials.
- After a snowfall to incorporate moisture if needed.
- Visual observations or measurements (porosity or bulk density test) indicate that the materials have become compacted or that there is no longer enough free space for air circulation.
- Observations (e.g., odours) or measurements (oxygen concentration) indicate that oxygen-free (anaerobic) conditions have set in.[22]

As for aerated static piles, they are usually not or rarely stirred. Rather, it is the intensity and frequency of the aeration that varies.

Caution!

- A drop in temperature does not always mean the compost need oxygen. Il could also be caused by other parameters that are in poor condition, such as moisture. It is therefore important to monitor and adjust all parameters properly.
- Aeration also causes the pile to lose heat. Airing too frequently or at too high intensity could therefore prevent optimum temperatures from being reached and slow down the process, especially in the cold season. This is also why it must be reduced in winter, or even stopped as appropriate.

[22] Alberta Environment and Parks. 2018. Compost Facility Operator Study Guide. https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/co

3.1.4. Moisture

How does it work?

Water is essential for all life, even for microorganisms. Moisture allows them to move around and eat and break down materials. When the moisture level is too low, the process slows down. However, if it is too high, water will prevent air from flowing between the materials. There is then not enough oxygen, which causes odours.

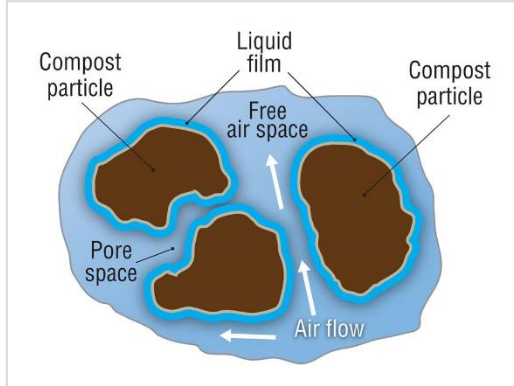


Figure 21: Air flow in a compost pile

What to do?

Test the moisture regularly. If the materials are too dry, add water or add a larger proportion of green materials the next time you introduce materials. If there is too much moisture, add more brown materials.

Maintain the moisture level: Between 50 and 65% during the active phase and between 40 and 50% during the curing phase.

How to do it?

Testing Moisture

Three methods can be used to test the moisture level: squeeze test, a hygrometer and the drying method[23]. They are presented in the following table and then detailed.

Table 3: Moisture evaluation methods

Method	Description
1. Squeeze test	Simple and fast Not very precise (precision increases with the operator experience) Can be used in addition to other methods
2. Hygrometer	Fast, more complex calibration Tool with variable reliability requiring regular calibration
3. Drying method	Longer, more complex calculation Reliable and precise

[23] Fortin A., Hénault-Éthier L. 2009. Guide technique pour le compostage sur site en ICI. https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/Guide_technique_compost_ici.pdf

For a novice operator, the squeeze test can be used to get a general idea before doing a more precise test with the other two methods, either the hygrometer or drying method. Of these two, the drying method is recommended since it provides the most reliable information.

An experienced operator might rely more on the squeeze test for their operations, as they will have learned to recognize the texture of the compost by comparing it to the results of other methods. They could for example use the squeeze test in an alternating fashion with the precise tests, or use them as needed. To ensure a more standardized monitoring of moisture, a hygrometer or the drying method can remain the main methods used regardless of the operator's experience level.

1. Squeeze test

Squeeze a handful of compost in one hand.

- **Good moisture:** A few drops of water slip between the fingers, but water does not flow. When you open your hand, the compost forms a ball.
- **Too much moisture:** Water leaks out.
- **Too dry:** Water does not come out and the compost breaks up and crumbles when you open your hand.

Figure 22: Squeeze test

2. Hygrometer

Tool that measures moisture using a probe that goes directly into the compost. Instructions are included with the purchased device.


Figure 23: Hygrometer

3. Drying Method

Materials

- Scale
- Standard oven, toaster oven or microwave oven (see procedure variation)
- Pyrex or aluminum container
- Calculator

Procedure – Standard oven and toaster oven

1. Weigh a small Pyrex or aluminum container.
2. Add 10 g of compost (called a wet sample).
3. Dry the sample for 24 hours in a toaster oven or standard oven at 105°C.
4. Weigh the dry sample and subtract the weight of the container.
5. Use the following formula to determine the moisture of the compost.

$$\text{Sample moisture} = \left(\frac{\text{Wet sample weight} - \text{Dry sample weight}}{\text{Wet sample weight}}\right) \times 100$$

Procedure – Variation for microwave ovens (step 3)

Using a microwave oven is faster, but an experiment must be done at the beginning to know the right heating time (step 3) according to the strength of the microwave:

1. Heat a 100 g sample for 8 to 10 minutes in a microwave oven of at least 600W.
    a. If the microwave oven is less powerful, increase the drying time.
    b. If the compost is drier, such as finished compost, reduce the drying time.
2. Remove the sample from the microwave and weigh it.
3. Heat the sample for 2 more minutes and reweigh it.
4. Repeat the cycle at 1-minute intervals until the sample maintains a constant weight.
5. If the sample has burned, start over with a new sample with shorter time intervals.

Do this test for the first few samples to determine the time required to dry a sample (without burning it). Drying can then be done in a single continuous step.

Example

Container weight: 5 g
Wet sample weight: 10 g
Weight of the wet sample with the container: 5 g + 10 g = 15 g
Weight of the dry sample with the container: 9 g
Dry sample weight: 9 g – 5 g = 4 g

$$Moisture = \left(\frac{10\ g - 4\ g}{10\ g}\right) \times\ 100 = \left(\frac{6\ g}{10\ g}\right) \times\ 100 = 0.6\ g\ \times\ 100 = \mathbf{60}\%$$

3.1.5. Porosity, Structure, Particle Size

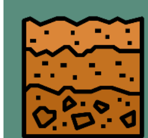
How does it work?

Porosity, structure, and particle size affect compost on two levels:

- **Aeration**: Good porosity and structure results in compost that is not too compact and that allows air to flow between the materials.
- **Decomposition rate**: Decomposition is faster if the contact surface with decomposer organisms is larger, as with smaller particles. Large pieces therefore take longer to decompose than small ones.

What to do?

Porosity and particle size can be optimized by using organic materials and bulking agents that are large enough to allow good aeration while being small enough to decompose quickly. Shredding and mixing also helps to give the desired size and texture to materials.



- Have particles between 1/8" and 2" in average diameter (0.3 cm and 5 cm)
- Have a bulk density between 300 and 600 kg/m^3 for turned windrows and between 500 and 700 kg/m^3 for an aerated static pile
- Have a porosity of at least 20%

How to do it?

The particle size can be adjusted during the material preparation stage, for example by using a shredder. If a shredder is not used, you can encourage members of your community to cut their waste into pieces. They will also have more space in the collection bins.

Porosity and structure can be assessed by two methods throughout the process (material preparation, active composting, curing). These methods show how well air can flow in the compost pile. These are the porosity test and the bulk density test, shown below[24]. Only one of the two tests should be used (as desired) since their results are similar.

[24] Poulin S. 2005. *Recueil de méthodes d'analyse* and *Outils de formulation pour le compostage des matières organiques*.

Testing Porosity

Figure 24: Test de porosité

Materials

- Graduated container
- Measuring cup
- Spatula
- Water
- Calculator
- Spreadsheet

Procedure

1. Take a sample of compost from a pile at a depth of 60 cm (2 feet) while measuring its volume (e.g., 5 litres).
2. Place the sample in a graduated container.
3. Pour water into the container with a measuring cup and note the volume of water added.
4. Pour in water to cover the compost.
5. Stir well with a spatula to remove the air from the compost.
6. Let stand for a few minutes.
7. Make sure there is free water on top of the compost after the standing period. Otherwise, add more water.
8. Note the volume occupied by the water and the compost, called the total volume without air.
9. Calculate the total volume with air by adding the volume of compost (measured initially) and the volume of water.

$$Total\ volume\ with\ air = Compost\ volume + Water\ volume$$

10. Calculate the pore volume by subtracting the total volume with air from the total volume without air.

$$Pore\ volume = Total\ volume\ with\ air - Total\ volume\ without\ air$$

11. Calculate the porosity with the following formula.

$$Porosity\ (\%) = \frac{Pore\ volume \text{ x } 100}{Compost\ volume}$$

Example

Compost volume: 5 litres (L)

Water volume: 3 L

Total volume without air: 6 L

Total volume with air: 5 L + 3 L = 8 L

Pore volume: 8 L – 6 L = 2 L

$$Porosity = \frac{2\ L \text{ x } 100}{5\ L} = \frac{200}{5\ L} = 40\%$$

Testing Bulk Density

Materials

- 10 to 20 litre container
- Scale
- Calculator
- Spreadsheet

Procedure

1. **Weigh** the **empty** container.
2. Determine the **volume** of the container. This is usually indicated under the container. If the volume is not known, calculate it by measuring its height and diameter.
3. Take a sample of compost from a pile at a depth of 60 cm (2 feet).
4. Fill the container **one-third** full of compost. Drop it to the ground 10 times from a height of 15 cm (6 inches).
5. Add material to fill **two thirds** of the container. Drop it to the ground 10 times from a height of 15 cm (6 inches).
6. Fill the container **completely**. Drop it to the ground 10 times from a height of 15 cm (6 inches).
7. Fill the container completely (do not fill beyond the edges of the container).
8. **Weigh** the **full** container.
9. **Subtract** the weight of the **empty** container from the weight of the **full** container to calculate the weight of the sample.
10. **Divide** the **weight** of the sample by the **volume** of the container.

$$Density = \frac{(\text{Full container weight} - \text{Empty container weight})}{\text{Container volume}}$$

Example

Empty container volume: 19 L (0.019 m^3)

Weight of the empty container: 1 kg

Weight of the full container: 10 kg

Sample weight: 9 kg

$$Density = \frac{10\ kg - 1\ kg}{0.019\ m3} = \frac{9\ kg}{0.019 m3} = 474\ kg/m3$$

Please note the result must be in kilograms per cubic meter (kg/m^3) to be compared with recommended values. The units of weight and volume must be converted if they are not already in kg and m^3.

1 L = 0.001 m^3
1 g = 0.001 kg

3.2. Parameter Monitoring

The parameters for monitoring composting conditions are summarized in the following table. The optimal conditions to be maintained as well as the evaluation methods for each parameter are included. Refer to the previous section *3.1: Parameters to be Satisfied* for detailed explanations and instructions on the assessment methods.

Table 4: Summary of the monitoring parameters

Parameters	Optimal conditions	Measurement tools or evaluation methods
Temperature	**Active phase**: 55 to 65°C to eliminate pathogens **Curing phase**: 40°C to near ambient temperature	Digital or analogue thermometer with probe
Moisture	**Active phase**: 50 to 65% **Curing phase**: 40 to 50%	Drying method Squeeze test Hygrometer
Oxygen	**Optimal**: 12 to 18% **Minimum**: 5%	Oximeter **OR** Regular mixing or aeration depending on the other parameters observed
Porosity	**Minimum**: 20%	Porosity test
Bulk density	**Turned pile**: 300 to 600 kg/m^3 **Aerated pile**: 500 to 700 kg/m^3	Bulk density test

3.2.1. Choice of Parameters and Monitoring Frequency

Managers and operators are responsible for deciding which parameters to test and how often based on their equipment, processing method, stages of operation and experience. Compost in the active phase requires more intense management and should be monitored more regularly than in the curing phase. In general, the parameters are monitored at least once a week. The temperature should be tested most often since it indicates whether the process is going well. This can be done every day for a less experienced operator. Moisture is also a basic element to be tested regularly. Porosity and bulk density are used to determine whether air can flow properly in the compost. It would be possible to choose to test only one of them. Finally, measuring the oxygen level with an oximeter provides additional help to operators. It is not essential, however, because it can be deduced based on the other parameters such as temperature.

3.2.2. Record

Parameter monitoring data should be recorded in order to track the evolution of compost temperatures and the other tests related. This keeps track the evolution of the process, and it is by referring to them that operators make decisions on the actions to be taken (e.g., aeration, addition of bulking agents). See section *3.3: Troubleshooting* for actions to take based on the observed parameters. An example of a parameter monitoring record is available in *Appendix 5*.

In addition to these parameters, it is advisable that the main actions performed on site, feedstock quantities, finished compost volumes and other relevant information be recorded. This data can be referred to later on, helping to continuously improve operations. See section *6: Data Monitoring* for all the information to include.

Pile Identification

In order to facilitate monitoring, it is recommended to assign an identification number to each pile or windrow when building them. The numbers can be written on signs or directly on wooden stakes. The date of construction and the stage at which the materials are (e.g., active, curing, storage) must also be indicated on the signs or in the record.

Figure 260: Identification of piles (wooden stakes)

Figure 251: Identification of piles (signs)

3.3. Troubleshooting

Based on the parameters measured to monitor the composting process, the following tables show suggested solutions to address temperature, odour, and animal issues[25].

3.3.1. Temperature

Table 5: Solving temperature problems

Problems	Possible reasons	Signs	Solutions (One or more at a time)
Temperature too low Under 55°C (active phase)	Too dry	Low moisture content **Active phase**: Under 50% **Curing**: Under 40%	• Add water • Revise the recipe if necessary (more green materials (nitrogenous))
	Too moist	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	• Add bulking agents (brown materials) • Stir or increase the intensity of the aeration • Review the recipe as needed
	Lack of brown materials (carbonaceous)	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	
	Lack of structure / too compact	Porosity under 20% Bulk density: Turned pile: Over 600 kg/m^3 Aerated pile: Over 700 kg/m^3	
	Piles too small	Pile under 3 feet high	• Combine piles
Temperature too high Over 65°C (active phase)	Lack of aeration	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	• Stir or increase the intensity of the aeration
	Too dry	Low moisture content **Active phase**: Under 50% **Curing**: Under 40%	• Add water and stir / aerate normally
	Piles too large	Pile Over 8 feet high	• Reduce the size of the piles

[25] Michigan recycling coalition. 2015. Compost Operator Guidebook: Best Management Practices for Commercial Scale Composting Operations. https://www.michigan.gov/documents/deq/deq-oea-compostoperatorguidebook_488399_7.pdf

3.3.2. Odours

Table 6: Solving odour problems

Problems	Possible reasons	Signs	Solutions (One or more at a time)
Ammonia smell	Lack of brown materials (carbonaceous)	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	• Add bulking agents (brown materials)
	Brown materials decomposing too slowly (carbon source not available)	Large pieces of wood	• Add bulking agents (brown materials) of smaller size or which degrade quickly
Fermentation or rotting smell Associated with lack of oxygen conditions (anaerobic)	Low temperature		
	Too moist	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	• Add dry bulking agents • Review the recipe as needed • Stir or increase the intensity of the aeration
	Lack of structure / too compact	Porosity Under 20% Bulk density: Turned pile: Over 600 kg/m^3 Aerated pile: Over 700 kg/m^3	• Add bulking agents • Stir the pile
	Lack of aeration		• Stir or increase the intensity of the aeration
	High temperature		
	Pile too large	Pile Over 8 feet high	• Reduce the size of the piles
	Uneven or incomplete airflow in the pile		• Increase the stirring frequency

3.3.3. Animals

Table 7: Solving problems related to the presence of animals

Problems	Possible reasons	Solutions (One or more at a time)
Presence of flies, insects or small mammals	Contaminated feedstock Flies are present as soon as materials arrive at the site	• Close the lids of the collection bins • Frequently wash the collection bins • Increase the collection frequency • Store the materials in a cool place
	Accessible compost	• Cover new feedstock or aerated static piles with 6 inches of mature compost or bulking agents • Put wire fences over the entrances or access points to the compost (if possible) • Ensure a high composting temperature • Frequently stir the materials
	Stagnant water (on site or at the base of compost piles)	• Level the site correctly • Maintain the platform surface
	Odours	• Manage the odour problems

4. Compost Quality Control - Under Revision -

*The following section (Compost Quality Control) is currently under revision. Some information may differ from current regulatory requirements. For more information, please contact the team at wm_gmr@iddpnql.ca.

When the compost has reached maturity, controlling its quality helps ensure its safety for human and environmental health. It is therefore recommended to determine its quality so that it can be used risk-free, especially if it is used in gardens. For example, some contaminants and pathogens like salmonella can be harmful to members of your community if they get into food.

In Quebec and Canada, standards are in place to ensure the proper use of compost according to its content. The following section presents the method for testing its quality according to the regulations of the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC). Refer to the *Guide sur le recyclage des matières résiduelles fertilisantes*[26] (French only) for more information.

Useful Resource (French only)

Guide sur le recyclage des matières résiduelles fertilisantes (guide to the recycling of fertilizing waste)

Webpage: http://www.environnement.gouv.qc.ca/matieres/mat_res/fertilisantes/critere/guide-mrf.pdf

[26] Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC), 2015. Guide sur le recyclage des matières résiduelles fertilisantes : Critères de référence et normes réglementaires – Édition 2015. Québec.
http://www.environnement.gouv.qc.ca/matieres/mat_res/fertilisantes/critere/guide-mrf.pdf

4.1. C-P-O-E Classification

Four elements are usually taken into account in assessing compost quality. In Quebec, they are represented in the C-P-O-E classification (Table 8).

Table 8: C-P-O-E classification categories

Elements	Category	Definition	Impact on use
Chemical contaminants (also called trace elements)	Category C	Undesirable chemical substance when found in abnormal amounts (often too high)	Application rate (amount applied)
Pathogens	Category P	What causes infections and diseases	Culture type
Odours	Category O	Noticeable smell	Distance between neighbours
Foreign bodies	Category E	Materials that should not end up in the compost such as plastic, metal, glass	Culture type

The categories can be classified as 1, 2, or 3. The lower the number, the better the quality of the compost. There are then fewer chemical contaminants, pathogens, odours and foreign bodies. Good quality compost has fewer restrictions on its use. For example, class C1-P1-O1-E1 is the highest quality and corresponds to all-purpose compost. The lower the quality, the fewer the allowed uses. C1-P1-O1-E1 classification could therefore be targeted to distribute the compost to members of your community. If the tests do not meet these requirements, refer to section 8.1 of the *Guide sur le recyclage des matières résiduelles fertilisantes* for possible uses.

4.2. Parameters Analyzed

To assess the compost class, samples must be taken and analyzed in a laboratory. The parameters to be analyzed are presented in Table 9, along with the limit values for category 1. To this are added the agronomic parameters, which are analyzed to give indications regarding the use of the compost (e.g., quantity to apply). Refer to the *Guide sur le recyclage des matières résiduelles fertilisantes*, section 8 (tables 8.2 to 8.6), for the limit values for categories 2 and 3.

Table 9: Compost analysis parameters – C-P-O-E classification

Parameters	Unit	Limit value
Agronomic parameters		
Dry material	%	No limit specified
Total nitrogen (TKN)	% (dry basis)	
Ammoniacal Nitrogen (NH4-N)	% (dry basis)	
Total phosphorus (P^2O^5)	% (dry basis)	
Total potassium (K^2O)	% (dry basis)	
Organic material	% (dry basis)	
Carbon to Nitrogen ratio (C:N)	-	
Chemical contaminants		Category C1
Arsenic (As)	Mg/kg (dry basis)	13
Cobalt (Co)	Mg/kg (dry basis)	34
Chrome (Cr)	Mg/kg (dry basis)	210
Copper (Cu)	Mg/kg (dry basis)	400
Molybdenum (Mo)	Mg/kg (dry basis)	10
Nickel (Ni)	Mg/kg (dry basis)	62
Selenium (Se)	Mg/kg (dry basis)	2.0
Zinc (Zn)	Mg/kg (dry basis)	700
Cadmium (Cd)	Mg/kg (dry basis)	3
Mercury (Hg)	Mg/kg (dry basis)	0.8
Lead (Pb)	Mg/kg (dry basis)	120
Dioxins and furans (1)	Mg/kg (dry basis)	17
Pathogens and stability		Category P1
Salmonella	Absence/ Presence	Absence (for at least 2 out of 3 samples)
E.coli (To be done if category P2 is targeted or if non-compliance with the requirements of category P1)	UFC/g (dry basis)	Category 2 criterion only
1 of 3 criteria: Respirometry (O^2 assimilation rate)	Mg O_2/kg organic material /hour	≤ 400
CO^2 evolution rate	Mg CO^2/g organic material /day	≤ 4
Self-heating(2)	°C	< 8
Foreign bodies		Category E1
Sharp foreign objects > 5 mm	Unit	≤ 1 per 500 ml
Foreign bodies of length > 25 mm and width < 3 mm	Unit	≤ 2 per 500 ml
Total foreign bodies > 2 mm	Unit	0.5% (dry material)
Odours		Category
Odours are classified according to the type of material (no need for testing)	Compost	O1

(1) Analysis required only if the compost is made from wood from sorting centres for construction, renovation and demolition (CRD) materials or from treated wood, waste from a textile factory or a tannery or municipal solid waste not sorted at source.

(2) The self-heating test can be done directly at the composting site. Instructions are available in *Appendix 2*.

4.3. Sampling

4.3.1. Method

A sample of mature compost must be collected according to the standard CAN / BNQ 0413-200 / 2016 - Organic Soil Conditioners - composts. A compliant sampling procedure is outlined in *Appendix 6*.

4.3.2. Frequency

The sampling frequency varies depending on the quantities of compost produced and the parameters to be analyzed. Table 10 shows the number of samples required over a 1-year period for a production of less than 300 tons per year. For a production of more than 300 tons per year, refer to table 6.2 on page 56 of the *Guide sur le recyclage des matières résiduelles fertilisantes.*

Table 10: Sampling frequency for the parameters to be analyzed

Parameters	Chemical contaminants (category C)(1)	Salmonella (category P)	Foreign bodies (category E)
Sampling frequency per year	2	2	1

(1) If the compost is produced continuously (and not in batches), it is possible to reduce the frequency to once a year if during the last 24 months the category (C1 or C2) has remained the same and the process has not been modified during this period.

The tests must be done on the compost when it is stable, and preferably mature. Step 6 of the composting service, *Assessing stability and maturity* of the compost, must therefore have been conducted beforehand on the batch being analyzed. For a better representative of the tests to be carried out twice a year, they can be done approximately every 6 months. For example, one in the spring and one in the fall. One of them could include the parameters to be tested once a year.

4.4. Sample Analysis

Samples must be analyzed by a laboratory accredited by the Centre d'expertise en analyse environnementale du Québec (CEAEQ).

It may be necessary to have to deal with several laboratories to do all the analyses, because some do not have all the accreditations needed to conduct the various compost analyses required. To consult the complete list of accredited laboratories and their areas of accreditation, refer to the CEAEQ web page[27]. Table 11 shows the areas of accreditation associated with the different tests.

Table 11: Areas of accreditation of the compost analysis parameters

Parameter	Area of accreditation
Agronomy (dry material, total nitrogen, ammoniacal nitrogen, total phosphorous, total potassium)	1020
Organic material	1012
Total organic carbon (for C:N)	223
Chemical contaminants	214 or 219
Salmonella	35
E. Coli	1, 30, 32 or 36
Respirometry	Investissement Québec – CRIQ (only place to test)
CO^{2} evolution rate	No accreditation necessary
Foreign bodies	237

Useful Resource (French only)

Centre d'expertise en analyse environnementale du Québec (CEAEQ)

Webpage: http://www.ceaeq.gouv.qc.ca/accreditation/PALA/lla01.htm

[27] MELCC. 2020. Centre d'expertise en analyse environnementale du Québec, Laboratoires accrédités offrant des services à la clientèle externe. Page viewed online on October 5, 2020. http://www.ceaeq.gouv.qc.ca/accreditation/PALA/lla01.htm

5. Health and Safety

The concepts of health and safety are addressed in this section. The risks and potential impacts on health and safety are presented, along with the operations recommended to prevent and minimize these risks. Operation recommendations are identified by green boxes including icons for the different subjects.

Safety must be taken very seriously during composting operations. It is **EVERYONE's responsibility** to:

- Ensure that the workplace is healthy and safe;
- Correct dangerous activities and situations;
- Ensure that personal protective equipment is available;
- Report and investigate all accidents and incidents.

The site operator is required to:

- Know and observe all regulatory instructions;
- Ensure their own safety and that of other people on the site;
- Notify the responsible person of dangerous activities and situations;
- Use mandatory personal protective equipment;
- Immediately report any accident and enter it in the work accident log.

The employer responsible for the site is required to:

- Train operators on potential risk;
- Make the necessary changes to minimize the risks related to health and safety at work;
- Keep knowledge up to date and renew training as needed;
- Provide the appropriate safety equipment.

5.1. Managing Health Impacts

Composting is considered safe for site operators and for neighbours. However, organic waste can become contaminated with or develop microorganisms during the process. Some of them can have harmful effects on health. Adequate hygiene and the monitoring of good management practices should limit the negative impacts of composting on health. Healthy people are generally not at all vulnerable, but people with serious health problems are considered to be at higher risk and should limit their direct (unprotected) exposure to the compost. In addition, these people should check with their physician if they can be in contact with the compost[28].

5.1.1. Dust

Organic dust is present in the air in proximity to the composting site. Among other things, it includes a fungus, called *Aspergillus fumigatus*, which is common in nature and present everywhere in our environment. A healthy human can breathe hundreds of them a day with no health consequences. However, some people can develop sensitivity to this fungus by being exposed to it at higher concentrations on a regular basis. People with immune system problems, respiratory problems or cancer may be at greater risk. It can cause allergies, asthma, aspergillosis, and aspergilloma.

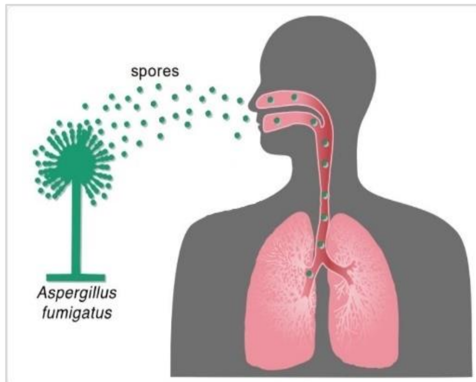


Figure 27: Inhalation of aspergillus fumigatus

The amounts of dust in the air increase particularly when the compost is agitated (stirred, turned, moved), but it decreases quickly after activities (within 2 to 5 hours). In addition, the dust stays near the compost. They are 100 to 1,000 times less concentrated just 10 metres away. In-vessel (closed) composting systems, for example in a box or a rotating drum, produce less dust than those in open areas.

[28] Fortin A., Hénault-Éthier L. 2009. Guide technique pour le compostage sur site en ICI. https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/Guide_technique_compost_ici.pdf

To **reduce the presence of the fungus and dust** in the air and **reduce health risks**, the following practices should be followed:

- Use personal protective equipment while handling compost (e.g., turning, mixing, shredding, or screening), including:
  - Dust mask (N95)
  - Safety glasses
  - Gloves
- Keep the compost moist.
- Avoid stirring the compost when it is dry or on a day with high winds.
- Keep the composting site clean.
- Remove dust from the site.
- Make sure that the feedstock is in good condition.[29]

5.1.2. Pathogens

Compost can potentially be contaminated with pathogenic microorganisms. These are bacteria that can lead to food poisoning if they are ingested (eaten). These include Escherichia coli, Salmonella sp. and Listeria monocytogenes. For example, exposure may occur when an operator who has handled feedstocks, compost or tools does not wash their hands before eating. There is also a risk for users of finished compost if pathogens are not all eliminated during processing. They could be exposed by direct handling of the compost or eating food that has grown in it. This is why the operator must follow a sound operating procedure to reduce the risk of contamination.

First, some materials are more likely than others to contain pathogens. It is therefore necessary to establish the types of materials that are accepted depending on the type of composting. Meats and dairy products for example are only recommended for medium- and large-scale facilities, where tight controls of composting parameters are in place.

The main way to ensure that pathogens are eliminated is by ensuring high, thermophilic composting temperatures. The temperature must reach 55°C for a certain amount of time, depending on the type of composting. This is 3 days for in-vessel systems (e.g., rotating drum, container) and aerated static piles or 15 days for windrows. It is also necessary to make sure that the compost is mixed well so that all parts of the pile has been exposed to this heat. Details are provided in section *3.1.2: Temperature*.

For the heated compost to remain free of pathogens until distribution, the operator must avoid cross-contamination. This involves contaminating the mature compost with new feedstock that still contains pathogens. To avoid cross-contamination, do not use the same tools in all of the composting phases or store them in the same place. If this is not possible, handle the healthy

[29] Idem

(mature) compost before touching the young compost (and not the other way around) and wash the tools between uses. It is also important to ensure that the young compost and its leachate (liquid it produces) are not in contact with the mature compost. Reception and composting areas should not be beside or up-slope from curing and storage areas.

To **reduce the risk of exposure to pathogens** for operators and users of the compost, apply the following practices:

- Wear clean work equipment.
- Avoid rubbing your eyes or touching your face with your hands.
- Wash your hands frequently, especially before eating or smoking.
- Keep your fingernails short and clean.
- Never keep food in the pockets of work clothes.
- Quickly disinfect and bandage cutaneous cuts.
- Wash equipment that has been in contact with contaminated materials after each use (e.g., thermometer, shovel).
- Do not wear work clothes at home.
- Take a quick shower and wash your hair after handling contaminated compost.[30]

[30] Idem

5.1.3. Handling Loads

The operation of the composting service may require handling loads, for example containers of organic materials or mature compost. Here are some **general tips** for working safely and avoiding injury:

- Take time to assess the load.
- Separate the load into small quantities.
- Respect your limits.
- Work as a team.
- Wear suitable protective gloves.
- Plan the trip.
- Stay in good physical shape.

To **lift loads**, apply the following basic principles:

1. Support the load, bend your knees and find the point of balance.
2. Keep your back straight and straighten up using your leg muscles.
3. Hold the load close to your body with arms straight.[31]

Figure 28: Lifting the load

[31] ASP Construction. Cours Santé et Sécurité générale sur les chantiers de construction. Prévention des troubles musculosquelettiques. 7e Édition.

5.2. Fire Prevention and Management

5.2.1. Fire Prevention

Composting sites are places that are at risk of fire. They contain many flammable materials, including organic materials, bulking agents made from wood or a derivative, dust from crushing, turning and screening activities, as well as gasoline and machinery lubricant.

The general recommendations for **preventing fires** are as follows:

- Keep the site clean.
- Store gasoline properly.
- Clean up leaks.
- Store hazardous products properly and according to WHMIS standards.
- Regularly remove dust from engines and exhaust systems.
- No smoking on the site.

When poorly maintained, piles of compost or bulking agents are also at risk of spontaneous combustion. This can happen when a pile heats up to ignite on its own.

The recommendations to **prevent spontaneous combustion** are as follows:

- Maintain the right conditions in the composting process.
- The moisture levels that pose the greatest risk of fire are between 30 and 40%. Keep the materials either drier or more humid (less than 30% or more than 40%). Keep the moisture uniform in the piles.[32]

[32] Alberta Environment and Parks. 2018. Compost Facility Operator Study Guide. https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/co

5.2.2. Fire Management

To be **prepared for the management of a fire**, it is recommended to:

- Provide appropriate fire extinguishing equipment on the site.
- Equip the site and mobile equipment with fire extinguishers.
- Ensure that there is a sufficient and accessible source of water.
- Have a reserve of soil available to smother the fire.
- Provide enough space on the site to fight a fire (e.g., distance between piles or windrows to allow a fire truck to pass though and to spread out the burning materials on the ground).
- Train employees on the use of fire-extinguishing equipment and compost pile fire management (below).
- Develop a response plan with the local fire department and train firefighters on the procedure to extinguish a fire in a compost pile.
- Set up a box at the entrances to the site for first responders containing:
    - A list of emergency telephone numbers
    - A site map identifying the location of the fire hydrant, fuel tank, gasoline, oil and grease stores, and other hazardous locations

The steps to **effectively manage a fire in a compost pile** are as follows:

1. Call first responders in case the fire spreads to buildings, equipment, or outside the site, or to avoid injuries.
2. Make a plan of action. Make sure everyone understands their role. Make sure there is enough room to spread the materials out on the ground.
3. Isolate burning materials.
4. Break up the compost pile with an excavator and spread the materials out on the ground to cool it down.
5. Remove cooled materials from around the pile rather than digging directly into the core of the pile.
6. Hose down with water or smother with soil any smoking or burning materials.
7. Have pumps and garden hoses on standby to extinguish any flames that develop, or to spray a loader or worker caught in the flames. [33]

[33] Idem

5.3. Safety Equipment

It is recommended to ensure that the operator has access to the following equipment **on the composting site** and **during collection**:

- Antiseptic soap without water or disposable cleaning towels
- First aid kit
- Means of communication (telephone or radio)

On the composting site, it is recommended that the operator **always** wear the following personal safety equipment:

- Steel toe boots
- Work overalls covering legs and body (washed regularly)
- High visibility vest or garment
- Work gloves

It is recommended that the operator wear the following personal protective equipment **when handling the compost** (incorporation of feedstock, mixing, transport, etc.):

- Protective glasses or visor
- Dust mask
- Hearing protection helmet (for use of machinery)

It is assumed that the operator will wear all other appropriate personal protective equipment in accordance with community regulations and labour standards.

6. Data Monitoring

Throughout all the stages of the composting service, record keeping and data monitoring are essential for proper management of the service. They allow to:

- Continuously improve practices by adapting them according to the results obtained;
- Measure the progress and improvement of the service;
- Measure the participation of members and their sorting efficiency;
- Build an experience that will remain even during personnel changes;
- Help other communities to set up their service.

The record should include the items presented in Table 12.

Table 12: Information to track in a record

Category	Information
Feedstock	• Type of feedstock • Source • Date and time of reception • Weight or volume
Operations	• Date of preparation of feedstock (mixtures with bulking agents) • Contamination level (qualitative assessment, volume or weight of material removed) • Conditioning recipe (types of bulking agents, quantities) • Measurement of temperature and other parameters • Adjustment of conditions (watering, addition of bulking agents, etc.) • Frequency of mixing or aeration • Date of transfer of the compost between the different processing sections (e.g., curing to storage)
Compost	• Results of quality tests (maturity, agronomy, C1-P1-O1-E1) • Approximate volume of the materials removed with screening • Distribution: date, volume, weight, name of user, sold or not • Label information in case of sale
Maintenance and environmental control	• Types of inspection and measures taken • Date • Companies / individuals concerned • Cause (preventive maintenance, irregularities, etc.) • Results / observations • Complaints

7. Human Resources Management

The organizational structure of human resources as well as the need for them in order to manage a composting facility vary. This variation depends on its size and the initial mode of operation of the department that supports the service. In general, two main roles ensure good service: the responsible employer (or supervisor) and the operator.

Role of the supervisor:

- Manage the composting service
- Provide adequate training for operators
- Provide safety equipment to operators
- Provide the required equipment for operations
- Supervise the operations of the facility
- Validate the records and monitoring carried out by operators
- Take care of communications and ensure member awareness
- Track costs and revenue
- Ensure the planning of activities and resource requirements (financial, human, material)

Role of the operator:

- Operate the composting platform
- Keep the records and monitoring up to date
- Ensure the cleaning of the facility (if applicable)
- Collect materials (if applicable)
- Distribute or bag the compost

It is recommended to designate operators who are responsible for the operation of the site so that these people can build their experience and learn how to manage the facility effectively. For a facility that processes organic materials in a First Nations community of approximately 300 to 10,000 members, a full-time or part-time responsible operator may be adequate to operate the site. However, they may need one or two additional people to carry out certain activities such as collecting, inspecting and preparing feedstock. This is when most of the material handling occurs.

Although one responsible operator is enough, it is recommended that at least two people be able to operate the site. This includes knowing the principles of composting, monitoring composting parameters and maintaining optimal process conditions (oxygen, moisture, carbon to nitrogen ratio). Having one or more additional competent persons ensures that the service will not be forced to shut down when the responsible operator cannot report to work. It will also be easier to train a new employee in the event of a personnel change.

Training

The operator must be trained in the following concepts:

- The basic principles of composting
- Operations to maintain optimal composting conditions and ensure the proper functioning of the site
- Data collection and monitoring
- Safety procedures
- Equipment maintenance
- Operation of the machinery

Each composting facility must have its own operating procedure. Each facility operates differently depending on the processing method used, its equipment, the types of materials it receives, etc. In addition, the procedure may change over time with the experience of the operators. There is therefore no universal training for the operation of a composting platform, nor are there any mandatory qualifications.

However, there are many training courses and general documents that facilitate acquiring the knowledge needed to be able to properly operate a facility. Depending on the chosen processing method, a specialist in the field can also provide support to get the activities off to a good start and ensure their success. A good procedure avoids several inconveniences, such as odours or an unoptimized process. Specialized consultants, non-profit organizations and public bodies offer several resources for this purpose. The FNQLSDI also offers personalized support as part of its Circuit Rider training program. Table 13 shows some training and documentation references to complement this guide. Others are also available online.

Table 13: Training and guides for composting operations

Provider	Title	Language	Cost	Link
Training				
Compost Council of Canada	National Compost Operator Certification Program	English	Course: $800 (non-members), certification exam (optional): $150	http://www.compost.org/ncocp/
Guide				
Alberta Environment and Parks	Compost Facility Operator Study Guide	English	Free	https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/compost-facility-operator-study-guide.pdf
Michigan Recycling Coalition	Compost Operator Guidebook: Best Management Practices for Commercial Scale Composting Operations	English	Free	https://www.michigan.gov/documents/deq/deq-oea-compostoperatorguidebook_488399_7.pdf
Alexis Fortin, Louise Hénault-Éthier	Guide technique pour le compostage sur site en ICI	French	Free	https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/Guide_technique_compost_ici.pdf

Regulations

Note that provincial and federal regulations govern composting activities. They mainly aim to limit the risks to the environment and human health as well as to limit the negative impacts in the vicinity of the facilities. Refer to the *Guide technique pour le compostage sur site en ICI* (French) presented in Table 13 to learn about the regulations applicable to composting. You can also consult the Compost Council of Canada website (English and French).

8. Conclusion

This guide provides an overview of the main aspects of managing and operating a composting facility. Operators and managers are encouraged to continue their learning process with the various additional resources proposed, and especially to take action by starting their own composting service. Time for adjustments to your operations should be expected as you work towards sound management of your facility. Each site has its own recipe, and some trial and error and motivation will help you find your own! Thank you for helping organic materials return to Mother Earth, and for reintroducing them into the cycle of life!

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Woods End laboratory inc. 2009. Dewar self-heating test, Instruction for use. 5th revised edition.

Appendix 1: Additional References

Additional references

Table 14: Additional references for planning and operating a composting facility

Author	Title	Language	Link
Environment Canada	Technical Document on Municipal Solid Waste Organics Processing	English	https://www.ec.gc.ca/gdd-mw/3E8CF6C7-F214-4BA2-A1A3-163978EE9D6E/13-047-ID-458-PDF_accessible_ANG_R2-reduced%20size.pdf
Alberta Environment and Parks	Compost Facility Operator Study Guide	English	https://open.alberta.ca/dataset/02fdef29-c234-4029-b269-8e8e3d12d9ab/resource/3ba8b5e3-33e6-4efc-abe4-79c3e7c703e2/download/compost-facility-operator-study-guide.pdf
Michigan recycling Coalition	Compost Operator Guidebook: Best Management Practices for Commercial Scale Composting Operations	English	https://www.michigan.gov/documents/deq/deq-oea-compostoperatorguidebook_488399_7.pdf
FNQLSDI	Review of composting technologies adapted to the context of the First Nations in Quebec	English	To come
RECYC-QUÉBEC	Guide sur la collecte et le compostage des matières organiques du secteur municipal, Document technique	French	http://collections.banq.qc.ca/ark:/52327/bs1995507#:~:text=Le%20Guide%20s'adresse%20aux,et%20de%20mise%20en%20valeur.
RECYC-QUÉBEC	Les matières organiques en fiches techniques : Le compostage	French	https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/Fiche-technique-compostage.pdf
Environnement Canada	Document technique sur la gestion des matières organiques municipales	French	http://publications.gc.ca/collections/collection_2013/ec/En14-83-2013-fra.pdf
Alexis Fortin, Louise Hénault-Éthier	Guide technique pour le compostage sur site en ICI Note: Also applies to a First Nations community	French	https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/Guide_technique_compost_ici.pdf
Chaire en éco-conseil, Université du Québec à Chicoutimi	Guide d'application: Mise en œuvre d'un programme de collecte de matières organiques pour la production de compost	French	https://www.recyc-quebec.gouv.qc.ca/sites/default/files/documents/Guide-application-collecte-compost-ici.pdf
FNQLSDI	Revue des types de technologies de compostage adaptées au contexte des Premières nations du Québec	French	To come
Chaire en éco-conseil, Université du Québec à Chicoutimi	Boîtes à outils de la gestion des matières résiduelles en milieu nordique isolé	French	https://www.environnement.gouv.qc.ca/matieres/territoire-nordique/GMR-portrait-Nord.pdf

Appendix 2: Dewar Self-Heating Test

Dewar self-heating test[34]

Figure 29: Dewar flask with thermometer

Compost stability assessment.
Duration of the test varies from about 5 to 10 days.
Perform the test in an area between 18°C and 22°C (65°F and 70°F).

Materials

- Trowel
- Clean bucket 20 L (5 gal)
- Dewar flask, 1.5 litre capacity, 105 mm ID
- Min-max thermometer (for ambient temperature)
- Min-max thermometer with probe (for compost)
- Spray bottle (if needed)

NOTE: Min-max thermometers can record the minimum and maximum temperatures of a day.

Procedure

1. Take 7 to 12 samples randomly from the compost pile at a depth of 60 cm (2 feet) with a trowel and place them in the bucket.
2. Mix all samples in the bucket.
3. Select 2 L (0.4 gal) of the mixture to test.
4. Check that the moisture content of the compost is close to 50% (see how to test for moisture in section *3.1.4*).
    a. If the sample **moisture is good**, let stand for 1 to 2 hours at room temperature before testing.
    b. If the sample is **too moist**, spread the sample on a clean, level surface and allow it to dry overnight. Repeat the moisture test.
    c. If the sample is **too dry**, add water with a spray bottle, stirring until the compost is barely moist. Let sit for 1 to 2 hours at room temperature.
5. Place the thermometer probe in the centre of the Dewar flask, 5 cm (2 inches) from the bottom. It must not touch the sides of the container.
6. Fill the container with the compost sample.
7. Shake and tap **gently** on the counter to simulate a natural deposit. Its density should be similar to that in the piles.

[34] Woods End laboratory inc. 2009. Dewar self-heating test, Instruction for use. 5th revised edition.

8. Leave the container **open** (without the lid).
9. Keep container in an area between 18°C and 22°C (65°F and 70°F).
10. Place the room temperature thermometer next to the container.
11. Program the two thermometers to start recording temperatures (see manufacturer's instructions).
12. Each day, note the maximum temperatures for the day of the two thermometers (temperature recording table).
13. Reset the thermometers after recording the temperature (if need be).
14. Record the temperatures until they decrease for at least 2 days after the maximum has been reached.
15. For each day, subtract the maximum temperature of the compost from the maximum ambient temperature.

$$Temperature\ difference = compost\ max.temp - ambient\ max.temp.$$

16. The largest temperature difference among the days tested is selected to analyze the results.

Temperature recording table

Day	Date/time	Max. temp. Compost	Max. temp. Ambient	*Max. temp. difference (Compost - ambient)
Day 0				
Day 1				
Day 2				
Day 3				
Day 4				
Etc.				

Analysis of the results

The standardized interpretation of the test indicates stability at a temperature range of 0° to 5°C.

The MELCC C1 standard (see section *4: Compost Quality Control*, table 9) is more flexible and accepts a temperature difference for the compost of up to **8°C** from the ambient temperature for a compost to be considered stable.

Table 15: Standardized test results interpretation table

Max. temp. diff.	Interpretation
0° – 5°C	Stable (mature or curing)
5° – 25°C	Active (mesophilic)
25° – 50°C	Very active (thermophilic)

Example

Day	Date/time	Max. temp. Compost (°C)	Max. temp. Ambient (°C)	*Max. temp. difference (Compost – ambient) (°C)
Day 0	March 6 – 10 am	20	20	20 – 20 = **0**
Day 1	March 7 – 11 am	20	20	20 – 20 = **0**
Day 2	March 8 – 9 am	21	20	↗ 21 – 20 = **1**
Day 3	March 9 – 10 am	22	20	↗ 22 – 20 = **2**
Day 4	March 10 – 9 am	24	20	(Maximum) 24 – 20 = **4**
Day 5	March 11 – 11 am	23	20	↘ 23 – 20 = **3**
Day 6	March 12 – 10 am	21	20	↘ 21 – 20 = **1**

Analysis of the results

Maximum temperature difference: 4°C
The compost is therefore stable.

Appendix 3: Product Sheet – Template

Logo

COMPOST 2021

Lot:

PRODUCT DESCRIPTION AND QUALITY SHEET

Inputs

Produced from source-separated food waste and green residues collected from the households business and institutions of the [community] community.

Description

- All-purpose compost meeting C1-P1-O1-E1 quality requirements from MELCC
- Screened to minimize the content of foreign objects such as plastics

Benefits

- Contributes to vegetation growth and root development
- Improves soil structure (porosity, permeability and infiltration capacity) which provides a better support for plants, optimal irrigation and reduces the risk of erosion
- Attracts earthworms and other beneficial organisms
- Enhances the soil's ability to clean the water that passes through it

GUARANTEED ANALYSIS	Moisture content (maximum):	%
	Organic matter (wet weight basis):	%

Direction for use

Type of usage	Recommended amount	Incorporation [2]	Comments

[2] Compost Council of Canada: www.compost.org

Compost Characteristics

Agronomic parameter	Average results [unit]
PH	
C/N Ratio	
Total Nitrogen Content (N)	
Phosphorus (P_2O_5)	
Potassium (K_2O)	
Calcium (Ca)	
Magnesium (Mg)	

Environmental Parameters	MELCC Category
Trace Element	C1
Pathogen Indicators (*Salmonella*)	P1
Maturity	P1
Foreign matter Content	E1

Cautionary notice

Small fragments of foreign objects (plastics, or other) may be found in the compost.

For further information, please contact:

Appendix 4: Printable Sheets

Monitoring Parameters of the Composting Process

Parameters	Optimal conditions	Measurement tools or evaluation methods
Temperature	**Active phase**: 55 to 65°C to eliminate pathogens **Curing phase**: 40°C to room temperature	Digital or analogue thermometer with probe
Moisture	**Active phase**: 50 to 65% **Curing phase**: 40 to 50%	Drying method Squeeze test Hygrometer
Oxygen	**Optimal**: 12 to 18% **Minimum**: 5%	Oximeter **OR** Regular mixing or aeration depending on the other parameters observed
Porosity	**Minimum**: 20%	Porosity test
Bulk density	**Turned pile**: 300 to 600 kg/m^3 **Aerated pile**: 500 to 700 kg/m^3	Bulk density test

Troubleshooting – Temperature

Problems	Possible reasons	Signs	Solutions (One or more at a time)
Temperature too low Under 55°C (active phase)	Too dry	Low moisture content **Active phase**: Under 50% **Curing**: Under 40%	• Add water • Revise the recipe if necessary (more green materials (nitrogenous))
	Too moist	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	• Add bulking agents (brown materials) • Stir or increase the intensity of the aeration • Review the recipe as needed
	Lack of brown materials (carbonaceous)	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	
	Lack of structure / too compact	Porosity under 20% Bulk density: Turned pile: Over 600 kg/m^3 Aerated pile: Over 700kg/m^3	
	Piles too small	Pile under 3 feet high	• Combine piles
Temperature too high Over 65°C (active phase)	Lack of aeration	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	• Stir or increase the intensity of the aeration
	Too dry	Low moisture content **Active phase**: Under 50% **Curing**: Under 40%	• Add water and stir / aerate normally
	Piles too large	Pile over 8 feet high	• Reduce the size of the piles

Troubleshooting – Odours

Problems	Possible reasons	Signs	Solutions (One or more at a time)
Ammonia smell	Lack of brown materials (carbonaceous)	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	• Add bulking agents (brown materials)
	Brown materials decomposing too slowly (carbon source not available)	Large pieces of wood	• Add bulking agents (brown materials) of smaller size or which degrade quickly
Fermentation or rotting smell Associated with lack of oxygen conditions (anaerobic)	Low temperature		
	Too moist	High moisture content **Active phase**: Over 65% **Curing**: Over 50%	• Add dry bulking agents • Review the recipe as needed • Stir or increase the intensity of the aeration
	Lack of structure / too compact	Porosity under 20% Bulk density: Turned pile: Over 600 kg/m^3 Aerated pile: Over 700 kg/m^3	• Add bulking agents • Stir the pile
	Lack of aeration		• Stir or increase the intensity of the aeration
	High temperature		
	Pile too large	Pile over 8 feet high	• Reduce the size of the piles
	Uneven or incomplete airflow in the pile		• Increase the stirring frequency

Troubleshooting – Animals

Problems	Possible reasons	Solutions (One or more at a time)
Presence of flies, insects, or small mammals	Contaminated feedstock Flies are present as soon as materials arrive at the site	• Close the lids of the collection bins • Frequently wash the collection bins • Increase the collection frequency • Store the materials in a cool place
	Accessible compost	• Cover new feedstock or aerated static piles with 6 inches of mature compost or bulking agents • Put wire fences over the entrances or access points to the compost (if possible) • Ensure a high composting temperature • Frequently stir the materials
	Stagnant water (on site or at the base of compost piles)	• Level the site correctly • Maintain the platform surface
	Odours	• Manage the odour problems

Calculating Feedstock Recipe

Materials

- Calculators
- Spreadsheet

  OR
- Excel spreadsheet or web page

Procedure

4. Define the desired proportion of bulking agents (%)
5. Evaluate the quantity of collected materials to introduce (by weight or by volume)
6. Use the following formula to calculate the amount of bulking agents to add:

$$\text{Bulking agents} = \text{Desired proportion (\%)} \times \text{Collected materials}$$

Example

Desired proportion of bulking agents: 30% (0.3)
Quantity of collected materials: 10 kg
Quantity of bulking agents to be added = 0.3 x 10 kg = 3 kg

Testing Moisture – Squeeze Test

Squeeze a handful of compost in one hand.

- **Good moisture:** A few drops of water slip between the fingers, but water does not flow. When you open your hand, the compost forms a ball.
- **Too much moisture:** Water leaks out.
- **Too dry:** Water does not come out and the compost breaks up and crumbles when you open your hand.

Figure 30: Squeeze test

Testing Moisture – Drying Method

Materials

- Scale
- Standard oven, toaster oven or microwave oven (see procedure variation)
- Pyrex or aluminum container
- Calculator

Procedure – Standard oven and toaster oven

6. Weigh a small Pyrex or aluminum container.
7. Add 10 g of compost (called a wet sample).
8. Dry the sample for 24 hours in a toaster oven or standard oven at 105°C.
9. Weigh the dry sample and subtract the weight of the container.
10. Use the following formula to determine the moisture of the compost.

$$\text{Sample moisture} = \left(\frac{\text{Wet sample weight} - \text{Dry sample weight}}{\text{Wet sample weight}}\right) \times 100$$

Procedure – Variation for microwave ovens (step 3)

Using a microwave oven is faster, but an experiment must be done at the beginning to know the right heating time (step 3) according to the strength of the microwave:

6. Heat a 100 g sample for 8 to 10 minutes in a microwave oven of at least 600W.
   a. If the microwave oven is less powerful, increase the drying time.
   b. If the compost is drier, such as finished compost, reduce the drying time.
7. Remove the sample from the microwave and weigh it.
8. Heat the sample for 2 more minutes and reweigh it.
9. Repeat the cycle at 1-minute intervals until the sample maintains a constant weight.
10. If the sample has burned, start over with a new sample with shorter time intervals.

Do this test for the first few samples to determine the time required to dry a sample (without burning it). Drying can then be done in a single continuous step.

Example

Container weight: 5 g
Wet sample weight: 10 g
Weight of the wet sample with the container: 5 g + 10 g = 15 g
Weight of the dry sample with the container: 9 g
Dry sample weight: 9 g – 5 g = 4 g

$$Moisture = \left(\frac{10\ g - 4\ g}{10\ g}\right) \times\ 100 = \left(\frac{6\ g}{10\ g}\right) \times\ 100 = 0.6\ g\ \times\ 100 = \mathbf{60}\%$$

Testing Porosity

Figure 31: Porosity test

Materials

- Graduated container
- Measuring cup
- Spatula
- Water
- Calculator
- Spreadsheet

Procedure

12. Take a sample of compost from a pile at a depth of 60 cm (2 feet) while measuring its volume (e.g., 5 litres).
13. Place the sample in a graduated container.
14. Pour water into the container with a measuring cup and note the volume of water added.
15. Pour in water to cover the compost.
16. Stir well with a spatula to remove the air from the compost.
17. Let stand for a few minutes.
18. Make sure there is free water on top of the compost after the standing period. Otherwise, add more water.
19. Note the volume occupied by the water and the compost, called the total volume without air.
20. Calculate the total volume with air by adding the volume of compost (measured initially) and the volume of water.

$$Total\ volume\ with\ air = Compost\ volume + Water\ volume$$

21. Calculate the pore volume by subtracting the total volume with air from the total volume without air.

$$Pore\ volume = Total\ volume\ with\ air - Total\ volume\ without\ air$$

22. Calculate the porosity with the following formula.

$$Porosity\ (\%) = \frac{Pore\ volume \text{ x } 100}{Compost\ volume}$$

Example

Compost volume: 5 litres (L)
Water volume: 3 L
Total volume without air: 6 L
Total volume with air: 5 L + 3 L = 8 L
Pore volume: 8 L – 6 L = 2 L

$$Porosity = \frac{2\,L \text{ x } 100}{5\,L} = \frac{200}{5\,L} = 40\%$$

Testing Bulk Density

Materials

- 10 to 20 litre container
- Scale
- Calculator
- Spreadsheet

Procedure

11. **Weigh** the **empty** container.
12. Determine the **volume** of the container. This is usually indicated under the container. If the volume is not known, calculate it by measuring its height and diameter.
13. Take a sample of compost from a pile at a depth of 60 cm (2 feet).
14. Fill the container **one-third** full of compost. Drop it to the ground 10 times from a height of 15 cm (6 inches).
15. Add material to fill **two thirds** of the container. Drop it to the ground 10 times from a height of 15 cm (6 inches).
16. Fill the container **completely**. Drop it to the ground 10 times from a height of 15 cm (6 inches).
17. Fill the container completely (do not fill beyond the edges of the container).
18. **Weigh** the **full** container.
19. **Subtract** the weight of the **empty** container from the weight of the **full** container to calculate the weight of the sample.
20. **Divide** the **weight** of the sample by the **volume** of the container.

$$Density = \frac{\text{(Full container weight} - \text{ Empty container weight)}}{\text{Container volume}}$$

Example

Empty container volume: 19 L (0.019 m^3)

Weight of the empty container: 1 kg

Weight of the full container: 10 kg

Sample weight: 9 kg

$$Density = \frac{10\ kg - 1\ kg}{0.019\ m3} = \frac{9\ kg}{0.019m3} = 474\ kg/m3$$

Please note the result must be in kilograms per litre (kg/m^3) to be compared with recommended values. The units of weight and volume must be converted if they are not already in kg and m^3.

1 L = 0.001 m^3
1 g = 0.001 kg

Appendix 5: Composting Parameter Monitoring Record – Example

Composting parameter monitoring record – Example

Pile / windrow / row number: _______________

Creation date: __________________

Recipe:

____

Comments:

____

Date	Temp. (°C) Location (specify)				Odour	Moisture	Porosity / Bulk Density	Action
	1	2	3	4				

Appendix 6: Instructions for Compost Sampling

Instructions for compost sampling

In compliance with BNQ/CAN 0413-200/2016 method

Materials

- Metal trowel
- Disposable latex gloves (medical grade)
- Sealable new plastic bags (ex. average-size Ziploc bags)
- 5-gallon plastic buckets with lid (1 bucket per pile to be sampled)
- Rubber or plastic sheet
- Ethanol 70% (rubbing alcohol available in pharmacies)
- Plastic bottle with spray gun
- Distilled or demineralized water
- Coolers with cooling agents (frozen icepacks and ice in plastic bags)

Sterilization protocol – before sampling (for pathogens testing)

Between each sampling, all sampling material must be cleaned and disinfected.

1. Clean materials (trowel, bucket, sheet) with soap, rinse with water, then rinse a second time with distilled or demineralized water.
2. Wash hands and spray hands and a few pairs of sterilized gloves with 70% alcohol.
3. Spray the bucket with ethanol (inside and outside). Shake to dry the alcohol.
4. Spay the sheet with ethanol.
5. Spray a Ziploc bag spray with ethanol (outside) and leave it in the bucket.
6. Spray the trowel with ethanol and put it in a disinfected Ziploc bag.

Sampling instructions

1. Put on a new pair of sterilized gloves.

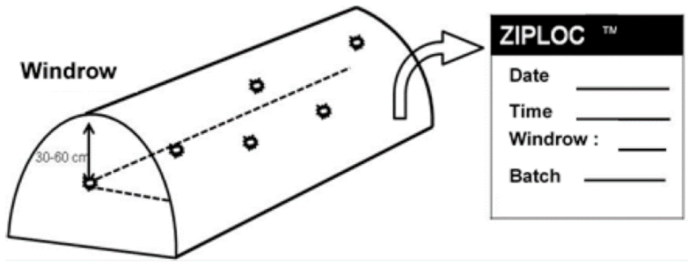
2. Collect 10 subsamples of 2 litres from the pile with a trowel. Place them in the bucket. Collect the subsamples at regular intervals locations along the pile. Make sure the samples are collected alternately from the top, middle and bottom for the compost pile at a depth of 50 cm, after a depth of 10 cm of compost has been removed from the surface of the pile.

3. Between each subsample, put the trowel back in the sterilized Ziploc bag and put the lid back on the bucket. It is recommended to change gloves at least at all three sampling points.

4. Mix all subsamples in the bucket and place them on the sheet. Collect one or several samples from the mixture by using the quartering method (following). The volume of the sample is determined by the laboratory conducting the analyses.

5. Place the sample in the sealable plastic bag and label it with the number lot, the date (by order year-month-day) and the hour the sample was prepared.

6. Store the bagged sample in a cooler with cooling agents (ice, icepacks) for transportation. The temperature shall be from 0°C to 5°C until the time of analysis.



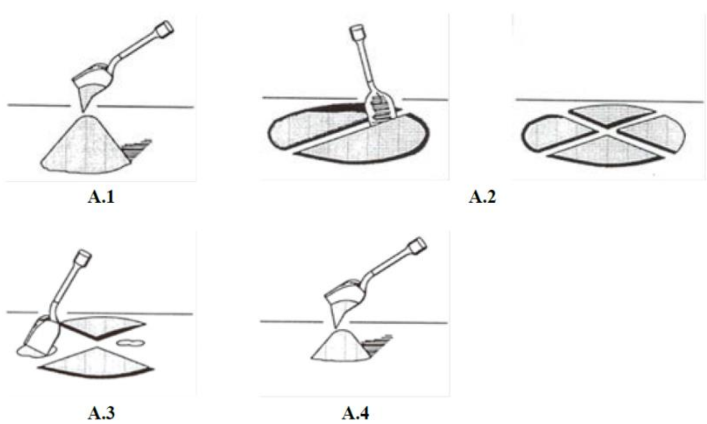
Quartering method

A.1 Form the compost sample to be reduced into a conical pile.

A.2 Flatten the top of the cone and divide the compost into four piles along two diameters at right angles to each other.

A.3 Remove and discard two diagonally opposite quarters, leaving a clean surface in theses free spaces.

A.4 Mix the remaining quarters and repeat steps 1 to 3 until the required amount of test sample is obtained.



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