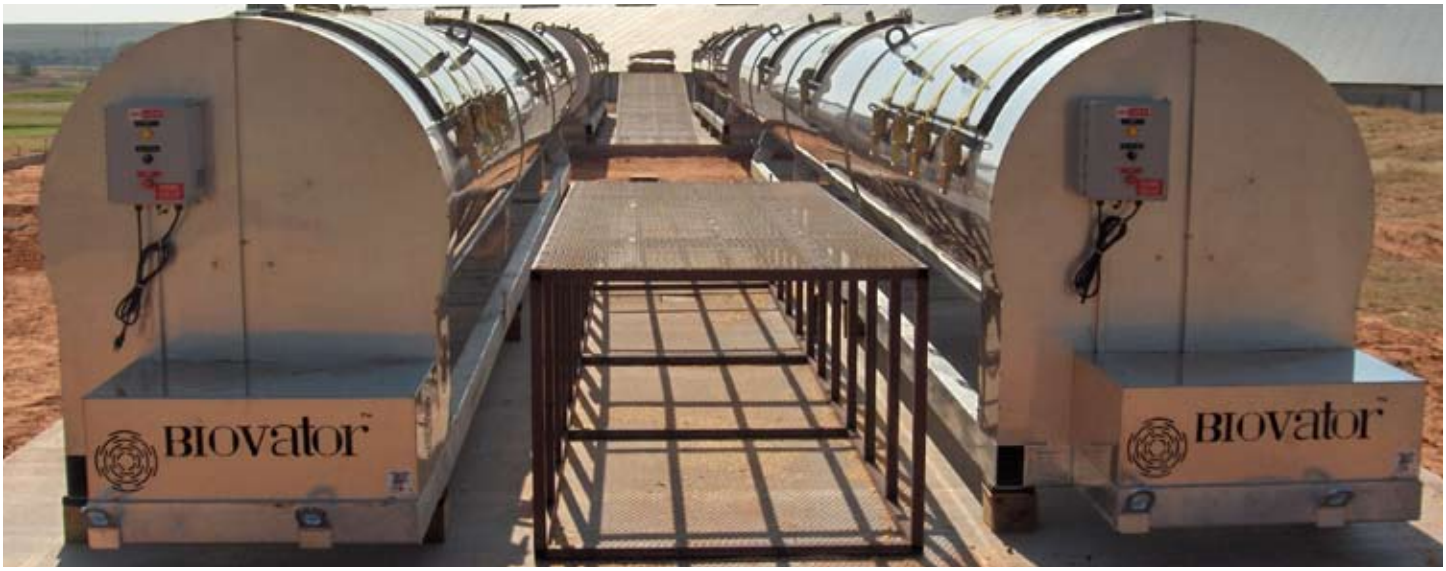
Nioex Systems Inc.
ENVIRONMENTALLY AND SOCIALLY ACCEPTABLE SOLUTIONS

BIOvator™ MANUAL

The #1 Name for In-Vessel Composting

Set-up, use and troubleshooting information



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BIOvator™

The #1 Name for In-Vessel Composting

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INTRODUCTION

The BIOvator™ was developed after extensive research and development work conducted at The Puratone Corporation in Southern Manitoba. The main objective of the R&D work was “development of a cost-effective alternative to the outdoor composting process”. The BIOvator™ achieves this goal, and its introduction into the market was the result of successful operation at Puratone’s own farms.

The BIOvator™ is a combination of a device and process, targeting the quickest transformation of animal carcasses into consistent - quality compost at the lowest possible cost and management effort.

This manual includes the information you may need to successfully operate the BIOvator™. The manual is divided into three main parts:

Part A: general information about composting, including an overview of mortality and organic composting and how it differs from regular composting.

Part B: how to compost using the BIOvator™, including material mix requirements, how to control the process, set-up requirements and instructions for first time use, and general operation guidelines.

Part C: information about the BIOvator™ mechanical components, including available BIOvator™ models, the capacities and technical specifications of each, service and maintenance requirements, and your warranty certificate.

Appendices I and II: Frequently Asked Questions, recommendations for troubleshooting, and composting recording sheet.

With the BIOvator™ you are ahead of the rest -- ready to meet any stringent environmental standards that may restrict operations from using traditional disposal methods. By following the guidelines set out in this manual, you will be able to transform your mortality and organic wastes into a value added to your operation and in turn recover some or all of its capital investment.

SAFETY FIRST

People who manage on-site composting should use precautions, just as they would when working with any other soil amendment. Minimize direct contact. Always wear a mask when opening the BIOvator™ doors for inspection or loading. If discharged compost is dry, use the mask to minimize inhalation of particles during handling or spreading. (Good quality compost, however, should not be allowed to dry out to that extent.) People with asthma, allergies or serious health problems should not work with soil amendments.

Working with the BIOvator™ requires paying attention to the following:

- Driving system cover: The BIOvator™ comes with safety guards to all mechanical parts. Make sure the motor, gearboxes, pulleys, belts, chains and rollers are well covered.
- Loading of waste and shavings: If using a front-end loader, make sure not to hit the BIOvator™ or any part of its supporting structure.
- Opening of doors: Loading and inspection doors are heavy. Make sure you are standing on a solid and stable support while opening or closing these doors.

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PART A: COMPOSTING

1. COMPOSTING

1.1. What is Composting?

Normal decay of any organic material occurs naturally, due to the action of micro-organisms. Some of these micro-organisms (bacteria and fungi) can live without air (anaerobic) and the rest (aerobic) need air to survive and carry out the decomposing of organic material.

General composting of organic matter is a method of speeding up the normal decay processes caused by bacteria and fungi. During this process, bacteria and fungi decompose organic material in a predominantly aerobic (with air) environment. These micro-organisms break down organic material into a stable mixture called compost. Brown to dark brown in colour and odourless, compost is considered an ideal soil amendment.

1.2. Mortality Composting

In contrast to general composting, mortality composting takes place in both aerobic (with air) and anaerobic (without air) zones. The animal carcass (high in nitrogen, with high moisture content and near zero porosity) is placed into a mixture of bulking agent (high in carbon, with high porosity and moderate moisture content), creating an inconsistent mixture of materials. During this stage, called the primary stage, the carcass degrades through the action of anaerobic bacteria and micro-organisms, releasing fluids and gases which diffuse away from the carcass and enter the aerobic zone.

In the aerobic zone, aerobic bacteria and micro-organisms degrade the fluids and gases into carbon dioxide (CO_2) and moisture (H_2O). This action results in the emission of heat. The composting (complete transformation of the mixture, including the decomposed carcass which may include a few bones, into a neutral and odourless dark compost), must undergo a curing process to complete the transformation.

This curing process is called the secondary stage. Throughout the process, the compost is turned to allow the aerobic bacteria to finish their job. The composting is successfully completed when you can hold a handful of material and smell no foul odour in it, squeeze no moisture from it, and feel no heat coming out of it. This form of composting conserves the nutrients contained in dead animals, preserves the environment, and reduces odours and nuisance associated with storing or incinerating carcasses.

PART B: THE BIOvator™ COMPOSTING PROCESS

Besides the economic advantage the BIOvator™ offers, composting with the BIOvator™ is simple to manage and results are guaranteed. The BIOvator™ offers a continuous composting process throughout the year, and eliminates problems associated with outdoor composting.

Mortalities or organic waste are mixed with measured quantities of wood shavings and occasionally water.While anaerobic activities are underway inside carcasses, aerobic micro-organisms are also in action throughout the vessel, breaking all organic matter down into humus-like material that is consistent in quality and can be used as a soil-enhancing agent. Unlike outdoor composting, the BIOvator™ offers a highly controlled process, which accelerates the natural process of decaying. Regardless of outdoor conditions, the composting temperature inside the BIOvator™ is always higher than 100˚F/38˚C. In less than 7 days in summer (14 days in winter), the bulk of the composting process is finished inside the BIOvator™, and the operator can discharge and pile it up, or recycle it back with the addition of more mortalities and less wood shavings.

2. MATERIAL REQUIREMENTS (USING MORTALITIES AS A FEEDSTOCK EXAMPLE)

2.1. The “Recipe”

To survive and effectively do their intended job, micro-organisms that speed up the decaying process of carcasses need:

- Carbon and Nitrogen
- Moisture
- Heat
- Aeration

While composting may eventually occur naturally, the BIOvator™ process utilizes proper mixing of those ingredients so that composting occurs rapidly, minimizing odours and nuisance problems and yielding good quality compost. The following presents the “recipe” that must be followed for successful composting.

2.2. Carbon and Nitrogen

Carbon and nitrogen are key compost ingredients. While the dead animals themselves supply nitrogen, carbon is supplied through the use of carbon-rich bulking material such as wood shavings or sawdust, which may be used as is. Other woody materials, such as bark, brush, tree trimming, branches, leaves, paper, and straw should be shredded before use.

Carbon and nitrogen, however, must be supplied in proper balance. Without such a proper balance (called Carbon to Nitrogen or C:N ratio), microbial growth is retarded, the rate of decay slows down, and odours can be generated. This proper balance varies between 20:1 and 40:1. Lower carbon: nitrogen ratios (lower than 20:1) may result in emission of ammonia and other odours. Higher carbon:nitrogen ratios (higher than 40:1) may reduce compost temperature and slow down the decomposition process.

Carbon to nitrogen ratio is the weight of carbon divided by the weight of nitrogen in the composting material. When adjusting C:N ratio of a mixture for composting, the C:N ratio of each added material needs to be considered.

Example:

Imagine that we would like to compost hog mortalities with added wood shavings as a bulking agent so that the mixture has a C:N ratio of 25 and a water content of 50 percent. In this example, we assume that hog mortalities contain 65 to 75 percent water, 1 percent nitrogen, and 5 to 10 percent carbon. Wood shavings contain 5 percent water, 0.5 percent nitrogen and 25 to 50 percent carbon. Each pound of carcasses contains an average of 0.30 lb solid, 0.01 lb nitrogen and 0.075 lb carbon, while each pound of wood shavings contains an average of 0.95 lb solid, 0.005 lb nitrogen and 0.375 lb carbon.For each pound of carcasses, the amount of shavings (SH) to add is calculated as follows:

$$\textbf{C:N= 25=} \quad \frac{\text{Carbon in 1 lb of carcass + (SH x Carbon in 1 lb of SH)}}{\text{Nitrogen in 1 lb of carcass + (SH x Nitrogen in 1 lb of SH)}}$$

$$\frac{(0.075 \times 1) + (0.375 \times SH)}{(0.01 \times 1) + (0.005 \times SH)}$$

where for each pound of carcass, 0.7 lb of shavings (SH) needs to be added.
If the unit weight of wood shavings is 10 lb/ft^3, then we add about 0.07 ft^3 of shavings to every 1 lb of carcass.

All efforts should be made to use sawdust or wood shavings as bulking materials, because of their better physical properties (particle size, moisture retention, etc.). Also, whenever possible, use manure and/or recycled compost since they contain all of the nutrients needed by the micro-organisms as well as the micro-organisms themselves, which act to ignite the composting process.

The following table lists approximate quantities that may be used as “recipes” for proper composting.

	Wood Shavings	Recycled Compost
For each 1 lb of carcass, add	0.07 ft^3	
Or	0.035 ft^3	0.035 ft^3

In addition to providing proper carbon for the mix, bulking material also acts as a filter that suppresses odours generated by the decaying process and reduces accumulation of flies and maggots. Therefore, as a rule of thumb, carcasses should be “wrapped” completely with a 6” to 12” layer of such material.

Bulking material should be stored as close as possible to the BIOvator™. If an empty bin or a shed is available, use it for storage. If stored outdoors, use tarps (or any impervious plastic sheets) to cover the pile. Moist shavings or sawdust is better than “bone” dry material, since moisture is uniformly distributed in wet material and it reduces the amount of water to be added.

2.3. Moisture Content

A proper moisture level is very important for proper composting. Like all living things, bacteria need water to survive. To encourage bacterial growth and rapid composting, the mixture should have 40% to 60% moisture. Lower moisture contents (less than 40%) will result in slow decaying of mortalities. Higher moisture contents (above 60%) results in filling all pores needed to provide oxygen with moisture, replacing aerobic bacteria with anaerobic ones that produce high odours and grow much more slowly than aerobic bacteria. Hence, the composting rate becomes much slower.

Example:

To precisely calculate the amount of water needed for composting, let us consider the above example again, where the water content is the weight of water in the carcass and shavings divided by the total weight of the composting material. The following relationship will give 40% moisture content in both the carcass and the shavings:

$$\text{Water content (\%)} = \frac{(1 \times 0.65) + (0.7 \times 0.05))}{1 + 0.7} \times 100$$

Since carcasses have zero porosity when freshly added to the BIOvator™, an equivalent amount of water (to that contained in the carcasses) plus an additional 10% must be added to the shavings, so that the total mixture has enough moisture content (50%) for bacteria to begin composting. This amounts to 0.5 liter of water for each 1 lb of carcass and .07 ft^3 of wood shavings.

The following table shows recommended values of water added with different recipes to achieve target moisture content of 50%

	Wood Shavings	Recycled Compost	Water
For each 1 lb of carcass, add	0.07 ft^3		0.5 L
Or	0.035 ft^3	0.035 ft^3	0.25 L-0.50L

These are start-up values.

As a rule of thumb, once the composting process has started within the vessel, the moisture released from the mortalities is sufficient to maintain the required 40% to 60% moisture level in the mix.

2.4. Heat and Aeration

The temperature of compost is a very important indicator that the process of composting is working properly. Warm mortalities degrade much more rapidly than cold ones. As bacteria begin to break down the organic materials, heat is generated. As the compost warms up, different bacteria will flourish in the higher temperatures, and the mass of composting material will be more active and break down faster. Above 150˚F/66˚C, the rate of composting will decrease as bacteria are inactivated or even destroyed by the excessive temperature. Therefore, it is important to monitor the temperature and maintain it at the proper levels during the different stages of composting. Generally speaking, the temperature inside the BIOvator™ should be above 100˚F/38˚C and should never be allowed to be lower than this, or to exceed 160˚F/71˚C. Unlike outdoor composting, this range of temperature is sufficient to kill all pathogens (disease and odour causing bacteria). Different temperatures may overlap inside the BIOvator™, with higher levels normally at the front end and lower temperatures close to the discharge opening. These varying levels of heat are direct results of the actions of the aerobic bacteria.

Since these bacteria need oxygen, open spaces throughout the BIOvator™ are important so that air can move through the compost. It is estimated that 5% oxygen (or more) is essential for aerobic action. This level is maintained by maintaining 35% to 50% porosity in the compost; therefore, it is important not to over-wet the wood shavings. It is also important not to over-fill the BIOvator™ (more than 75%) to allow some aeration through the empty portion of the vessel.

3. OPERATING THE BIOVATOR™

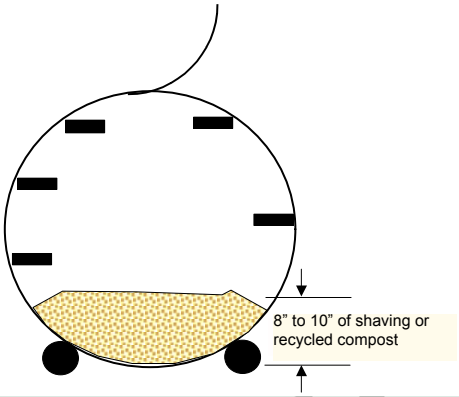
3.1. Guidelines: for First Time Operation

First: Testing:

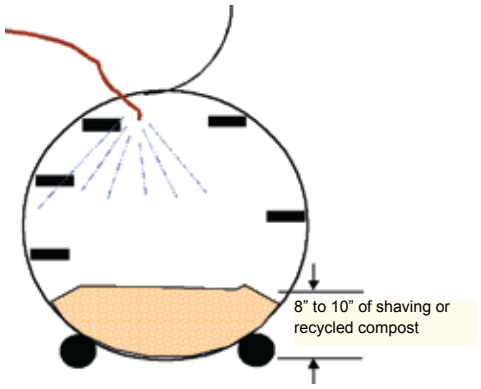
- Make sure all doors open and close freely, and that all bolts for hinges and locks are secured with the proper nuts and washers.
- Make sure all chains and rubber belts connecting the motor and gearboxes to the vessel are attached properly.
- Make sure the pillow block is secured to the vessel shaft.
- Make sure the nylon casters are placed properly inside the channels.
- Make sure the motor is connected to the correct power outlet.
- Close all doors, turn power on, and observe rotations for at least 2 revolutions before loading for the first time.

Second: Preparing the BIOvator™ for first time use

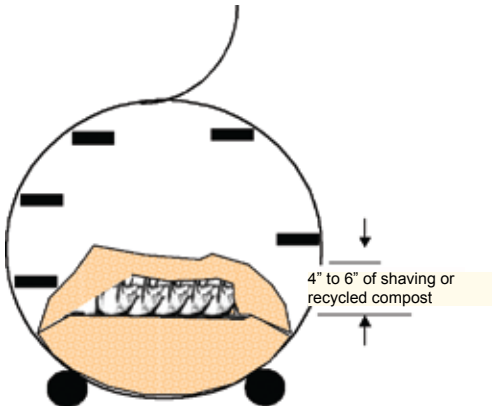
- Add 8” to 10” layer of shavings at the bottom of the BIOvator™, preferably along the whole length of the vessel (or at least at the loading door section).



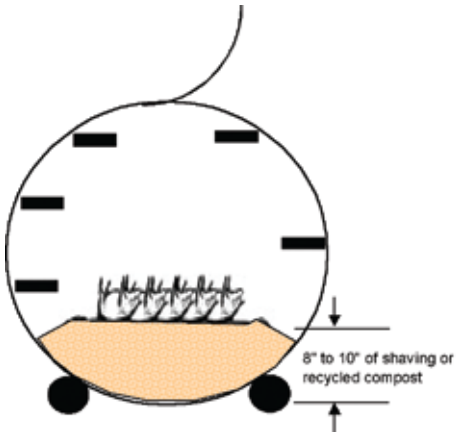
- Moisten the shavings - not excessively, just enough for the shavings to absorb moisture without getting mushy or fully saturated.



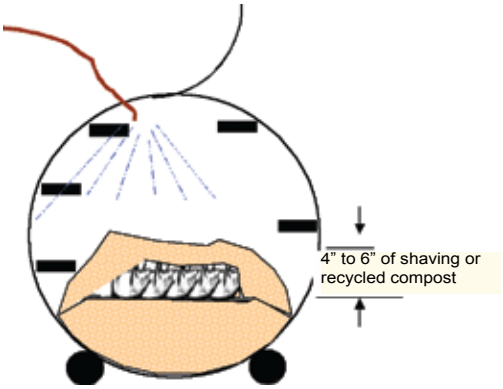
- Add feedstock. Make sure not to overcrowd the loading area.



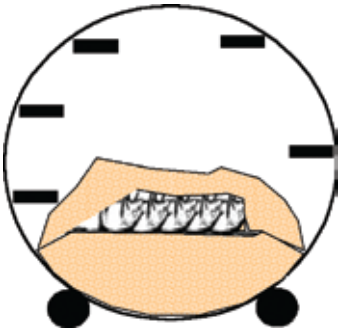
- Add another layer of shavings (4” to 6”) on top of feedstock. Make sure all flesh is covered.



- Again, add enough water to the shavings to moisten it without over soaking it.



- Close doors and leave for 4-5 days, or until temperatures reach 100˚F/38˚C, after which you may begin regular operation.



3.2. Guidelines for Regular Operation

In 4 to 5 days from first loading of the BIOvator™, or when temperatures reach 100˚F/38˚C, regular operation may commence.

The composting process begins by loading feedstock and adding properly calculated moisture and bulking material, then rotating the BIOvator™. Continue monitoring heat and moisture of the compost. Adjustments to amounts of bulking material and/or moisture are done according to levels of heat inside the BIOvator™. Controlling these conditions along with the slow movement of material drastically reduces the time of composting. Material reaches the discharge end in less than a week and it is then ready for discharge. Part of the discharged material is recycled back into the BIOvator™ while the rest is stockpiled until ready for use.

The following are general instructions for maximum results of the BIOvator™.

<u>First:</u> Loading The BIOvator™ With Mortalities:

- If your operation produces daily mortalities at a rate approaching that specified in the average daily capacity of the BIOvator™ (refer to section 5.4), you may have to load the BIOvator™ on a daily basis. If mortalities are produced on an irregular basis, as is the case with most operations, you may want to do the loading 2 or 3 times a week instead, provided carcasses are not rotting.

The BIOvator™ may even allow you to load only once a week, provided that the amount loaded does not exceed the weekly rates specified in the BIOvator™ weekly capacity. Of course, you may add any amount of mortality less than that for daily or weekly averages.

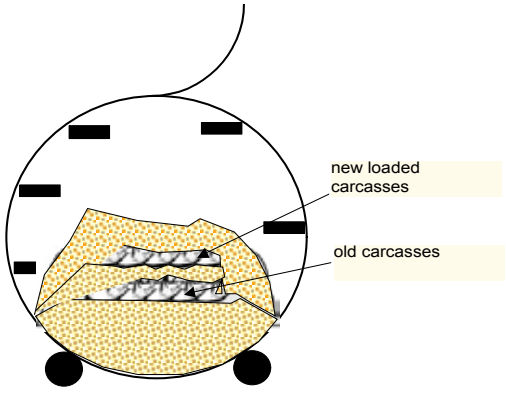
As a rule of thumb, you may load the BIOvator™ with more than its daily capacity as long as weekly capacity is not exceeded.

- Before loading, make sure the BIOvator™ is not rotating and that power is disconnected.
- Depending on the size of mortalities, you may use one or both loading doors. The BIOvator™ may be set right on the ground to facilitate loading. However, for large size mortalities or if the BIOvator™ is placed on a higher elevation, you may use a loader to load mortalities.
- Make sure the section of the BIOvator™ under the loading doors has enough area to accommodate the mortalities you are about to load. If this section is overcrowded, shut the doors, connect the power, and start rotating the BIOvator™ for as many rotations as are needed to push the material forward and away from the loading area.

As a rule of thumb, do not load additional mortalities unless the area under the loading doors is less than 50% full.

- Add part of the required shavings or a combination of shavings and recycled compost on top of carcasses already existing in the BIOvator™ before adding the new mortalities.
- Add the new mortalities, and then cover with the balance of the required shavings or a combination of recycled compost and shavings.
- If water is required, add uniformly.

If no calculations were done, as a rule of thumb, add a 2” to 4” layer of shavings (or a combination of shavings and recycled compost, 50/50) on top of old carcasses. Then cover the new loaded mortalities with a 6” to 8” layer of shavings (or a combination of shavings and recycled compost, 50/50), or make sure that the flesh of different carcasses are separated and totally hidden in the bulking material.



Second: Turning The BIOvator™

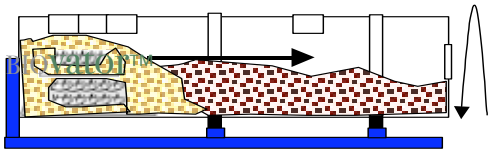
The reasons for turning the BIOvator™ are:

1. Aeration, so that porosity of mix is enhanced and aerobic bacteria get enough oxygen to survive and do their job properly.
2. Moving materials towards the discharge opening.
3. Discharging compost. (from the discharge opening)

The following guidelines may be helpful in deciding how much rotation is needed:

- If adding mortality is done regularly, with amounts reasonably close to that suggested in the capacities (e.g. adding 200 lb to 300 lb daily, or 1000 lb 2 to 3 times a week), you may rotate the BIOvator™ for 4 to 8 revolutions per day (about 1 to 2 hours per day). This rate is found to be enough for aeration purposes.
- If you need to add new mortalities and find the loading area overcrowded with old carcasses, you may rotate the BIOvator™ as many times as necessary to clear this area before adding the new carcasses.

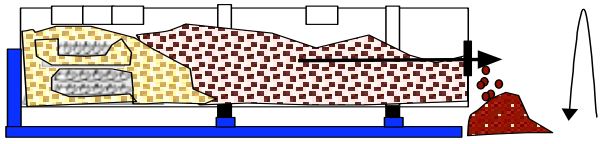
As a rule of thumb, with each complete revolution, the material inside the BIOvator™ moves 6" to 12" towards the discharge opening.



Third: Discharging The Compost From The BIOvator™

It is a good practice not to keep the BIOvator™ more than 75% full with material. Therefore, once the level of compost reaches the discharge opening at the back of the BIOvator™, it should be kept open during rotation. As the BIOvator™ rotates, finished compost is scooped and pushed through the discharge opening.

As a rule of thumb, with each complete revolution, 5 lb to 10 lb of compost (approximately 0.5 ft^3 to 1 ft^3) is pushed through the discharge opening.



3.3 Guidelines for Higher Than Average Mortalities

When dealing with grow/finish operations it is typical to have low mortality weights during the beginning of a cycle with higher mortality weights as the animals get larger. Mortality amounts increase throughout the grow/finish period and during disease breaks, occasionally creating capacity requirements in excess of the BIOvator™'s recommended daily capacity. However, the BIOvator™ has been demonstrated to handle mortality weights exceeding the weekly capacity for short periods of time during high mortality peaks.

In order to effectively utilize the BIOvator™ and comply with Provincial and State requirements for maintaining a temperature of 130˚F/55˚C for a minimum of 5 days, the following procedures will be applied.

Standard Operations for normal spikes in mortality during the grow/finish process:

Continue to fill the BIOvator™ to its rated capacity of mortality. As capacity requirements increase, producers should increase the daily rotations of the BIOvator™ (up to 24 revolutions), which will move the product through faster and allow as much as double the daily recommended loading rate to be placed in the BIOvator™. Depending on the length of time and amount of overloading above weekly capacities, the temperatures in the BIOvator™ may drop below the 130˚F/55˚C standard, which may result in an end product that is not in a mature state and will not have met the 5 days, 130˚F/55˚C requirement.

At this point, producers should store this product in a bin with additional fresh shavings so that it can be recycled into the BIOvator™ when mortality rates have decreased or ended due to the end of the grow/finish cycle. This will ensure a complete composting process and allow the BIOvator™ to remain active, aerobic, and ready as producers await the next turn of animals, which in some cases may be as long as 6 weeks. This procedure will ensure that the BIOvator™ maintains constant mortality consumption throughout the entire grow/finish process and that all mortalities will be disposed of following the proper Provincial/State guidelines.

Operation for higher than normal (catastrophic) mortality spikes in grow/finish process:

If a producer experiences mortality that exceeds a normal spike in mortalities, a static compost pile should be started in an empty compost bin. Producers should put fresh shavings onto the floor of the empty bin (12-18inches) and lay the mortalities side by side until that layer is complete. Repeat the process for the next layer if needed or cover the pile with the fresh shavings. Producers with large animals such as sows may find that 24 inches or more may be required on each layer to contain any leachate from the mortalities.

Continue this procedure until the end of the grow/finish cycle or until mortality rates are within the BIOvator™'s normal loading recommendations. Producers may then begin putting the static pile back into the BIOvator™; however they may wish to leave the static pile for 30 days to avoid any leachate or odor issues.

Following this procedure will ensure that the BIOvator™ maintains constant mortality consumption through the entire grow/finish, and that all mortalities will be disposed of following the proper Provincial/State guidelines.

Example situation: Poultry or Swine Operation with a 42', 500 lb /day-3500 lb/week capacity BIOvator™ during high mortalities or end of a grow/finish cycle.

As producers anticipate mortalities above 3500 lb. /week, begin increasing revolutions from the standard rate of 12 revolutions per day to 14 when you approach 500 lb/day.

Note: **The rate you increase the rotations depends on how soon you anticipate higher mortality rates. Don't wait to increase revolutions until you are over the standard daily capacity.**

For example:

At 400-500 lb/day. Rotations would remain at 12 revolutions (normal),

Anticipating: 500+ pounds a day increase to 14 revolutions

Anticipating: 600+ pounds a day increase to 16 revolutions

Anticipating: 700+ pounds a day increase to 18 revolutions

Anticipating: 800+ pounds a day increase to 22 revolutions

Anticipate higher mortality rates and speed up the BIOvator™ in order to make additional room as needed. As mortalities decrease, reduce the revolutions accordingly back to 12-14 per day and begin recycling any compost that did not complete the minimum of the 5 days at 130˚F/55˚C requirement. If any static compost piles were used, they should be recycled back into the BIOvator™ during this period.

****It is important that producers clean out bins prior to new production cycles or during low mortality periods in order to be prepared for unexpected spikes in mortality.**

3.4. Winter Operation

As long as it is managed properly, composting continues consistently throughout the year. However, the process can sometimes be quickly disrupted during cold weather, due to mismanagement. This disruption may manifest itself in the form of compost temperature dropping below that required, or even total failure. Therefore, the BIOvator™ offers its users a unique advantage over other composting systems. Besides the R8 foam insulation preventing loss of heat from the inside and the full enclosure of the vessel, the BIOvator™ can be set up close to any winter ventilation exhaust fan. The warm and moist air exhausted from the barn can greatly contribute to maintaining conditions in and around the BIOvator™ within reasonable levels.

BIOvator™'s can be enclosed in buildings with proper ventilation to aid in cold climate operation but it is not a necessity. Protection from prevailing winds is all that is required for continued operation of the BIOvator™ year round.

4. CONTROLLING COMPOSTING CONDITIONS

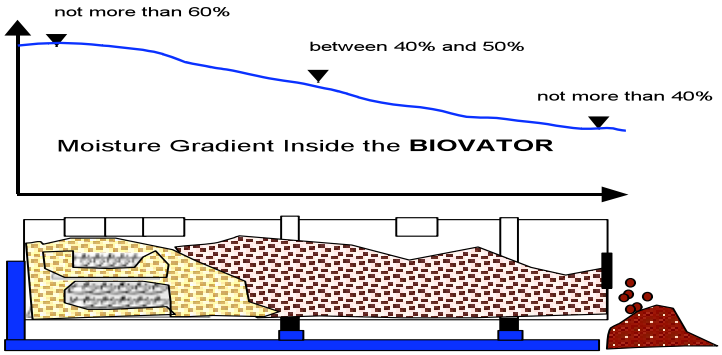
Unlike any other mortality disposal methods, composting with the BIOvator™ is a "forgiving" process as long as a minimum level of management is provided. Such management is needed to control conditions inside the BIOvator™ and to eventually produce good quality compost in the shortest period of time. The following sections present different ways of controlling the composting process:

4.1. Temperature and Moisture Control

Remember, moisture level should be between 40% and 60%.

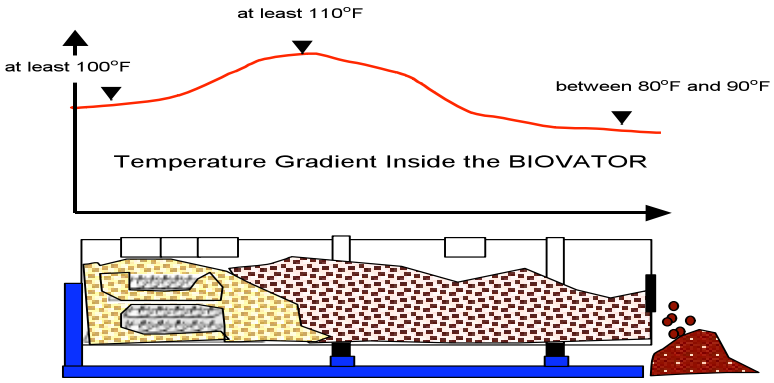
Note that the compost should appear moist, but not soggy. If moisture can be squeezed from a handful of compost material, it is usually too wet for effective composting. Drier bulking material should be added and mixed with the wet material. On the other hand, if compost looks dry, add water to obtain a damp feel and appearance.

As a rule of thumb, moisture at the first 1/3rd of the BIOvator™ (at the loading zone) should not exceed 60%, while moisture at the middle 1/3rd should be between 40% and 50%. Maximum moisture at the end 1/3rd is 40%.



As for the temperature, remember that if it falls lower than 100˚F/38˚C, the process slows down. If higher than 150˚F/66˚C, there is a risk the composting microorganisms are being destroyed. Lower temperature is an indication of lack of shavings, high C:N ratio, or too much moisture. It may also be due to lack of oxygen. It is therefore important to maintain these parameters within the required limits. Unlike outdoor composting, the BIOvator™ has the advantage of rotation that allows the compost to aerate and maintain the temperature within the required limits. Turning the BIOvator™ for 5 to 10 turns every day achieves that. It is also suggested that not more than 75% of the BIOvator™ is kept full with compost material.

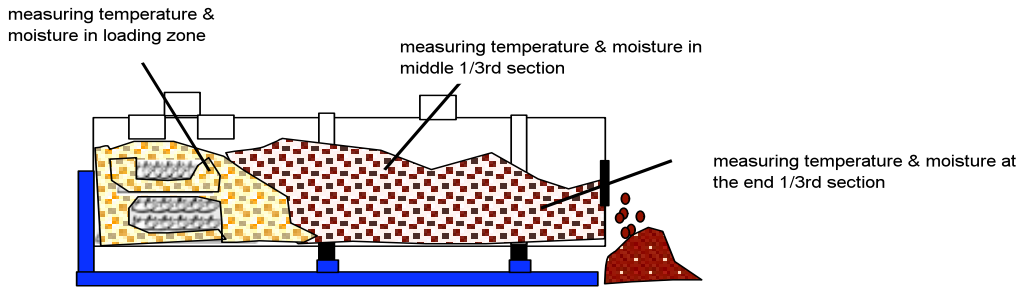
As a rule of thumb, temperature at the first 1/3rd of the BIOvator™ (at the loading zone) should be above 100˚F/38˚C. Temperature at the middle 1/3rd should be above 110˚F/43˚C. The temperature of the compost (or material at the back 1/3rd) may be between 80˚F/27˚C and 90˚F/32˚C.



There are a number of ways to monitor both the temperature and moisture inside the BIOvator™. The most effective method is to use a 32" hay bale tester. The probe can be used to measure both temperature and moisture of the compost. The frequency of monitoring temperature and moisture is dependent on:

- The frequency of adding mortalities: It is good practice to measure temperature and moisture every time before you add mortalities.
- The experience of the operator: As the BIOvator™ operator gains "hands on" experience with compost and its conditions/requirements, measuring of temperature and moisture can be done bi-weekly or monthly, unless problems happen (e.g. foul odour, flies, no sign/feeling of heat when opening any of the BIOvator™ doors etc).

When measuring, take the average of three readings. Record values on a data sheet similar to that shown in Appendix II.



Monitoring and recording temperature and moisture ensures that the composting process is progressing properly and will alert you to any problems in the process. These problems and how to rectify them are listed in Appendix I (troubleshooting).

The BIOvator™ also comes with two thermometers installed in the wall of the drum (see photo below) to give the operator a quick view of the temperatures at the loading and inspection zones. These are in place to alert the operator of any drastic changes in operating temperature that could indicate a possible problem. These are a guideline only, and do not necessarily represent the actual temperatures in the center of the compost mix. Typically, temperatures will be higher in the center than the readings on the surface thermometers.

4.2. Bones

Some bones, such as large skulls, teeth, or ball joints, may not be fully composted in the same short time as flesh and muscles. The BIOvator™ has an optional bone screener attachment (see photo below) that prevents the bones from exiting with the compost. Bones carry on to their own discharge pile. It is estimated that some of the bones may take up to 3 months to break down and disappear. If longer periods of time are noticed to break down these bones, look for reasons the process is being slowed. Many times it is because of not enough shavings in the system.

4.3. Odour

Odour does not generate in a correctly managed BIOvator™. The presence of odour is an indication of one, some, or all of the following conditions: excessive load at the front part of the vessel, too low or high moisture content, or lack of adequate shavings covering the carcasses. Odour can also be noticed if partially decaying carcasses are added to the compost. Odour is more noticeable when opening the loading doors, inspection doors or the discharge opening. It is unlikely to notice such odour outside The BIOvator™, unless doors have been kept open for long periods of time with such mismanaged conditions existing.

Monitoring the compost temperature is a good check to avoid odour. Temperatures that are too low or do not increase after loading indicate a problem with the process and forewarn of impending odour.

4.4. Flies, Insects, Vermin and Scavengers

Due to the complete confinement of the compost mixture inside the BIOvator™, scavengers and vermin do not exist. The heat produced combined with the turning of the BIOvator™ also prevents development of insect larvae or maggots. The continuous addition of dry shavings and recycled compost reduces the wet conditions required for egg laying.

Flies may appear around the BIOvator™ during hot weather if doors were left open. Odour is generated due to lack of shaving, or fluid is leaking from openings. If the latter is noticed, check the loading and inspection door seals and make sure any leak is collected or cleaned from underneath the BIOvator™.

PART C: THE BIOvator™ DEVICE

5. THE BIOvator™

5.1. The BIOvator™ Set-up Instructions

First: Selecting the BIOvator™ Site:

As long as composting is totally confined inside the BIOvator™, and as long as all doors are sealed properly, it can be located in close proximity to a building. In selecting the proper location, consider these factors:

- Closeness to the feedstock supply.
- Closeness to a winter exhaust fan.
- Closeness to power and water outlets.
- Closeness to wood shaving (or any bulk material) storage.
- Leveled ground- concrete or gravel are preferred.

Second: Transporting, Unloading and Leveling:

- Exercise extreme caution while transporting and unloading the BIOvator™ so that neither the exterior shell nor the driving components (chains, belts, motor, gearboxes, etc.) are damaged or moved.
- The BIOvator™ should be leveled on the ground. Avoid any sloping side to side, but a slight incline towards the discharge is acceptable to keep accumulation of liquids at the loading zone. Leveling will also prevent structural or mechanical damage due to impact when loading mortalities and to long-term stresses.
- Avoid placing the BIOvator™ skid right on the ground. Prevent direct contact with wet conditions and subsequent rusting by lifting the skid off the ground, using wood ties or 4 by 4 strips.
- If placed on concrete blocks, piles or any similar supports, the BIOvator™ frame must be supported below the end truss and below each set of rollers to prevent any excessive deflection of the skid.
- Avoid stopping the BIOvator™ drum with the doors at the bottom. If full, excessive weight may damage door latches. Fluids may also leak in this position.

5.2. Description of the Device

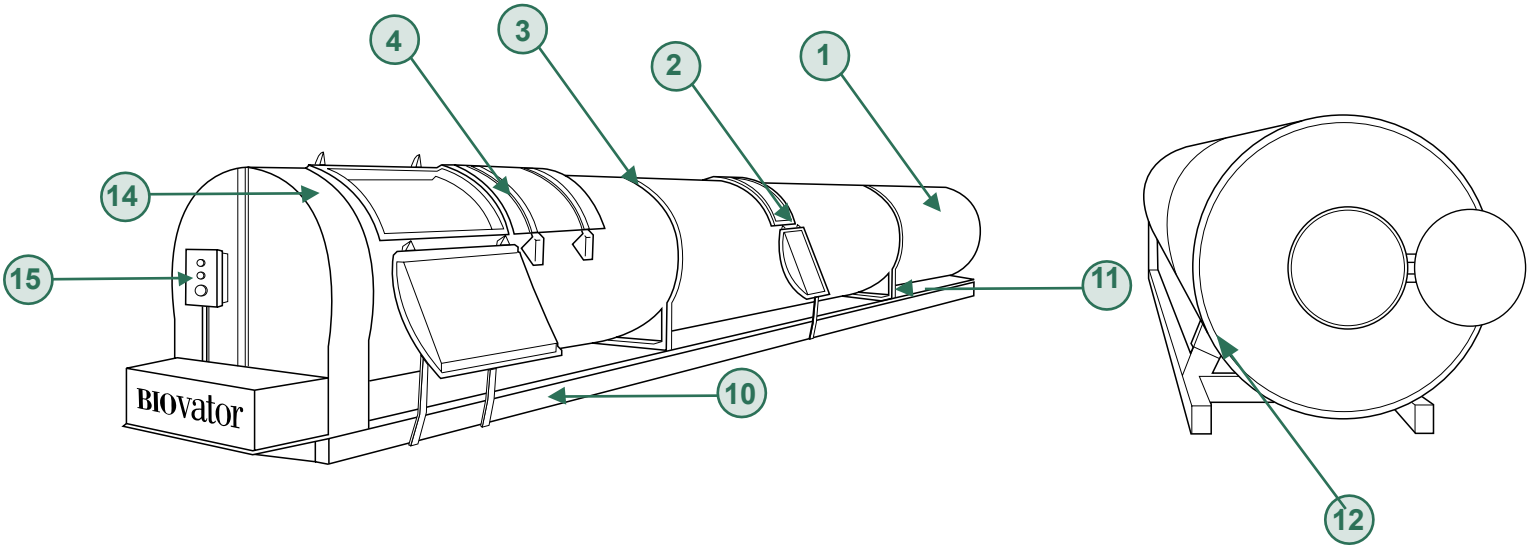
The BIOvator™ is a device and process for disposing of organic waste material. While Part B described the process, this part of the manual covers the equipment details.

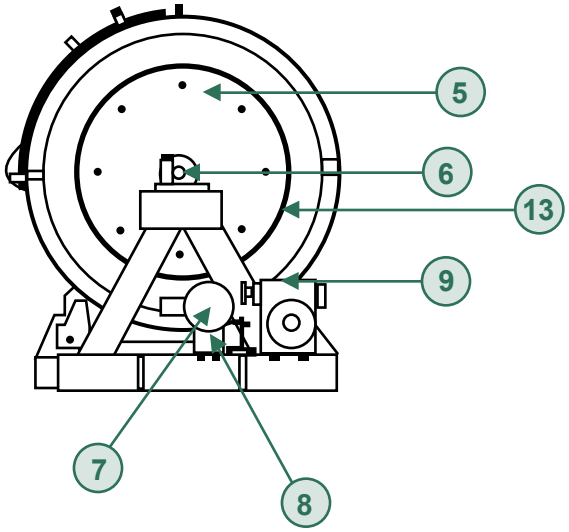
The device is a stationary composting vessel. The composting vessel consists of a slowly rotating steel drum that has steel paddles mounted on the inside walls. The paddles are mounted in a spiral shaped pattern with varying spacings to allow material to move in one direction at a certain speed inside the vessel.

The vessel has loading, inspection and discharge openings. The loading openings are used for loading carcasses and bulking material.

The vessel is supported on side nylon rollers and a front pillow block. Nylon rollers are supported by a steel skid. The vessel rotates at a speed of 3 revolutions per hour (or 20 minutes per revolution approximately).

5.3. BIOvator™ Components & Technical Specifications





Component	Description	Technical Specification	Model BIO316	Model BIO418	Model BIO430	Model BIO442
1	Steel drum Spiral welded	Mild steel 1/4" thick Two-part epoxy coated	16 feet long 3' dia	18 feet long 4' dia	30 feet long 4' dia	42 feet long 4' dia
2	Inspection door	17 1/2" 24" opening SS 304 construction Foam insulated Nitrile seal 1 3/4" x 3/4" Ratchet type locking device	no door	no door	1 door	2 doors (1 vented)
3	Steel channel	6" x 10.5 pounds per foot Welded to the drum Hot dipped galvanize	1 channel	1 channel	2 channels	3 channels
4	Loading door	24" x 90" opening (2 doors) SS 304 construction Foam insulated Nitrile seal 1 3/4" x 3/4" Ratchet type locking device	1 door	2 doors	2 doors	2 doors
5	Steel sprocket	Bolted to center of the loading end of the rotary vessel	Fit #60 chain 99 teeth	Fit #100 chain 89 teeth	Fit #100 chain 89 teeth	Fit # 100 chain 89 teeth
6	Pillow block		SAP208-24 for 1.5" shaft	HCP211-32 for 2" shaft	HCP211-32 for 2" shaft	HCP211-32 for 2" shaft
7	Electric motor	110 volts single phase Baldor farm duty motor	0.5 HP 1725 RPM 60 Hz	1 HP 1725 RPM 60 Hz	1 HP 1725 RPM 60 Hz	1 HP 1725 RPM 60 Hz
8	Speed reducer	60:1 Synthetic gear box oil	Frame #80	Frame #80	Frame #80	Frame #80
9	Speed reducer	60:1 Synthetic gear box oil	Frame #80	Frame #120	Frame #120	Frame #120
10	Steel frame	Hot dipped galvanize	4" x 4" x .188 thick tubing	4" x 6" x .188 thick tubing	4" x 6" x .188 thick tubing	4" x 6" x .188 thick tubing
11	Nylon roller with sealed bearings	6" dia x 3" wide 3/4" bore 5,500 pound capacity each	2	2	4	6
12	Foam Insulation	1 1/2- 2" thick spray-on insulation R-8, Cover with SS 304 liner	1	1	1	1
13	Chain	Heavy duty roller chain	#60	#100	#100	#100
14	Drive guard	All SS 304	1	1	1	1
15	Control box	EEMAC 4X Fiberglass enclosure, 120VAC 1 phase, 24 hour automated time switch with proximity switch de-activation	1	1	1	1

Besides the main components of the BIOvator™, as listed in the table above, the following features may be added:

- Temperature monitoring data logger: PLC based control system for continuous monitoring of temperatures in the vessel.
- Bone Screener attachment: Powder Coated Steel option for screening bones and inorganic material from the finished compost.

5.4. BIOvator™ Models and Capacities

There are four main models currently available for the BIOvator™, **316**, **418, 430** and **442.** These models vary in sizes and capacities to process organic material. The capacity of the BIOvator™ is defined as the maximum amount of organic material that can be processed into compost within optimum time limits and with the highest-possible consistency. The amount of organic material is based on weekly averages a facility may produce under normal operation.

BIOvator ™ MODEL	Diameter D (ft)	Length L (ft)	Estimated Average Annual Capacity (lb)	Estimated Average Weekly Capacity (lb)	Estimated Average Daily Capacity (lb)	Example Hog Operation
316	3	16	Less than 45,000	850	120	-2500 finishers -200 sow, farrow to finish -525 sow, farrow to wean
418	4	18	Less than 65,000	1,250	175	-4000 finishers -300 sow farrow to finish -800 sow, farrow to early wean
430	4	30	65,000 to 130,000	2,500	350	-7500 finishers -750 sow, farrow to finish -1500 sow, farrow to early wean
442	4	42	130,000 to 200,000	3,750	500	-10000 finishers - 1500 sow, farrow to finish -2600 sow, farrow to early wean

Estimated Average Capacities are equivalent for Swine, Poultry and Processing Plants. Pre-processed organic waste and fish waste have capacities of up to two times these rates.

6. MAINTENANCE AND SERVICE GUIDE

6.1. Maintenance Guidelines

In order for the BIOvator™ to run properly, the following checks need to be made routinely:

- Gearboxes should be kept full of synthetic gear oil. There is a sight glass or a plug located on the side of the gearbox. The oil level should be somewhere between the top and bottom of the sight glass. The large gearbox should be filled to the top shaft level to allow proper lubrication.
- The drive system contains two chains. A 50 series chain used to connect the two gearboxes together, and a 60/100 series chain used to turn the main drum. Both chains have adjustable idler sprockets to keep them tight (Figures 1 & 2). These idler sprockets may need to be adjusted over time to maintain proper tension in the chains. The chains should also be lubricated annually to prevent premature wear.

Figure 1 – 50 series idler sprocket

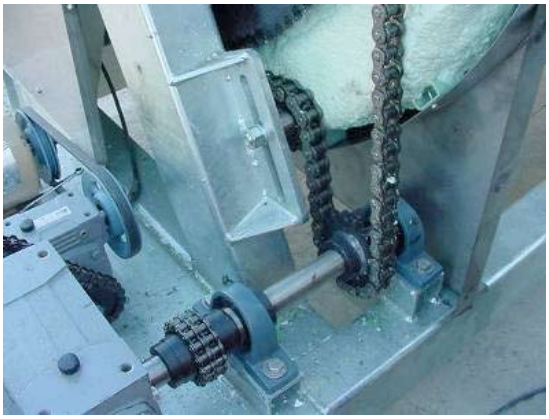


Figure 2 – 100 series idler sprocket

- The drive system also has a v-belt connecting the motor to the first gearbox. This belt may need to be tensioned periodically. Loosening motor bolts, Figure 3, and sliding the motor horizontally can tension this belt.

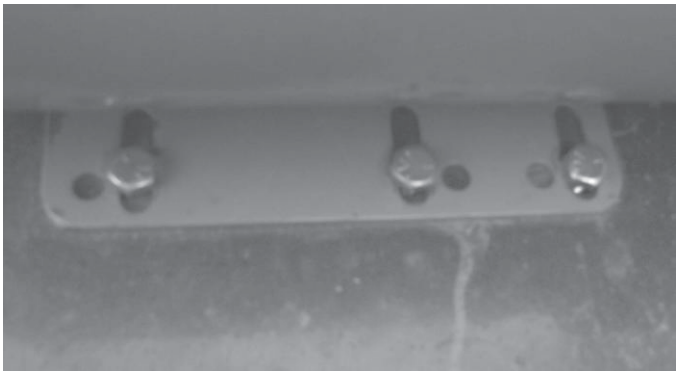


Figure 3 – motor bolts

Figure 4 – support roller/nylon caster

Figure 5 – 2” bearing in pillow block

Figure 6 – 1 ½” bearings with chain coupler

- The support roller wheels, Figure 4, are maintenance free with stainless steel sealed bearings. The drive bearings, Figures 5 & 6, have been greased from the factory but should be greased at least annually.

In addition to the above, the following maintenance guidelines are recommended for prolonging the BIOvator™’s life:

- Rubber seals: Make sure rubber seals are fastened to the doors at all times. Loosening these seals will allow liquids to seep through the doors.
- Removing falling material: bulking material, remnants of loaded mortalities mixed with moisture could fall on the steel skid, door frames, chains and the rest of the driving components. It is a good practice to clean underneath the BIOvator™ and remove these falling materials regularly. These materials would contribute to corrosion of steel parts as well as accumulation of flies and maggots.
- Stainless steel outer shell: check regularly for damage. Repair cuts or openings to prevent moisture from entering the foam space, which could cause damage in cold conditions.

APPENDIX I

FREQUENTLY ASKED QUESTIONS AND TROUBLESHOOTING GUIDE (MORTALITIES COMPOST MANAGEMENT)

Frequently Asked Questions

Q. Does the composting action continue during winter months in cold climate areas?

A. If started during summer or early winter (not later than November), composting would continue during the winter months, provided thicker layers of woodchips are added on top of the carcasses after turning and hording is used to shelter the BIOvator™. The barn's warm exhaust air may be used to keep the heat inside the BIOvator™ above 100˚F/38˚C.

Q. Does it stink around the BIOvator™?

A. When properly managed and when carcasses inside the BIOvator™ are totally covered with enough sawdust (straw), odours are sufficiently suppressed or absorbed. Using insufficient (less than 6" cover at any time) bulking material is the single greatest factor causing odours in and around the facility.

Q. Is cutting/dismembering required for large carcasses?

A. No. However, if facility managers wish to speed up the process and have the means to do it, they may put a few holes or cuts in the carcasses. It should be noted large carcasses (400-600 lbs) would take longer to decompose than smaller ones.

Q. What about diseases, flies and pathogens?

A. The high compost temperatures, cover of sawdust and full enclosure of the BIOvator™ are sufficient to restrict pathogen survival and fly incubation. No disease outbreaks attributable to composting have been documented to date.

Q. What are other sources of bulking materials?

A. Any granular organic material with high carbon content should work. Long fibrous material, such as hay or cornstalks, may be used. Lack of absorption, however, may be more evident with these materials because of their poor moisture retaining qualities. Shredded paper has been used at some facilities.

Q. What is the composition of the compost?

A. Generally speaking, compost includes the following nutrients: Nitrate, Ammonium, Calcium, Phosphorous, Potassium, Magnesium, Iron, Manganese, Sodium and other salts. The amounts of these nutrients in the compost will vary according to the age of the compost and management of the process.

Q: What is the compost material used for?

A. If properly managed, the qualities of the finished compost would resemble that of peat moss. Therefore, compost can be used as a peat moss substitute in greenhouse and landscape applications, such as:

- For improvement of organic matter content and fertility of soil.
- For increasing water holding capacity.
- For increasing aeration and drainage of clay soils.
- For erosion protection of lagoon banks.

Q. Are there any additives that can be used to speed up composting, even further?

A. Some composting experiments where inoculants were used have been documented. The results were inconclusive in showing any advantage from use of such inoculants.

Q. Does composting fail?

A. If not managed properly, compost may not heat enough particularly in wintertime, and may produce odours in summer. Composting is a biological process that depends on providing nutrients and an environment favorable for bacterial decomposition. Common mistakes are:

- Failure to provide enough shaving (or bulking material) inside the BIOvator™ to provide for the bio-filter and to maintain an appropriate carbon source for the system to operate over time
- Overloading the BIOvator™ and creating a large anaerobic mass

Fortunately, rectifying strategies can be followed to reverse such failures. (Discussed in the trouble shooting section)

Q. How can I tell when compost is cured?

A. If steam is emitting from the discharged pile, it is not fully cured. You may leave it in the pile for more time, or recycle it back into the BIOvator™. Once pile temperature is down to ambient temperature and compost color is dark brown, it is cured.

Q. How large a carcass can be put in the BIOvator™?

A. Mature sows and boars over 600 lb can be loaded in the BIOvator™. Expect longer composting time for larger carcasses.

Q. What about contaminants in the finished compost?

A. Again, if managed properly, the finished compost would have no contaminants. Tests conducted on finished compost (provided in Appendix III) where composting conditions were within the limits described in Part B, have shown no contaminants, such as Ecoli or Fecal Coliform present. If proper compost recipes and operational protocol are followed, the BIOvator™ will produce "Class A" compost.

Q. How do I add moisture?

A. The best way to uniformly distribute the water is to use a garden hose with a sprinkle/spray head. Adding water with a pail would cause some parts to be very wet and others to remain dry. Be careful not to over water and create anaerobic conditions.

Q. Can finished compost be used as a full substitute for fresh shavings in the BIOvator™?

A. Experience to date indicates that up to 50% of the fresh shavings requirement may be substituted with finished compost. The long-term viability of the process cannot be maintained if fresh shavings are not added, because the source of carbon would eventually be exhausted. Advantages of recycling finished compost include: less fresh shavings required, active bacteria and heat are available in the finished compost, less finished compost to haul for spreading and speeding up the disappearance of bones.

Q. What about maggots?

A. Generally, all kinds of earthworms are beneficial for composting. Large-sized maggots are particularly beneficial for composting. The maggots to be concerned with are the small, pale-coloured housefly larvae, which may present a public health problem. Usually, the main cause for harmful larvae is lack of shavings inside the BIOvator™ or leakage of fluids. Therefore, it is good practice to maintain a sufficient cover of shavings on top of the carcasses and eliminate any leakage.

Q. **Can the BIOvator™ be set right on the ground?**

A. Yes, the BIOvator™ may be set on gravel, concrete pads or supports.

MORTALITY COMPOSTING TROUBLE SHOOTING GUIDE

Probable Symptom	Probable Cause	Other Clues	Suggestions for Remedy
Compost fails to heat	• Materials too dry • Materials too wet • Not enough nitrogen, or slow decaying • Too much turning • Cold weather	• Cannot squeeze water from material; or moisture reading is below 30% • Materials look and feel soggy; mixture slumps; or moisture reading is more than 60% • C:N ratio greater than 50:1 large amount of woody materials	• Add water, liquid manure or wet bulking agent • Add dry bulking agent • Add more carcasses, perhaps cut or poke holes in them • Stop rotation until heat is back • Use external heat; add highly degradable materials (manure)
Failure to maintain temperature	• Compost has dried out • Cold weather • Too much moisture	• Looks very dry • Looks soggy	• Open pile and add water or manure • Ensure adequate cover with bulking agent and avoid adding frozen carcasses- use external heat • Add fresh bulking agent to absorb moisture
Failure to decompose carcass tissues	• Improper C:N ratio • Carcasses layered on top of each other • Carcasses placed on the inside walls of the BIOvator™	• Carcass is intact even after 2-3 days of being added to the BIOvator™	• Improper mix of ingredients or very old shavings, sawdust or straw • Make sure there is 4” -6” of bulking material between layers • Fill at least 6” of space between carcass and inside wall of the BIOvator™ with shavings
Smell of decaying flesh	• Inadequate cover of bulking material over carcass • Extended period of low temperature		• Cover carcass with at least 1 ft of bulking material • Add manure and partially cut carcasses and cover with ft of bulking material
Pile overheating (temperature greater than 150° F/66°C)	• Insufficient aeration in the bulking agent layer • Pile is too large •Low moisture	• Pile is too moist • BIOvator™ is more than 75% full	• Add drier material and start rotation until well mixed with wet material • Start discharging • Add water
Extremely high temperature (greater than 170°F/77°C)	•Spontaneous combustion	• Low moisture content; pile interior looks or smells charred	• Start rotation and discharging; add water to charred or smoldering sections
High temperatures or odours in the curing pile	• Compost is not stable •Pile is too large	• Higher than 6 ft	• Turn and mix pile until the temperature and moisture are within limits or recycle back into the BIOvator™ • Decrease pile size
Ammonia odours coming from the curing pile	• High nitrogen level or pH		• Add more sawdust
Rotten-eggs odours coming from the curing pile	• Anaerobic conditions • Inadequate cover over carcasses	• Low pile temperature	• Add dry shaving and mix • Maintain 6” of cover
Fly problems	• Poor sanitation conditions • Failure to achieve desired conditions • Too high moisture		• Check for leaks from the doors- keep the surrounding site clean and free of garbage or debris • Follow as above • Add more cover of bulking material
Compost does not reheat even after turning	• Low moisture • Composting near completion	• Cannot squeeze water from material • Approaching expected composting time period	• Add water and mix • None required- you may discharge
Compost contains lumps of materials and large bones; texture is generally not uniform	• Poor mixing of materials or insufficient mixing/turning for materials ready for discharging • Active composting not complete	• Visible raw material; lumps of compost • Curing pile heats or develops odours	• Scoop and recycle back into the BIOvator™ • Increase retaining time inside the BIOvator™ or improve composting conditions

COMPOST CONTROL CONDITIONS MONITORING SHEET

Date	Approx. weight of mortality or organic waste added	Approx. Gal of water added	Approx. weight of bulking material added	Pile Temperature & Moisture						Weather Condition	Name of Operator
				Loading Zone		Inspection Zone		Discharge Pile			
				F°/C°	%	F°/C°	%	F°/C°	%		

APPENDIX III

HOG COMPOST

ENVIRO - TEST
ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier	D.L.	Units	Extracted	Analyzed	By	Batch
L224759-3 SAMPLE #3 ENDPRODUCT								
Sample Date: 10- NOV-04								
Matrix: Escherichia Coli	<3		3	MPN/gram	10-NOV-04	10-NOV-04	HNT	R237806
Salmonella	<3		3	MPN/gram	10-NOV-04	10-NOV-04	HNT	R237805
	Not isolated				10-NOV-04	10-NOV-04	HNT	R237807
Metals								
Silver (Ag)-Total	<1		1	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Aluminum (Al)- Total	299		3	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Arsenic (As)- Total	0.29		0.03	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Boron (B)-Total	4.9		0.6	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Barium (Ba)- Total	12.5	RAMB	0.04	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Beryllium (Be) - Total	<0.06		0.06	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Bismuth (Bi)- Total	<0.02		0.02	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Calcium (Ca)- Total	43700	RAMB	7	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Cadmium (Cd)- Total	0.04		0.02	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Cobalt (Co) - Total	0.51	RAMB	0.01	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Chromium (Cr) - Total	3.7		0.1	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Copper (Cu) - Total	18.1	RAMB	0.2	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Iron (Fe) - Total	1020		6	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Potassium (K) - Total	6080		7	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Magnesium (Mg) - Total	24200		2	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Manganese (Mn) - Total	76.7	RAMB	0.03	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Molybdenum (Mo) - Total	0.26		0.02	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Sodium (Na) - Total	2690	RAMB	2	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Nickel (Ni) - Total	3.1	RAMB	0.2	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Lead (Pb) - Total	0.58	RAMB	0.05	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Selenium (Se) - Total	0.7		0.1	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Tin (Sn) - Total	<4	RAMB	4	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Strontium (Sr) - Total	10.7	RAMB	0.02	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Titanium (Ti) - Total	15.5	RAMB	0.03	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Thallium (TI) - Total	<0.2		0.2	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Uranium (U) - Total	0.129		0.006	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Vanadium (V) - Total	1.30		0.006	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Zinc (Zn) - Total	67		2	mg/kg	15-NOV-04	16-NOV-04	DAG	R238805
Solid Manure Package MS2								
% Moisture	55.4		0.5	%	17-NOV-04	17-NOV-04	HSL	R239495
Total Kjeldahl Nitrogen	30.4		0.1	lb/ton	16-NOV-04	17-NOV-04	JRB	R239093
Total Nutrients (Complete List)								
Phosphorus (P)	5.4		0.4	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Potassium (K)	6.3		0.4	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Sulfur (S)	2.7		0.4	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Sodium (Na)	6		1	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Calcium (Ca)	39.3		0.4	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Magnesium (Mg)	20.7		0.4	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Copper (Cu)	0.019		0.004	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Iron (Fe)	1.85		0.004	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Maganese (Mn)	0.061		0.004	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Zinc (Zn)	0.075		0.004	lb/ton	19-NOV-04	19-NOV-04	BEM	R239907
Refer to Reference Information for Qualifiers (if any) and Methodology.								

BIOvator™ LIMITED WARRANTY CERTIFICATE

SAVE THIS CERTIFICATE.

If your unit needs servicing, contact a qualified dealer or sales representative. When requesting service, please have the model and serial number from the unit readily available. If your dealer needs assistance, Nioex Systems is available to provide support.
Fill in the installation date and model and serial numbers of the unit in the space provided below and retain this Limited Warranty for your files.

GENERAL TERMS

The term of this Limited Warranty is one (1) year on workmanship, two (2) years on motor and gearboxes and ten (10) years pro-rated on inner steel barrel against perforation due to corrosion in normal use. The use of acid material will cancel this warranty. All drive components are under warranty from the manufacturer.
The warranty commences on the date the unit was invoiced to the customer as shown on the customer invoice.

Installation Date _____

Model No. _____. Serial No. _____.

Nioex Systems Inc. 171 Waverly Drive Brandon MB R7B 4A4

NOTES: