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In-vessel Composters for Livestock Mortality Management

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In-vessel Composters for Livestock Mortality Management

Introduction

In-vessel composting is done in an enclosure, such as a large-diameter drum. The compost is typically agitated, turned, or force-aerated. The composting process starts quickly, and the highly degradable, oxygen-demanding materials are decomposed in a shorter time frame than windrow or static pile composting. Further decomposition or finishing of the material is typically necessary and is accomplished through a second stage of composting, usually in windrows or static piles.

Several States have conducted pilots, approving limited installation of these types of composters. Limited use of these composters allows a State to study the effectiveness of the technology under the environmental conditions present in their location and judge whether they want to make the technology available under general application.

Manufactured in-vessel composters for animal mortality can be installed as a component of a compost facility under U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Conservation Practice Standard 316, Animal Mortality Facility. The in-vessel composter should be considered for the initial or primary composting of the carcasses. The complete facility must include provisions for secondary composting. Provisions should also be made for the storage of the composted material. This storage may be an additional component of the composting facility or a separate facility.

This note will describe and compare four manufactured in-vessel composting units (tables 1, 2, and 3). It may be used as a guide to evaluate units from other manufacturers.

Models reviewed

Manufacturers who were contacted and provided information for inclusion in this report include Nioex Systems Inc., Biovator®; Dutch Industries Ltd., Dutch Composter; Tri-Form Poly Inc., Ecodrum Composter; and Rotary Composters LLC, Rotoposter™.

Other in-vessels are generally available, but were not reviewed by NRCS. The models in this review are for informational examples and are not to be construed as a complete list or an endorsement of one product or brand over another.

Biovator®

The Biovator® (fig. 1) is manufactured by Nioex Systems Inc. in Manitoba, Canada. The cylinder-shaped unit (table 3) is constructed of a quarter-inch mild steel protected with a two-part epoxy coating and is insulated with spray-on foam insulation covered with a stainless steel liner. It is loaded through two hinged doors at the top of the unit.

Figure 1 Biovator®

Biovator® describes the device as 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 variable spacing to allow material to move in one direction at a certain axial speed inside the vessel. The vessel has loading, inspection, and discharge openings. The loading openings are used for loading carcasses and bulking material.

The control panel is located at the loading end of the composter. 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 three revolutions per hour (or approximately 20 minutes per revolution). The Biovator® comes with two thermometers installed in the wall of the drum near the loading and inspection zones. An optional programmable logic controller (PLC), based control system for continuous temperature monitoring of temperatures is available. There is a door located in the middle drum sections for inspecting and adjusting the compost mix as needed. The composting process takes less than 7 days in summer and up to 14 days in winter.

Dutch composter

The Dutch In-vessel Composter (fig. 2) is manufactured by Dutch Industries LLC, located in Pilot Butte, Saskatchewan, Canada. The upright funnel-shaped unit is loaded from the top with a front-end loader or by an optional electric motor driven cart hoist incorporated into the unit.

Table 1 Composter model dimensions

Model	Diameter (ft)	Length (ft)	Capacity (ft^3)	Maximum daily mortality capacity (lb)
Biovator® 316	3	16		120
Biovator® 418	4	18		175
Biovator® 430	4	30		350
Biovator® 442	4	42		500
Dutch composter	8	8 x 8 1/	800	1,500
Ecodrum™ 260	5	22	366	370
Ecodrum™ 360	5	33	549	570
Ecodrum™ 460	5	44	732	740
Ecodrum™ 560	5	55	915	925
Ecodrum™ 660	5	66	1,098	1,110
Rotoposter™ 516	5	16	285	1.000 2/
Rotoposter™ 524	5	24	442	1,500 2/
Rotoposter™ 532	5	32	599	2,000 2/
Rotoposter™ 540	5	40	756	2,500 2/
Rotoposter™ 724	7	24	865	3,000 2/
Rotoposter™ 732	7	32	1,212	4,500 2/
Rotoposter™ 740	7	40	1,481	6,000 2/
Rotoposter™ 748	7	48	1,788	7,500 2/
Rotoposter™ 1032	10	32	2,473	8.500 2/
Rotoposter™ 1040	10	40	3,022	10,000 2/

1/ Height from ground to loading opening is 11 feet.

2/ Estimated weekly capacity, estimates based on experience with Model 1040. While these throughout values are not guaranteed, it is believed that given the proper mix (carbon/nitrogen ratio, proper moisture and oxygen level), these estimates are achievable.

Table 2 Composter prices (USD) as of September 2012

Model	Cost
Prices should be confirmed with manufacturer or supplier prior to purchase Prices shown may not include shipping and handling costs or applicable taxes Prices shown do not include installation and setup costs	
Biovator® 316	$23,660
Biovator® 418	$31,685
Biovator® 430	$41,950
Biovator® 442	$51,325
Biovator® pricing notes: Current as of September 2012. Pricing is freight on board (FOB) Canada	
Dutch composter	$58,200
Dutch composter—Automatic greasing unit	$2,250
Dutch composter—Optional bucket loading system	$6,200
Dutch composter pricing notes: prices as of 7/13/2011	
Ecodrum™ 560 (approx 55 × 5 ft) (inc. two analog temperature probes)	$63,900
Ecodrum™ 660 (approx 66 × 5 ft) (inc. two analog temperature probes)	$69,900
Ecodrum™—Optional additional loading door and ladders	$2,000
Ecodrum™—Optional loading extensions	$2,500
Ecodrum™—Optional exhaust fan system	$2,750
Ecodrum™ Notes: Retail price list effective July 2009. prices subject to applicable taxes All prices FOB Morris, MB. All Ecodrum™ models are comprised of an insulated composter with one loading door and ladders, mounted on steel base with drive and control system. All Ecodrum™ models (except Model 160) rotate counterclockwise and discharge material every rotation. Due to its small size, the Model 160 rotates clockwise, and only discharges composted material when manually switched to reverse rotate counterclockwise.	
Rotoposter™ 516	$49,048
Rotoposter™ 524	$53,746
Rotoposter™ 532	$57,512
Rotoposter™ 540	$59,794
Rotoposter™ 724	$85,851
Rotoposter™ 732	$89,694
Rotoposter™ 740	$93,582
Rotoposter™ 748	$96,675
Rotoposter™ 1032	$101,462
Rotoposter™ 1040	$104,373
Rotoposter™—Optional discharge bone screen/large particle screen (holes 2” o/c)	$2,772
Rotoposter™—Optional thermo well with thermometer	$389 each
Rotoposter™ Notes: MSRP effective June 2012. Prices subject to change. Please confirm price with Rotary Composters prior to quoting to customer. All priced FOB assembly plant in southeast Pennsylvania. Standard price includes loading hopper, discharge sleeve and minimum of two plugged monitoring ports.	

Table 3 Compostor comparisons

Characteristic	Biovator® 442 Model	Dutch composter	Ecodrum™ 360 Model	Rotoposter™ 532
Loading process type	Continuous loading	Batch loading	Continuous loading	Continuous loading
Shape	Cylinder on its side	Upright funnel	Cylinder on its side	Cylinder on its side
Maximum daily capacity	500 lb	2,000 lb	570 lb	2,000 lb weekly
Material	Steel	Powder coated steel	Polyethylene	Steel
Heated or insulated	R-8 foam insulation	Heated with electric heaters and insulated	Insulated w/polyethylene foam	Insulated w/polyethylene foam
Loaded from	Top	Top	Top	Top
Dimensions of loading entrance	24” × 90” (2 doors on 4-ft dia. units)	92” × 46”	47” × 33”	Front load: 78” × 47.5” Optional side load: 60” × 17.75”
Cycle time	4 to 14 days	1 day up to 1,500 lb mortality 2 days for 2,000 lb catastrophic mortality (initial cycle time)	4 to 14 days	14 to 21 days
Self-emptying	Yes	Yes	Yes	Yes
Power source	110-volt single-phase electric motor	208/240 volt single-phase, custom electrical systems available	Electric motor	1Ph 230V, 2HP, 12A electric motor three-phase available
Drive system	Chain driven, drum supported by six nylon casters	Direct-drive gear box	Electric motor, chain drive, nylon rollers running the length of the drum	Ratcheting cog system driven by a hydraulic pump with a 1Ph 230V, 2HP, 12A electric motor (three-phase available upon request)
Air entrainment	Uses passive air intake	Uses passive air intake, which can be controlled using the two vents at the top of the machine	Optional air system recommended	Standard with a fan that introduces air into the drum during rotation and on any other interval as required which is easily programmable on the PLC
Standard equipment	Two thermometers installed in the wall of the drum	Main tank, which includes, controls, heating system, drive train and a unloading chute	Control box Forward/reverse switch Manual and automatic setting switch Safety ladders for loading analog temperature probes	PLC control system that allows variable settings depending on the application Hydraulic power unit Fan with snorkel All safety shields 24-in discharge extension Two 2 in monitoring ports every 8 ft. (total no. will vary according to length of unit ordered)

Table 3 Compostor comparisons—continued

Characteristic	Biovator® 442 Model	Dutch composter	Ecodrum™ 360 Model	Rotoposter™ 532
Optional equipment	PLC controller for continuous monitoring of temperatures in the vessel bone screener	Bucket loading system Automatic greasing system for the main stirring shaft	Air entrainment system PLC controller and Wireless temperature sensors Hopper delivery systems for loading manure into drum Second door for monitoring and rebulking Bone screen Loading slide to assist with loading	Thermometer with thermo well. Bone screen at discharge.
Operating Costs	Energy—$135 per year $0.03/lb of mortality for wood shavings 0.20 to 0.23 lb wood shavings per lb of mortality	Carbon and electricity costs $0.022/lb of mortality to compost hogs and poultry and $0.03 to $0.05/lb of cattle mortality. Note: When composting cattle, the heaters are used, which uses more energy and the run times are generally more frequent.	Energy—$3 to $8 per month Operational - $400 to $8,000 per year, depending upon species and bulking materials.	1 to 3 hours of running a 2HP electric motor per day (actual cost will vary by region)
Level of training, support and operating manual provided	Onsite setup and training provided at no extra charge-Operating manual provided	Onsite training provided to all customers. An owner's manual for the machine posted on the Dutch Web site: http://www.dutchopeners.com/Downloads	Training and assistance offered at no extra charge.Training manual offered.	Training and assistance provided as requested. Installation/operation and maintenance manual provides detailed instructions.

Notes: All information taken from manufacturers' literature and information supplied by company representatives.

The composter can handle mortalities as large as an entire cow or horse carcass. The mortalities and carbon source materials are introduced into the vessel by lifting and dumping the carcasses into the top of the vessel. During cold weather periods, additional heat can be added with an included heating system to activate the breakdown of the product into compost. Teeth within the vessel cut mortalities and crush the bones into small particles. Throughout the processing time, the stirring arm will mix the mortality and carbon source while introducing oxygen into the compost mixture.

The Dutch Composter has an electronic control system that can be set to any number of cycle times. The current recommended run time is about 50 percent, but with different animals and moisture contents the settings change. When composting cattle, the heating system is used to ensure that the hide breaks down properly, and with hogs and poultry the heaters are rarely needed.

Figure 2 Dutch composter

A sample composting cycle for pork or poultry includes running for 6 hours then a “sleep” cycle where the unit runs for 5 minutes every half hour and repeated. This assumes that each day a couple of hundred pounds of mortalities will need to be added. When the unit is finally full, set the machine to run continuously for 2 to 3 days to complete the cycle. For mature dairy cattle, the cycle begins by adding a carcass and running the unit for one day. Then another carcass is added and the unit is run for 4 days to complete the cycle.

Dutch Industries and SEMA Equipment of Spring Valley, MN, found that a ratio of 300 to 400 pounds of corn stalks to 1,000 pounds of mortalities is optimal for quick composting in the Midwest area of the United States.

There is a 40 percent reduction, with a potential 50 to 60 percent, in material weight of all additives. Total nitrogen concentration is roughly 5 to 70 percent, depending on the amount of bulking agent added. The compost material contains many micronutrients beneficial to crop production.

The Dutch Composter is designed for a normal capacity of 100 to 700 pounds of mortalities per day on average. In the case of a disease outbreak, it can handle up to 200 pounds per day, but there will still be animal bones and hide in the mix and the unit will need to run for 2 days before additional mortalities can be added. Secondary composting of the material from the Dutch Composter should be carefully monitored to ensure the time and temperature is sufficient for pathogen destruction. Pathogen destruction generally requires that the compost temperature be greater than 130 degrees Fahrenheit for 5 days.

Ecodrum™

The Ecodrum™ (fig. 3 and 4) is manufactured by Tri-Form Poly Inc. in Morris, Manitoba, Canada. The cylinder-shaped (table 3) unit is loaded through a hinged door at the top of the unit. The drum is constructed of noncorrosive polyethylene material and insulated with polyethylene foam.

The control box is placed on the side of the Ecodrum™ for easy access by the producer. Forward and reverse switches are provided to correct a recipe inside the drum, and “manual” and “automatic” setting switches are included for varying the number of drum rotations. The optional “Air System” provides a positive airflow to push air through the mix. The discharge system is designed to ensure composted material is continuously discharged. The Ecodrum™ has rollers running the course of the drum. Safety ladders are located on both sides of the loading door. Door hardware is all chrome and safety pins are standard on all drums. Ecodrum™ uses a tapered door system that seals to prevent leakage. The drum has a built-in draining system to prevent moisture from building up in the drum or in the doorway. All drums come with analog temperature probes; however, an optional PLC controller and wireless temperature sensors are offered. Compound end-users are offered hopper delivery systems for easy transfer of materials to the drum. The Ecodrum™ system is a continuous-flow process, and once set, it will rotate automatically 3 to 4 times a day, moving the product forward in the drum with each rotation. Ecodrum™ draws oxygen through the drum with each rotation and exhausts it in the front of the drum to provide oxygen for microbial activity in the drum.

Figure 3 Ecodrum™

A temperature probe that can be easily read is located on the second section of the drum, and on larger drums two are located so temperature can be read and monitored daily. The Ecodrum™ allows the user to correct the recipe, by changing the direction of the drum, to add more bulking material. The larger models have a secondary loading door to adjust a recipe, if necessary.

The process itself usually takes between 4 and 14 days depending on what is being composted. The Ecodrum™ exit system is a 20-inch diameter opening where product discharges.

Rotoposter™

The patent-pending Rotoposter™ (fig. 5) is manufactured by Rotary Composters LLC, in Denver, PA. The cylinder shaped unit (table 3) is loaded through a hopper at one end of the unit. The drum is constructed of carbon steel and has insulation options of spray-on closed cell polyurethane or rigid wool rigidflex foil scrim kraft (FSK) with a banded aluminum jacket.

Three series (5, 7, and 10) of models are offered (table 1). The series number indicates the drum diameter of the unit. The dimensions of the loading entrance vary for each series. The openings are 78 by 47.5 inches for the 5-series, 64 by 31 inches for the 7 series, and 66 by 46 inches for the 10-series.

The control box (fig. 6) is placed on the side of the unit at the front near the loading hopper. The PLC control system allows variable settings depending upon the application of the unit. The unit comes standard with a fan that introduces air into the drum during rotation and on any other interval as required and is easily

Figure 4 Ecodrum™ composter loading.end

Figure 5 Rotoposter™

programmable on the PLC. The PLC control system allows variable settings depending on the application. Additional standard equipment includes a hydraulic power unit, a fan with snorkel, all safety shields 24-inch discharge extension, and, 2-inch monitoring ports every 8 feet (total number will vary according to length of unit ordered).

Optional equipment includes a thermometer with thermometer well, a bone screen at the discharge end (fig. 7) and a side-load door (fig. 8) on the 5-series models.

Figure 6 Rotoposter™ PLC control panel

The unit is powered by a single phase motor. The motor size is dependent upon the size of the composter (5-series: 1Ph 230V, 2HP, 2A series; 7-series: 1Ph 230V, 5HP, 23A; 10-series-: 1Ph 230V, 10HP, 38A). Three-phase is available upon request for any of the model series. Run times can vary from site to site to suit their operating parameters (mortality volume, available composting materials, etc.). The units typically run approximately 1 to 3 hours per day and rarely at full load.

The manual explains how to setup and use the basic PLC control system. There are four grease points, accessible on the drive end of the machine. Recommended maintenance includes a weekly greasing of the unit, quarterly inspection of hardware, semiannual replacement of hydraulic fluid filter and annual replacement of the hydraulic fluid.

The unit is a continuous flow system. When operating at full capacity with mature swine, it takes 2 to 3 weeks from when material is loaded until it is discharged.

Design considerations

Siting for the in-vessel composter

In selecting the proper location, consider these factors:

- closeness or visibility to neighbors and public roads
- closeness to the feedstock (animal carcasses) supply

Figure 7 Rotoposter™ bone screen at discharge end

Figure 8 Rotoposter side load door

- closeness to a winter exhaust fan for additional winter heating, if necessary
- closeness to power and water outlets
- closeness to wood shaving (or any bulk material) storage
- leveled ground—concrete or gravel are recommended; avoid any sloping side to side
- consider housing the composters in a building in cold weather areas to protect the composter from cold weather and snow accumulation related issues

Sizing the secondary bins

For the selected in-vessel composter product, design the capacity of the secondary bins to handle the output of the in-vessel composter when running at full capacity (which may be higher than the design daily mortality rate), to account for instances when higher than average mortality is experienced.

Use the manufacturers predicted rate for output volume of primary stage compost per day. This will be less than the theoretical output of the device if calculated based strictly on available volume and cycle time, because during proper operation, there will be significant air space in the vessel to allow for proper moisture control and aerobic bacteria composting activity. Also, a volumetric reduction takes place during the primary composting phase in the vessel.

The designer and operator should plan for a percentage of the primary stage compost to be recycled back into the in-vessel composter along with any bones that have not been fully processed. This material can be used as part of the carbon source for new mortalities. Use manufacturer's recommendation for this percentage.

Sizing of the secondary bins may be done as follows:

- Determine the daily production volume (ft^3/d) of primary-stage compost to be moved into secondary processing by applying the manufacturer's recommended percentages and rates as described.
- Secondary composting can be done in a variety of ways, such as bins, static pile, and windrows. Even though the volume calculations are similar for the secondary approaches, the following information is based on bin usage.
- Select a bin size that will work for the producer, taking into account available equipment and management style.
- For the selected bin size, calculate the available volume of each bin. In the absence of actual data, use an angle of repose of 1:1 (45 degrees). Note that a narrower bin width will mean less volume lost to the angle of repose as in place walls will support the pile.
- Determine the number of days worth of storage each bin represents by dividing the available bin volume by the daily production volume.
- Determine process and storage time. Plan for the secondary treatment to take 90 days. This is conservative. If appropriate for the planned management of the system, add up to 60 days worth of storage capacity for each batch of compost, to accommodate scheduling of land application, for a total of up to 150 days that a batch of compost will occupy the secondary bin after the bin is completely filled.
- Calculate total cycle time by summing the number of days to fill the bin with the process and storage time determined above. This cycle time represents the amount of time until each bin can be emptied and used again.
- Calculate minimum number of secondary bins needed, by dividing the total cycle time by the number of days to fill the bin. Also allow for compost storage needed in case of restrictions on winter spreading. Add an extra bin if desired, for storage of carbon source/bulking material.

Operation and maintenance

The operation and maintenance instructions are very important for the in-vessel composting system, and should rely heavily on the manufacturer's recommendations. The operational instructions should address both the primary device and the secondary composting system. Some general considerations include:

- Typically, wood chips or shavings are ideal carbon sources due to their high bulk, ease of handling, absorbency, and high carbon content. Straw or sawdust are not recommended because these materials are too fine and do not allow proper air movement, and straw will flatten out. However, use the manufacturer's recommendations for carbon source.
- Do not use oak, cedar, or redwood material because of their tannin content. Do not use treated wood material because the treatment will kill the aerobic bacteria that are needed to accomplish the composting.
- Use manufacturer's instructions. Ask for a recommendation for a startup recipe and opera-

tion. Determining the best recipe for the operation will require some initial experimentation.

- New in-vessel composter users should consider using a higher percentage of carbon source than the recipe calls for. As the user becomes familiar with the performance of the in-vessel composter, the percentage of carbon material may be adjusted until the optimum moisture content is achieved.
- Provide a recommendation for monitoring of moisture in the in-vessel unit. To meet NRCS Conservation Practice Standard 316, Animal Mortality Facility, the moisture content of the compost mix must be maintained at 40 to 65 percent by weight (wet basis), to enable the aerobic bacteria to work effectively. Manufacturer's recommendations may vary; the resulting instructions should meet both NRCS standard and manufacturer's recommendations. Too much moisture in the mix prevents adequate oxygen content and inhibits the composting activity. Add bulking material to create a more porous mix whenever moisture content begins to approach the upper limit, and monitor more frequently until moisture content is successfully brought back down to the desired range.
- Measurement of moisture content may be done by visual observation if the producer has experience with silage production. Proper silage moisture content is approximately 65 percent, so the operator would need to make sure that the mix does not get quite that wet.
- Provide a recommendation for monitoring of temperature. Some in-vessel composters contain built-in thermometers for this purpose. Specify that the compost temperature must reach 130 to 160 degrees Fahrenheit during the composting cycle and be recorded daily.
- For the secondary stage bins, compost temperature should again reach at least 130 degrees Fahrenheit for 5 days then cool to a temperature lower than 100 degrees Fahrenheit.

Adjustment of the basic recipe is done by observation of the color of the completed primary stage compost, as instructed by the manufacturer. In general:

- Milk chocolate color is desirable.
- Tan color means add more recycle materials.
- Black coffee color means add more fresh carbon source.

Observations from selected actual installations

General observations

- The material produced by the in-vessel device is typically still biologically active and can be recycled into the front end with new mortalities to boost the initiation of the composting process. A secondary composting stage system is recommended to complete the composting process and serve as a backup system in the event of operational issues with the in-vessel composter. Extra bins are also extremely useful for temporarily storing carcasses during periods with operation issues, for storing raw materials, or final curing and storage of the finished compost.
- The learning curve for setup and operation of a composter is steep. Good customer support from the manufacturer's representative is essential during the startup phase, which can take months.
- The producer must be committed to make the system work. In-vessel composting units are not for everyone.
- Management of an in-vessel composter system is different from that of a static-bin system, and does not necessarily mean less labor.
- Moisture control is critical. Too much moisture can completely clog an in-vessel device, depending on the design.
- Roofing the composting facility can facilitate moisture management.
- Enclosing an in-vessel composter in a building (fig. 9), and roofing the secondary composting system can facilitate temperature and moisture control.
- Using an in-vessel device as a primary stage significantly speeds up the composting process. If the composting time period is not critical, the benefits of an in-vessel system may not be justified because of the increased cost over other operations such as bins or windrows.
- Using an in-vessel composting device improves biosecurity, protecting the primary stage materials from scavengers and insects.

Biovator®

Midwest—In 2007, NRCS staff observed an in-vessel swine mortality composter manufactured by Biovator®.

The model 440 Biovator® is installed on a concrete pad. The composter is a cylinder approximately 4 feet in diameter and 30 feet long. The cylinder is rotated by a gear reduction electric motor that operates on a programmable schedule. The carcasses of piglets and sows (that will fit through the doors on the composter) are placed in one end of the composter, along with pine shavings, and up to 50 percent recycled material. The compost mixture is aerated by rotating the cylinder. The composted material comes out the other end (fig. 10).

Temperature measurements were taken to evaluate the composting process. The ambient temperature of the air during the site visit was 40 degrees Fahrenheit The temperature of the Biovator® measured at the mid-stage door vents was 132 degrees Fahrenheit.

Material is added to and removed from the composter daily. The compost removed from the cylinder is not completely composted and requires further composting or curing in order to produce a stable, low-odor material. Two static bins for additional composting are on site.

There were two static piles, one made up of fresh material less than 10 days old and one made of material over 30 days old. Both were measured. The older pile was dry on the outside, but within a few inches moisture could be found on the material. The temperature probe was inserted midway up the pile, approximately 32 inches towards the center of the pile. The temperature readings were 96 degrees Fahrenheit for the old pile and 100 degrees Farhenheit for the newer pile.

The description about the operation and maintenance of the system on a swine farm is the basis for the following:

- The in-vessel system performs as advertised. Soft tissue is significantly composted in 10 to 14 days. The bones, however, have not been degraded during this time.
- A secondary compost area is needed to finish the composting (curing) and for storage of the finished material. The installation uses a static pile system for curing and storage.
- Additional mortality management options are needed for large animals or when death loss exceeds the capacity of the in-vessel system.
- The in-vessel system appears to be sensitive to the type of carbon source used. The issue may be related to the moisture content of the carbon source. More information is needed to verify this issue.
- The mechanical components have performed well during the first year of operation. The only deficiency observed were the rubber seals on the access doors.

The system is equivalent to the primary stage of a typical static pile mortality composter. The vendor sizing criteria appears to be sufficient to complete the primary stage of mortality composting. A static pile type composter for secondary stage and storage area is required in order to have a complete mortality management system.

Figure 9 Composter building

Figure 10 Discharged composted materials

Midwest—In April 2010, NRCS personnel visited a swine operation to evaluate a Biovator® composter installed under a pilot project to cost share on in-vessel mortality composters.

This system was installed at a 3,000 finishing hog, 220 to 260 pound, operation. The composter was loaded with an estimated mortality rate of 213.5 pounds per day. The system consisted of one Biovator® 430 unit and four secondary bins. The secondary bins were 9.3 by 12.5 feet and half of bin 1 was being used as a material handling area (fig. 11).

The Biovator® achieves proper aeration without an air fan, and has a fixed speed of 20 minutes per revolution. Current management involves turning the drum on 6 times in a 24-hour period. Fewer turns yields more odors and less aeration. More turns reduce the temperature significantly, not allowing proper composting to take place. The Biovator® is mounted so that the output end is raised higher than the input end (a 3 percent reverse grade) to keep liquid from draining to the outlet end. This aids in moisture control of the compost. The reverse grade is also used to control the speed at which material moves through the system. The conical screen at the outlet of the unit is a bone separator, and an optional attachment.

The producer has also loaded some cattle into the Biovator®: six or seven, 700 pound feeders. According to him, a cow head takes 3 weeks to properly break down in the Biovator®. The producer indicates that the rebulking step (adding more wood chips halfway through the process) is not very effective. It is better to get the recipe right at the beginning. Currently, the producer aims to balance the physical volume of mortality with volume of bulking material each time mortalities are loaded. For the bulking material, 50 percent primary stage compost (plus any bones) and 50 percent new material (wood chips, etc) are used.

For this operation, wood shavings are available during the winter and early spring from horse shows in the area. Sawdust is available year round, but does not control the moisture as well, because the fine texture allows less air movement. The producer indicates that the primary compost end product is wetter during cold weather, and condensation has been observed dripping out the end of the Biovator® at those times.

Southeast—In October 2010, a visit to a 4,000 sow, farrow to wean, operation in the southeast was made. The grower has two units. Unit 1 is loaded one day and unit 2 the next. One revolution of the drum takes 2 hours. Some odor in the vicinity of the unit has been detected. A 600-pound sow will yield a skull bone at the discharge end. The compost does appear a little greasy. There was a bone screen at the discharge end. Large fragments will be rerun through the unit. Since there is a free source of carbon material, more is used than required which appears to improve the process. There are two static compost bins. One is currently used, one to store the carbon material, and the other for the compost. One bin will handle all the winter compost.

Figure 11 Biovator® discharge end with bone screen

Dutch composter

Midwest—In March 2012, NRCS personnel met with a swine producer who installed a Dutch Composter (figs. 12 and 13) within the last couple of years.

The producer was very satisfied initially with the unit. The model was one of the first models to be available from the Dutch Composter company. The units were originally designed to use hogs only. Dutch Composter indicated that others had tried using the unit for cows, however, it caused problems with the bushings in the bottom of the composter. The bushing failure was causing the stirring arm to rub along the inside of the drum and was wearing out both the arm and the inside of the drum. This unit never had this issue, however. The company redesigned the bushings and went through a couple of iterations on securing the gearbox below the unit to solve the torque and bushing failure problems. The company voluntarily replaced the bushings, which had no problems, with the new and improved bushings and retrofitted the new bracing on the gearbox. All of this was done on the company's own cost. The bushings have been changed three times now since the new bushings were installed. A few cows and several beef steers have been run through, along with a couple of ponies, and, in general, it works pretty much as well as it does with hogs.

The replacement of the bushings costs 2 days of operation of the unit each time they go out. Up until now, the company have stood behind their product and all have been free of charge. Since the unit is not manufactured in the United States, it can take quite awhile to get parts for repairs and upgrades.

When the recipe is correct inside the composter, everything works fine. The unit is loaded with straw. Dead hogs are added to smash the straw down and more straw can be added. About 500 pounds of hogs and 25 to 300 pounds of straw are run per cycle. If there isn't enough carbon in the unit, the skins start getting all twisted up and the mix turns into a mess. To clear the obstruction, the producer must climb into the unit on a couple of occasions to clear the unit. It takes about 3 days to run a full load. The machine runs for 15 minutes out of every hour, though the factory recommends only 5 minutes per hour.

Straw is used for mixture. Sawdust and corncobs have been tried, however, straw is the only material that works correctly. Corn shucks could be tried. The finer materials do not work and the mix ends up like a slurry of pudding. About 30 acres worth of straw is used per year. The composted material looked like bedded horse manure. The unit has a slide door at the bottom and when the arm is turned, the bottom is rotated to the top. A skid loader is used to then move the compost to a secondary pile. The USDA Animal and Plant Health Inspection Service suggests the material probably was not truly totally composted and it is recommended piling it longer to kill the pathogens. The materials inside the composter would be about 120 to 135 degrees Fahrenheit and 136 to 141 degrees Fahrenheit in the pile. The unit does have a heater, but it is only necessary in really cold temperatures. The final product tested out at 2 percent nitrogen, 8 percent phosphorous, and 10 percent potassium.

In general, the machine was satisfactory, but should not be recommended to anyone until the bushing issue is resolved. The cycle time is nice and keeps up with 4 to 5 percent loss rates. It works very well in summer due to the dryer conditions and it is tougher to keep the mix dry when it is colder and more humid outside. In addition to the mixture not working correctly when it gets too wet, the unit will push out more grease around the bushings and shaft when the recipe gets too wet as well. An auto-greaser is sold for $800, but one was not installed on the machine. The company urges to grease the unit more. It appears that maintaining the proper moisture is important for operation of these units.

Figure 12 Dutch composter

Figure 13 Dutch composter discharge

The advantages are the speed of composting and the lack of bones that come out. No bones or skins were seen in the pile of composted material onsite. The unit added between $50 and $100 a month to the electric bill and maybe a bit more when the heater was being used more often. A concrete pad with concrete walls already existed, so there was no need to create a secondary containment site. An additional cost that this operation did incur was in the construction of a ramp (fig. 14) made of concrete waste blocks and aggregate fill that allows them to dump directly into the unit with a smaller front-end loader/backhoe bucket. If an operator was not the best manager or lived a good distance from where the unit was going to be located, this type of composter may not be the best option.

Ecodrum™

Upper Midwest—In December 2009, NRCS personnel made a visit to a swine operation in the upper Midwest with a recently installed Ecodrum™ in-vessel mortality composter.

The installation consisted of two drums: the loading drum with the hatch (fig. 15) and the discharge drum with the flights in it. All materials and manufacturing on the Ecodrum™ appeared to be high quality and should have no trouble meeting the required lifespan for the Environmental Quality Incentives Program (EQIP). The diameter of the drum is smaller than had been expected. It was not believed to be large enough for a whole animal larger than a sow.

The producer started using the composter in the summer of 2009, and kept records of what was placed in it. Wood planer shavings were used as a carbon source and the first "batch" seemed to work well. Larger bones do come through, but they are very soft. Those are thrown back in and usually decompose during the next cycle.

The mix inside the drum appeared as though the mix probably had too much wood shavings and the material was frozen for the most part (figs. 16 and 17). One

Figure 15 Ecodrum™ loading door

Figure 14 Producer installed ramp for easier access

Figure 16 Ecodrum™ view inside discharge door

hog placed the previous week appeared to be whole and there was very little odor. The area had been experiencing some very cold weather recently (near 0 °F), and the discharge door had stuck open. It appears that the cold air inside may have "killed" the composting action. The producer had fixed the door so it would no longer stick. Two hogs were added and butchering remains from a cow the following day in hopes that would restart the composting process. Rotating the drum in reverse so the flights do not auger material at this time. The timer is set for one revolution every 24 hours.

Regarding the frozen material, it should be pointed out that an additional stop was made in bin-type mortality composter for swine, and it also appeared to be frozen. That composter seemed to suffer from a lack of management and had uncovered animals on the pile. As well insulated as the Ecodrum™ is, it should be able to maintain composting temperatures in cold weather if the mix is appropriate and the discharge door closes tightly.

The producer had constructed a small concrete pad for discharge. Although not a pollution issue, it seems that a small concrete stacking area should be included as a component.

The producer was asked what the plans were in the event of a catastrophic loss. The producer would need to bury them or use a rendering service. This producer was still figuring out the operation of the Ecodrum™, but, in general, was pleased to have a place to go with the mortalities as they occur. This would be a good solution for the operation.

NRCS personnel observations did not change their opinion regarding EQIP assistance for this type of equipment.

Midwest—In April 2010, NRCS personnel visited a swine operation to evaluate an Ecodrum™ composter installed under a pilot project to cost share on in-vessel mortality composters. The operation was then at 2,250 sows, 1,000 piglets per week weaned with an estimated daily mortality rate of 169 pounds per day. The system consisted of one Ecodrum™ 460 unit (fig. 18) 4 four secondary bins. The secondary bins were 12 by 14 feet.

The Ecodrum™ uses a fan to add oxygen while running. Maximum speed is 40 minutes per turn, and recommended operating condition is four turns in each 24-hour period. The composter is mounted level, to reduce stress on the rotating mechanism. The producer has had significant problems with moisture control, and the Ecodrum™ stopped functioning in November 2009. The company made modifications to the design of the installation, adding internal vanes (especially at the beginning of the unit) to move the material in a tighter spiral, improving the roller design for better traction, and providing new doors to correct leaky seals.

The producer restarted the system in April 2010, after the modifications to the design were made by the company. Part of the problem was believed to be due to the fact that this Ecodrum™ had been a display model at several trade shows, and had a fairly significant

Figure 17 Ecodrum™ view inside drum

Figure 18 Ecodrum™ 460 composter

amount of water in the drum on delivery, which was not removed prior to putting the device in service.

For future projects, the producer would recommend narrower secondary static bin widths—maybe a foot or so wider than the bucket of the loading equipment—for ease of management. He would also recommend having a scrape alley or curb configuration at the collection end of the composter unit, to facilitate picking up the primary compost material with the bucket of his loader.

The producer commented that the sows do not need to be cut up when loading into the Ecodrum™. The carcasses are split, but this step will not be required once the operation is successfully up and running.

Southeast—In October 2010, NRCS personnel visited an Ecodrum™ composter recently installed on a layer operation. The drum was set to rotate once in the morning and the evening at about 15 minutes per revolution. A forced air ventilation system exchanged the air during each revolution. The loading rate was well within the stated capacity of the unit, operating at or below the desired three-quarter full height inside the drum. The compost produced was of very good quality with no clumps and very few feathers or bones visible.

In March 2011, a follow-up visit was made by the same NRCS personnel. The owner had experienced larger than normal mortalities and was trying to push a larger volume of birds through the composter than had been seen at the earlier visit. Carcasses were being loaded to a higher level at the entrance door and the drum was being turned more often trying to push more material through the composter quicker. The resulting compost had several clumps and balls of material in the mix. One entire chicken breast was in a semi-cooked state and was rolled and covered with a coating of waste material. The designer should be very cautious when sizing the length of the drum so that it would not be overloaded. The owner should be advised that in a situation with excessive mortalities, he might even have to do some kind of static pile primary composting to avoid overloading the Ecodrum™.

It appears that these horizon drum-type composters do not function well if overloaded, so it will be very important for owners to be realistic about their mortalities and conscious about their actual daily loading rates.

Rotoposter™

No NRCS site visits were made to a livestock operation utilizing the Rotoposter™ system.

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