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Compost by Design

A PILOT PROJECT INVOLVING FIVE COMPOST BATCHES GIVES AN OREGON CITY VALUABLE INSIGHTS TO THE COMPOSTING PROCESS AND VERIFIES CAPABILITY TO PRODUCE CLASS A MATERIAL

By Brian Fuchs

Kristen Preston, city of Albany wastewater superintendent, leads an odor panel as part of the city's project to design a marketable biosolids compost product.

The Oregon city of Albany is assessing ways to improve solids treatment and handling at the Albany-Millersburg Water Reclamation Facility (WRF). The city, in the early stages of exploring composting, implemented a compost demonstration project.

The project objectives included:

- Evaluate the optimal mix ratio by weight and by volume of biosolids to bulking material
- Confirm that the finished product will qualify as Class A Exceptional Quality biosolids compost
- Assess the effectiveness of odor and emissions control from the compost process
- Identify the design, operational and environmental considerations for the process
- Confirm treatment time for system sizing, construction and design for a full-scale operation

The project gave the city valuable information to use in formulating its product and specifying the equipment and process parameters for full-scale compost production. Composting will enable the city to return to beneficial use of biosolids after landfilling most of the material for several years.

> "The city had a successful Class B biosolids land application program for many years and we were looking for an opportunity to return to a beneficial reuse program with the possibility of producing a Class A material that could be more widely used."
>
> **KRISTEN PRESTON, WASTEWATER SUPERINTENDENT, CITY OF ALBANY**

BACKGROUND

Before 2009, the wastewater treatment plant consisted of primary clarification, complete-mix activated sludge treatment, secondary clarification and anaerobic digestion of biosolids. The biosolids were thickened on belt filter presses and stored before land application. The Class B material was successfully land-applied for many years.

The current water reclamation facility, in operation since September 2009, is designed to treat an average flow of 12.4 mgd and a peak wet weather flow of 68 mgd. The liquid treatment stream is processed via headworks screening, a vertical-loop reactor activated sludge system, secondary clarification and chlorine disinfection. Depending on flow conditions and the time of year, all or some effluent is discharged to the Talking Water Gardens wetland for heat load reduction before final discharge to the Willamette River.

The solids are processed in open-air tanks that can operate as interchange reactors (IR) or aerobic digesters, which are fed with waste activated sludge. Since 2009, when the new plant came online, only a small amount of biosolids could be stabilized to meet Class B criteria. The material is dewatered on belt filter presses, temporarily stored on site in covered bins, and then hauled to the Coffin Butte Landfill. The city landfills 180 cubic yards (22 dry tons) of biosolids per week, but intends to return to beneficial use.

TEAM AND TECHNOLOGY

The project team included water reclamation facility staff, Sustainable Generation, W.L. Gore & Associates and Kennedy/Jenks Consultants.

The city selected covered aerated static pile (CASP) composting for the demonstration project. CASP, a forced aeration system for treating blended piles of organic residuals, uses aerobic biological degradation to reduce pathogens and organic solids. Process airflow pushed through the piles provides oxygen to support microbial activity while controlling the pile temperature. The method uses a cover over the pile to control moisture and odor, reduce temperature variation, protect the material from the elements and reduce impacts to stormwater.

The city partnered with Sustainable Generation, a provider of waste conversion products and services to the food waste and biosolids composting markets, to trial the SG Mobile System using the GORE Cover based on positive aeration. The technology is designed to adapt to naturally occurring batch-by-batch variations in feedstock material. The system's oxygen-controlled aeration adjusts its intensity to batch conditions and to changing oxygen demand during the composting cycle.

The microporous GORE Cover is waterproof and windproof and has semipermeable properties that produce a constant microclimate in the heap. Being permeable to water vapor, it influences the extraction of moisture during composting and allows carbon dioxide produced during the process to escape.

A resultant insulating layer of air guarantees an even distribution of temperature in the body of the heap and helps contain odor-causing compounds. The cover is weighted (sealed), creating a complete in-vessel enclosure so that the entire pile can be pressurized, ensuring an even distribution of air throughout the pile.

ODOR EVALUATION

Composted biosolids should not produce significant odors if the compost pile is kept in an aerobic condition. The city conducted a qualitative odor evaluation to test the ability of the CASP process in limiting odors.

Personnel documented the intensity (from not noticeable to overwhelming), and character (pleasant, earthy, offensive, fishy, sewage) of the odor for the feedstocks and at varying distances from the pile during different stages of composting (heap construction, active composting, turnover, maturation and finishing).

The results indicated that while the early stage had higher-intensity odors up close, odors were minimal at a distance. The raw sludge elicited the most negative responses, followed by the heap construction stages and the first turnover of the pile. These results were expected since the compost in the early stages had not been fully stabilized. During an open house with local policy leaders, the final compost products received favorable odor impressions.

Table 1: Comparison of Batch Composition and Process Duration

Parameters	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
Duration (Days)	56	56	55	50	56
Sludge Type	RAS	RAS	RAS	IR	RAS
Bulking Agent (Wood Waste)	Parks/Lane Hog Fuel	Lane Hog Fuel	Lane Hog Fuel	Overs/Lane Hog Fuel	Overs/Lane Hog Fuel
Carbon: Sludge Mix Ratio By Weight	1:2	1:2	1:2	1:2	1:2
Total Weight (Wet Tons)	212	203	202	195	191

Abbreviations: RAS = Return Activated Sludge IR = Internal Recycle

COMPOST DEMONSTRATION

The composting demonstration project used a series of five batches to test different durations, sludges and bulking agents (Table 1). Sustainable Generation and city staff jointly set up the technology and startup of Batches 1 and 2. As the city staff members gained experience, they took over responsibility to run Batches 3, 4 and 5. Kennedy/Jenks provided oversight and collected the data to be summarized in a final report.

On Nov. 5, 2014, Batch 1 underwent Phase I active composting for about four weeks, during which the heap reduced in size from compaction and solids decomposition. On Dec. 3, the cover was removed and the heap was flipped by moving it to the side with a front-end loader and reassembling it in the same location; the goal was to achieve ample mixing and incorporation of the toes of the heap.

The heap was then re-covered and underwent Phase II, maturation (curing) composting, for two weeks. On Dec. 15, the pile transitioned from Phase II to Phase III (finishing), during which the cover was removed and set aside. Phase III normally lasts 14 days, but in this case it was 20 days to accommodate the Christmas holiday. When Phase III was complete, the compost was set aside and stored unscreened for at least four weeks.

Batches 2 through 5 underwent similar processing from January 2015 through August 2015.

(continued)

Batches 1 and 2 were screened using rented equipment to 1/2-inch minus; the screened-out "overs" were used as part of the bulking material in Batches 4 and 5.

The same sludge (waste activated sludge) was used in each batch except for Batch 4, where solids directly from the interchange reactors were used. The demonstration was extended through the summer to check for differences in composting due to varying environmental conditions.

The initial mix is targeted to meet:

- A beginning carbon to nitrogen ratio (C:N) of 25-30:1
- A moisture content of 55-65 percent
- Adequate bulking agent to optimize the mixed material porosity: approximately 3-inch minus shredded wood waste, hog fuel or wood chips

The final compost product is targeted to meet:

- An ending carbon to nitrogen ratio (C:N) of 20-15:1
- A moisture content of below 50 percent
- Carbon dioxide respiration below 1 mg CO_2-C per gram of organic material per day

As the demonstration project moved from Batch 1 to Batch 5, the early batches were used to help:

- Train the operations team to run the technology
- Understand the feedstock components and identify the optimal mix ratio of dewatered sludge to bulking materials
- Understand how the mix ratio would influence the system control settings
- Monitor and record time and temperature requirements to meet Class A requirements

CONCLUSIONS

The biosolids compost demonstration study gave the city of Albany important information about the operational experience of a pilot-level compost system, the equipment required, and the laboratory methods and regulatory requirements of a biosolids compost program. The project documented that sludge from the water reclamation facility can be composted to meet Class A EQ compost regulatory requirements and can be sold as a marketable product. tpo

Table 2: Summary of Compost Characteristics in Batches 1 Through 5

Parameters	Batch 1		Batch 2		Batch 3		Batch 4		Batch 5	
Time of Sampling	Initial Mix	Screened	Initial Mix	Screened	Initial Mix	Screened	Initial Mix	Screened	Initial Mix	Screened
Bulk Density (lb/yd^3)	970	0	1,115	*	873	*	914	*	1,166	*
Moisture Content (%)	57	58	63	58	66.4	43	59.9	33	65.7	40
pH	6.4	5.8	6.4	6.5	6.2	6.5	7	6	7.4	6.1
Organic Matter (%)	28.3	30.7	31.2	30.7	27.7	47.9	32.3	43	28.4	42.1
C:N Ratio	24	25	30	25	19	29	36	17	26	16
Respiration (mg/CO_2/g/day)	*	0.6	7.1	0.6	*	0.8	4.9	1	3.5	0.5
Total N (dry) (%)	1.44	1.56	1.44	1.56	2.17	1.57	1.12	1.85	1.57	2.2
Phosphorus (%)	*	0.51	*	0.45	*	0.69	*	0.50	*	0.58
Potassium (%)	*	0.51	*	0.48	*	0.55	*	0.45	*	0.47

Notes/Abbreviations:

* = Not reported
lbs/yd^3 = Pounds per cubic yard
mg/CO_2/g = Milligrams of carbon dioxide per gram
C = Carbon
N = Nitrogen

Table 3: Summary of Compliance with 40 CFR Part 503 Regulations

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
EPA 503 PFRP Requirements Met(a)	YES	YES	YES	YES	YES
EPA 503 VAR Requirements Met(b)	YES	YES	YES	YES	YES
EPA 503 Pathogens(c)	PASS	PASS	PASS	PASS	PASS
EPA 503 Metals	PASS	PASS	PASS	PASS	PASS

Notes:

(a) Requires the sewage sludge is maintained at 131°F or higher for 3 days
(b) Requires biosolids to be kept under aerobic conditions at temperatures over 104°F for at least 14 days with an average temperature greater than 113°F
(c) Passed for *Salmonella Spp.*

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