

BIOSOLIDS COMPOSTING IN DAVENPORT, IOWA

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ABSTRACT

The City of Davenport, Iowa constructed an aerated static pile composting facility to process 28 dry tons per day of dewatered biosolids and 25,000 cubic yards per year of yard wastes. This is the first large totally enclosed aerated static pile biosolids composting facility to be built in several years in the United States. Design of the facility was completed in March 1994, construction began in July 1994, with substantial completion of the facility in August 1995. This paper outlines the major operating systems and describes the major components of the facility.

The facility processes all of the City's anaerobically digested biosolids which is currently dewatered by belt filter presses to 20% solids. Yard wastes are used as the primary bulking agent supplemented by wood chips and shredded rubber tires to minimize O&M costs. A mechanized continuous feed mixing system consisting of hoppers, conveyors, and pugmill mixers is used to combine bulking agents with the dewatered biosolids to the desired ratio for composting. Composting and drying of these materials occurs in a totally enclosed pre-fabricated metal building for maximum environmental control and odor control. Multiple aeration stations provide both positive and negative aeration through pre-cast aeration trenches beneath compost piles. This aeration design eliminates the labor and material costs associated with using above ground perforated piping for aeration. An engineered trench cover was designed to optimize airflow and distribution beneath compost piles. A centralized temperature feedback control system monitors the composting process for optimal process performance through aeration control. After composting, material is screened and further stabilized using aerated curing prior to product marketing. Odor control at the facility for the totally enclosed mixing, composting, and drying areas is accomplished by treating offgases from these processes using state-of-the-art biofiltration. Screening, curing, and storage areas are covered but not totally enclosed.

INTRODUCTION

The City of Davenport, Iowa operates a 1.14 cubic meters per second (26 MGD) capacity secondary wastewater treatment plant which serves approximately 150,000 persons. Thickened sludge from the treatment plant is anaerobically digested prior to dewatering. The resultant biosolids are dewatered using three two-meter belt filter presses to approximately 20%TS. Historically, dewatered biosolids have been landfilled at the Scott County landfill. Increasing costs and environmental concern over this practice prompted the City to consider alternative biosolids management techniques. After a cursory evaluation of all existing management options, lime stabilization, and composting were evaluated fully. The City visited numerous operating facilities in early 1993 to gather first-hand information about operating performance, costs, and operator friendliness of these operations. It was after this evaluation that the City chose aerated static pile composting as the preferred management method. The design of this facility was initiated in May 1993 with conceptual design completed by August. Final design was begun in October 1993 and completed in March 1994. After receipt of bids and contractor selection, construction began in June 1994. Construction of the facility was completed in August 1995 and is currently composting the biosolids generated at the treatment plant.

The following sections provide a description of the facility, and overview of the major operation system, and the economics of the facility.

FACILITY DESCRIPTION

The facility utilizes aerated static pile composting technology to process dewatered biosolids from the treatment plant. The composting facility is designed to process 25.4 dry metric tons (28 dry tons) per day of 20% total solids digested biosolids cake on a five-day per week operating basis. In addition to managing biosolids, the facility is designed to manage up to 19,115 cubic meters (25,000 cubic yards)

per year of yard wastes. Figure 1 shows the process flow diagram for the facility.

The compost facility is located on a 15 acre rectangular parcel of land immediately south of the wastewater treatment plant (WWTP). This parcel abuts a railroad yard to the West and the Mississippi River to the East. City owned property on the Southern border creates an additional buffer area to the only residential area within one-half mile of the site. A 1.8 meter (6 feet) high, 1,067 meter (3,500 feet) long levee completely surrounds the site to prevent flooding during a 100-year flood event. Figures 2 and 3 show the site plan and compost process building.

Materials Handling and Mixing System

In order to achieve the desired moisture content, porosity, carbon to nitrogen ratio, and porosity of the compost mix, bulking agents must be blended with the biosolids. The materials balance was based on obtaining a 40%TS compost mix with a 3:1 bulking agent to biosolids volumetric mix ratio. In order to obtain the desired compost mix, yard wastes must be supplemented with wood chips since not enough quantity of yard wastes are available to serve as the bulking agent. In addition, yard waste production is very seasonal in its quantity and relative makeup of grass, brush, and leaves. To minimize the quantity of purchased wood chips required, shredded rubber tires are used. Approximately one-third of the bulking agent requirement is made up of shredded rubber tires.

Yard wastes are delivered by private and public vehicles to an outside paved storage area. Yard waste material requiring size reduction is ground with a tubgrinder prior to use as a bulking agent. Wood chips and shredded tires are delivered by commercial trucks and stored under cover in the bulking agent storage area.

Dewatered biosolids are hauled via dump trucks from the WWTP to either of two biosolids receiving bins. Each bin has a capacity of 50 cubic yards (CY) with the combined bin capacity of storing over one-half days biosolids production.

Mixing of the bulking agents with biosolids is accomplished by an automated continuous feed system. This process occurs in a totally enclosed building. Biosolids are introduced to the system from either of the two 50 cubic yard live-bottom bins. Each bin has nine 12-inch diameter screws forming a live bottom. Bulking agents are added to the system through either of two 20 cubic yard bins. Each of the bulking agent bins consists of four 12-inch diameter screws forming a live-bottom. Each of the live-bottom bins has a variable speed discharge rate which is automatically controlled by weight belt sensors connected to the facility computer control system. The operator can vary the quantity of biosolids and/or bulking agent based on adjusting the mix ratio set point. A total of four screw conveyors and three belt conveyors transport the material from either of the bulking agent or biosolids bins to either of two continuous pugmill mixers where the material is thoroughly blended into a homogeneous mixture. The resultant blend is conveyed by belt conveyor and discharged into a concrete bunker located at the south end of the composting facility.

Odor Control

Because of the high priority to effectively manage odors at the facility, all building and process exhaust from the mixing and

composting buildings is collected and scrubbed through two large biofilters. A total airflow of 5,947 cubic meter per minute (210,000 CFM) is exhausted from the building by eight 75 horsepower blowers to provide 12 air changes per hour. Each blower has a variable frequency drive to allow the operator to reduce the number of air changes when the building is not occupied.

Each of the two biofilters is sized to treat 2,974 cubic meter per (105,000 CFM) of exhaust gas at a residence time of 45 seconds. A 1.25 meter (4 feet) deep mixture of yard waste compost and wood chips is used as the biofilter media. Each filter is divided into four independent zones with an individual blower and control system for each zone. This allows for redundancy during scheduled and unscheduled maintenance activities. Moisture control for the biofilter system is provided through in-line humidification nozzles and surface irrigation.

Compost Aeration System

Composting of the biosolids occurs in a 6,130 square meter (66,000 square foot) building which is totally enclosed and insulated. A 12 meter (40 foot) wide central access aisle separates the east and west aeration zones. Pre-cast polymerized concrete trenches are placed six feet on center to provide aeration to the compost piles. This eliminates costs associated with placing aeration pipe beneath the piles. The facility design allows for a 0.3 meter (1 foot) base of wood chips to be placed over the aeration trenches followed by 3 meters (10 feet) of mix and a 0.3 meter (1 foot) insulative cover of recycled compost. Compost piles are 27 meters (90 feet) long. A custom-designed hole pattern was used in heavy duty ductile iron covers to provide uniform aeration down the length of each trench. Four trenches are serviced by one of 24 aeration stations each capable of providing 39.6 cubic meters per minute (1,400 CFM) at 20 centimeters (8 inches) of water column. Each blower station is capable of operating in induced draft (negative) or forced (positive) aeration mode, depending on operator preference and the stage of the composting process. Negative aeration is practiced for the first 10 days of the composting process with exhaust gases being collected and vented directly to biofilters for treatment. The blowers are then switched to positive aeration mode for the remainder of the 21-day composting cycle to enhance drying. Offgas from the compost piles and the building are collected via centralized ducting for treatment with the compost pile exhaust through biofilters.

The aeration rate is controlled with a temperature feedback control system that is operated through the facility computer. Up to four aeration rates can be provided for each individual compost pile based on variations in blower run times (on/off cycles). Three thermocouples placed in the pile provide temperature readouts with one thermocouple selected as the temperature feedback control thermocouple. In this way, the oxygen, cooling, and drying requirements for each individual pile can be controlled independently of other piles. This automated system eliminates labor costs associated with recording pile temperature data.

Allowance for up to five days of aerated drying is provided in the composting building for periodic times when additional drying

is necessary. This area also serves as a yard waste pre-aeration area when large quantities of grass clippings are received.

An additional area under cover is provided to cure the compost. Aerated curing is provided utilizing portable blower stations and reusable perforated pipe. This area is sized to handle 30 days of screened compost production. Cycling timers control aeration cycles during this stage of the process.

Screening

After composting, a 1.8 meter (6 feet) diameter by 11 meter (36 feet) long trommel screen is provided at the east end of the compost building. Material is fed into an 11.5 cubic meter (15 CY) live-bottom bin by front-end loaders. This bin is located inside the compost building and discharges onto a belt conveyor which conveys material through the building wall to the trommel screen. An unders collecting conveyor and two stacking conveyors build a pile of 3/8-inch minus compost and a pile of overs. The overs are recycled and used as bulking agent. The screen system has a variable feed system capable of processing between 0 to 140 cubic yards per hour.

ECONOMICS

The entire composting facility was constructed for a cost of \$8.2 million, including all sitework, structures, stationary equipment, front-end loaders, engineering, permitting, and construction administration.

O&M costs for this facility are estimated to be \$120 per dry ton of biosolids processed. These estimates also include the cost of yard waste processing. Currently, ten full-time and two seasonal employees are planned to operate the facility.

CONCLUSIONS

The City of Davenport, Iowa has developed a unique biosolids composting facility capable of processing their entire biosolids production, as well as yard waste production. A completely automated mixing system provides for efficient operations and optimal control of materials receiving and handling processes. Total enclosure of crucial components of the facility allow for good process control and odor control. The aeration system which included the aeration trench and computer controlled temperature feedback system provides tremendous operator flexibility in controlling the process and providing significant labor savings.

This facility demonstrates how a composting system can be developed to manage both biosolids and yard wastes in an acceptable manner and at a reasonable cost.

Figure 1
City of Davenport Compost Facility
Process Flow Diagram

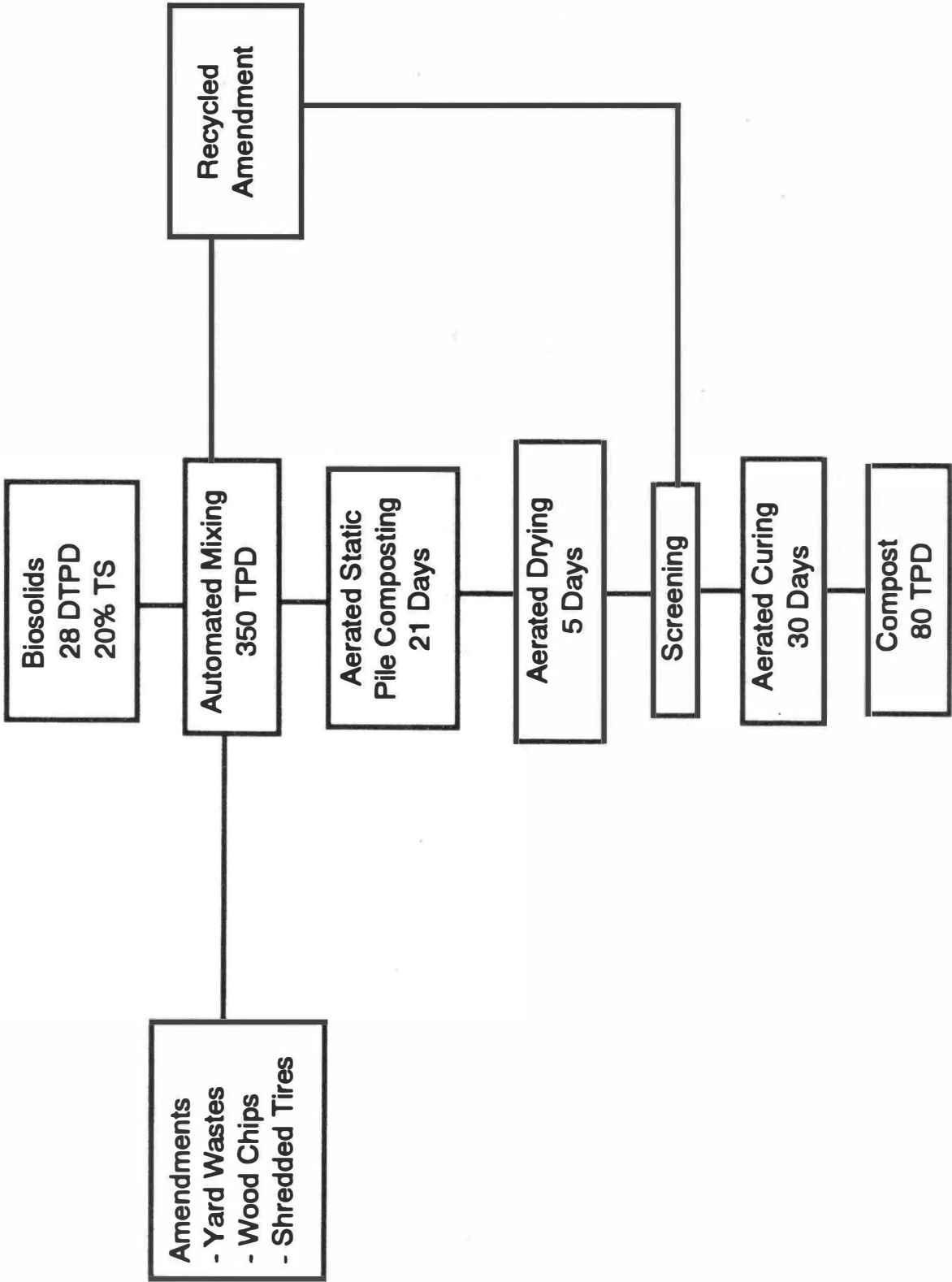


FIGURE 2 - CITY OF DAVENPORT
COMPOST FACILITY SITE PLAN

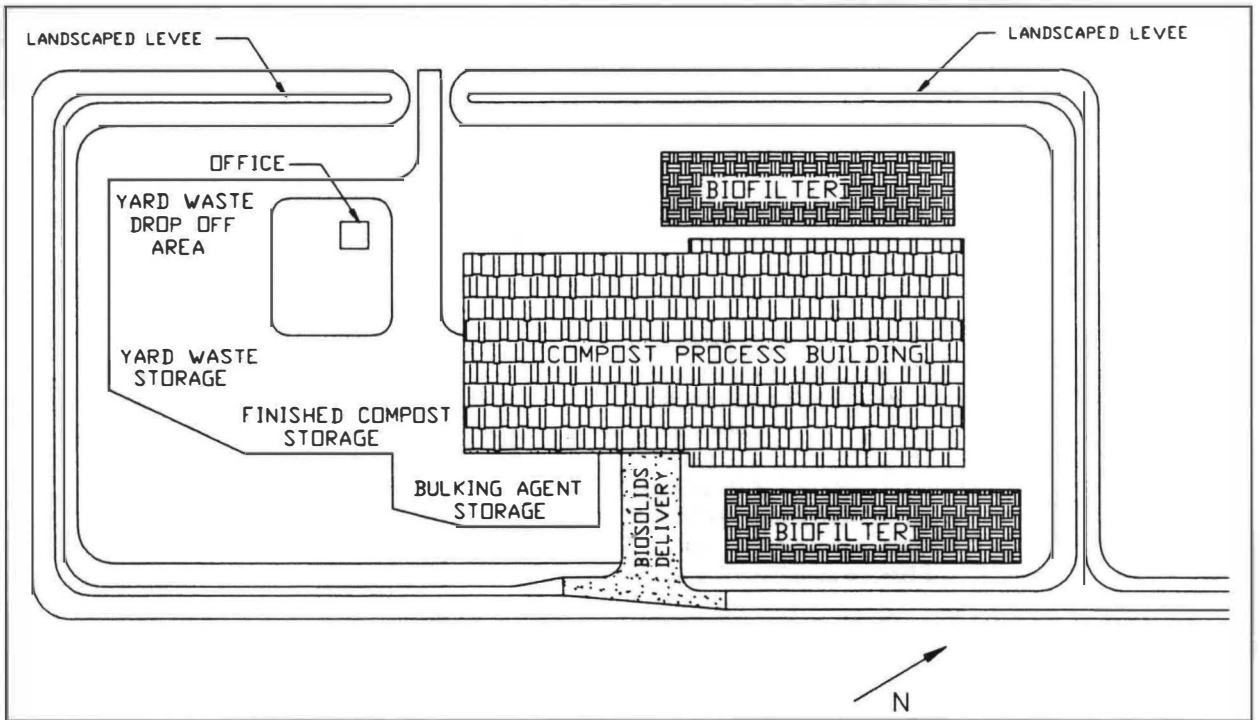


FIGURE 3 - CITY OF DAVENPORT
BIOSOLIDS COMPOST PROCESS BUILDING

