CONTENTS

Spain

Comparison Between In-Vessel And Turned Pile Composting Systems

Researchers in the Catalonia region of Spain analyze methods at 14 composting facilities there for temperature, oxygen concentration and moisture.

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CATALONIA in northeastern Spain, with a population of over six million, is a well-developed and industrial region where the most important city, Barcelona, and its metropolitan area, has three million people. Municipal solid waste (MSW) produced in Catalonia reached over 3.4 million metric tons in 2000, and its destination has traditionally been sanitary landfill or incineration. One special case is the landfill in Garraf (25 km from Barcelona), destination of most of the garbage generated in Barcelona and surrounding towns, which receives approximately 900,000 metric tons of MSW per year.

In recent years, pressure from the general public has been focused on the closing of this 30-year-old sanitary landfill. After several delays, it seems that the facility will be definitively closed in five years.

New Regulations From The European Community

New regulations from the European Directive on the Landfill of Waste, 1999 and Spanish and Catalan laws in reference to organic matter (OM) in MSW (which contains approximately 45 percent of OM) have promoted development of separate collection systems and the construction of new composting plants. At present, 14 composting plants are in operation or in final stages of construction in Catalonia, with a total capacity of over 300,000 metric tons/year. These new MSW processing plants include the "Ecoparcs" where recyclable fractions such as paper, cardboard, plastics and metals will be separated, and the OM fraction will be composted or anaerobically digested. (The operation in Catalonia is commonly referred to as "Methanization.") Ecoparc facilities, jointly with new composting plants, will replace sanitary landfills in the coming years to a large extent.

Composting Systems In Catalonia

Composting has been used in Catalonia as a garbage treatment for several decades. Nevertheless, the first developed systems were based on the aerobic decomposition of mixed MSW in low controlled conditions. The presence of large amounts of nonbiodegradable wastes such as plastics, and the fact that toxic residues (e.g. batteries) were often found in domestic garbage, resulted in a low quality final product, which could hardly be labeled as "compost." Bad practices in composting systems pro-

The main composting systems used in Catalonia are mechanically-turned piles (above) in rural or semirural areas, and in-vessel systems (above, right) in urban and high-density population areas.

duced a negative effect on the reputation of compost and composting, and today these former installations have been closed.

In the nineties, this situation radically changed when Catalan authorities (especially the Environmental Department of the Catalan Government), following EC directives, promoted construction of modern composting plants in Catalonia. Their aim was to obtain a high quality compost, which could be used as source of OM in agriculture and nursery. These new plants operate at present in Catalonia, and process basically household source separated food residuals and green residuals, which include yard and pruning wastes often used as amendment or bulking agents. Recently, new composting plants have started up for the processing of biosolids from urban wastewater treatment plants. The generation of these wastes in Catalonia reached 2.5 million metric tons in 2000.

The main composting systems used in Catalonia are:

Mechanically-turned piles: For rural or semirural areas, usually plants with a capacity range of 4,000-35,000 metric tons/year. This traditional composting method was implemented in the first composting plants constructed in Catalonia, and is based on the use of windrow composters that periodically mix an open pile. Temperature, moisture and oxygen content inside the material are monitored daily during the first weeks of composting (thermophillic initial phase), and weekly during the curing phase (mesophillic final phase). Total composting time is usually about 12 to 13 weeks.

In-vessel or reactor systems (called 'tunnel' systems): For urban and high-density population areas, plants range from 8,000 to 50,000 metric tons/year. In this case, material remains for two weeks in a tunnel digester with forced aeration systems and on-line monitoring of temperature, oxygen, carbon dioxide and ammonia exhaust gases. Data from different probes are computer collected and some control recipes can be applied to the system, usually in the form of temperature and oxygen setpoints, allowing a rapid decomposition of OM. Afterwards, material is piled for the curing phase for five to six weeks.

Figure 1a. Evolution of temperature in the turned pile

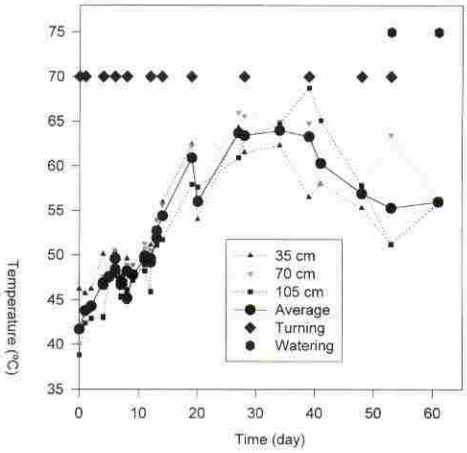
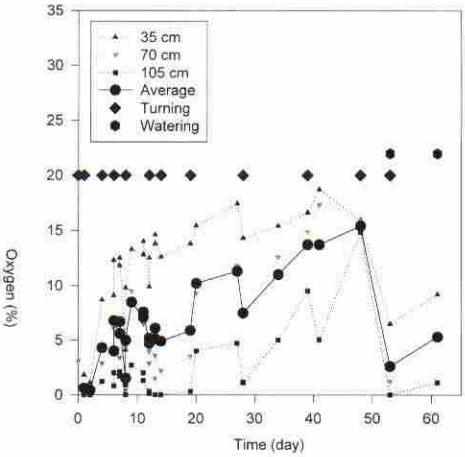


Figure 1b. Evolution of oxygen in the turned pile



Objectives Of The Project

A project to compare both composting systems was proposed. A mechanically-turned pile and a tunnel of separately collected OM (approximately 100 metric tons each) were operated with identical starting conditions in a composting plant located in Sant Cugat (10 km from Barcelona). Initial material was composed of two parts of household food residuals and one part of pruning residuals used as bulking agent. Differences between both composting systems were studied and evaluated in terms of composting parameters such as temperature, oxygen concentration and moisture. The intent of the project was primarily to determine the efficiency of the controlled

Figure 2a. Evolution of temperature in the tunnel

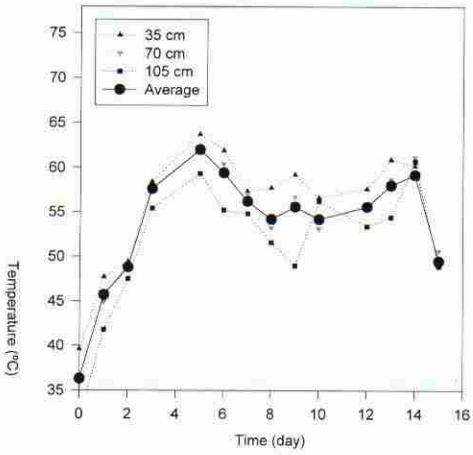
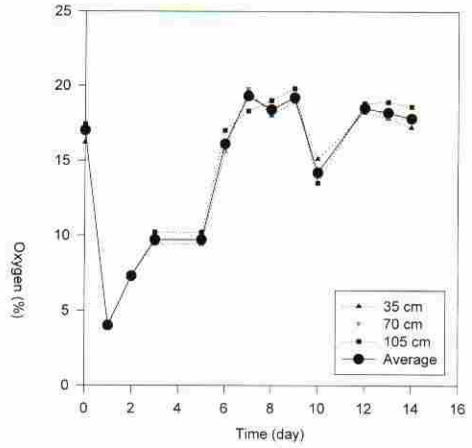


Figure 2b. Evolution of oxygen in the tunnel



tunnel system in the acceleration of the thermophillic phase, which would reduce the space needed for composting, a crucial aspect in high population density areas, such as the Barcelona Metropolitan Area. At the same time, temperature and oxygen profiles at different points of pile and tunnel materials are determined in order to compare both systems in terms of material homogenization.

Comparative Results

Temperature and oxygen

Temperature and oxygen content were calculated as an average of six sample points taken from the material pile. At the same time, temperature and oxygen contents were determined at three different points of 35, 70 and 105 cm deep for both tunnel and mechanically-turned pile. Results are presented in Figure 1 and 2 for both composting systems. In Figure 1a (turned pile), it can be observed that temperature reached a full thermophillic range (55°C) at day 20, whereas in the case of tunnel system, this value of temperature was found at day five. On the other hand, thermophillic temperatures were maintained in both systems for enough time to permit effective pathogen elimination.

Temperature dispersion in the tunnel system is significantly higher than in the case of the mechanically-turned pile. For instance, standard deviation for temperature values in tunnel material is about 5 to 6°C for all the points tested, whereas in the turned pile is always under 3°C. As expected, this fact implies that a better homogenization is provided by nonstatic composting systems. On the other hand, temperatures at the end of tunnel composting are over 50°C (Figure 2a), which indicates that a 15-day period may not be enough time to finish the thermophillic phase.

In reference to the oxygen content, it must be pointed out that important differences are observed between the studied systems. Thus, oxygen levels in the tunnel are in any case over ten percent, which ensures a complete aerobic decomposition of OM provided by forced aeration and on-line control of oxygen content (Figure 2b). On the other hand, turned pile is often under five percent of oxygen, and in the deepest samples, no oxygen is detected (Figure 1b). Usually, the lowest oxygen concentrations are determined just before turning. This fact seems responsible for the low decomposition rate found in the turned system (which implies longer total composting time), and for the lower temperature values. One possible improvement in this system might be an increase in the frequency of turning at the beginning of the composting process; however, punctual determinations of oxygen content after turning showed that oxygen content becomes limited in approximately one hour.

Moisture content

Moisture is an important factor that can be limiting in the composting processes. In the studied systems, moisture content is off-line analyzed and controlled by watering the material. This control permitted moisture content of the material at initially 53 percent, and the final content was 50 and 48 percent for turned pile and tunnel material, respectively. All these values are within the considered optimal values for composting systems (40 to 60 percent).

Odor control: The tunnel system appears to be the most appropriate in populated areas with limited space, since invessel systems allow collection of exhaust gases and its treatment. In Catalonia, gas treatment is often carried out by means of scrubbers followed by biofilters.

Leachate collection: Tunnel systems usually dispose of some pumping to return the collected leachates and water the material.

Flexibility of the composting systems: At this point, no definitive results can be concluded. On the one hand, the control of the process is developed in tunnel systems, which would theoretically permit a more flexible system which can be adjusted to different wastes. For example, livestock manure in Catalonia, is produced in an amount of over 19 million metric tons. On the other hand, however, the limitation of a static system such as tunnels can be an insurmountable factor in composting some wastes. In fact, invessel composting facilities with some agitation system are being tested for the composting of sludge from wastewater treatment plants.

System Selection

Differences between the composting systems operating in Catalonia have been determined. Of special interest is the fact that a proper oxygen content cannot be achieved in the mechanically-turned pile systems, which leads to a lower decomposition rate, when compared to a tunnel system.

Despite this different behavior, both studied systems were suitable for the composting of OM, although a more effective process and odor control, leachates production management and vector control could be achieved in the tunnel composting experiment. Since both composting systems are technically feasible, the selection must be based on economic and space limitation considerations. ■

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