SLUDGE AND YARD WASTE CO-COMPOSTING: IN-VESSEL SYSTEM DEVELOPMENT

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ABSTRACT

As municipalities address development of new, integrated solid waste management programs, two waste streams that can be co-disposed are wastewater treatment plant sludges and yard waste, including leaves, grass clippings[1] and brush and woody wastes. One attractive solution is to consider co-composting these organic wastes, using processed yard waste as a bulking/amendment agent for the sludges. Technical issues are identified for consideration in the planning and procurement of an in-vessel facility to manage these waste streams. Items to be addressed are facility sizing, management of incoming sludge and yard waste materials, mixing the sludge/amendment materials, process evaluation, and facility design considerations. Also included is a discussion on approaching product quality control within a system procurement and special problems that arise for consideration with a regional facility.

INTRODUCTION

Historically, municipal wastewater sludges have been disposed along with mixed municipal solid waste, or incinerated. As landfills close and incinerators become overloaded or require replacement, many municipalities have realized that implementation of a co-composting facility that will manage wastewater treatment plant sludge, together with processed yard waste (brush, leaves, and grass clippings), represents an effective, environmentally and politically acceptable management option. The purpose of this presentation is to identify and discuss principal issues which are associated with the planning and implementation of such a facility. In general, "in-vessel" systems are those where the sludge-yard waste compost mixture is composted in an enclosed or semi-enclosed vessel.

In-vessel systems are increasingly attractive to project developers since they offer a greater opportunity to control environmental impacts, such as odor generation, and are well suited to reliable, year-round operation in all climates. Open windrow or static pile composting systems, although well proven, often require larger sites without sensitive adjoining land uses, and can be impacted by sustained rainfall conditions, which can alter the processing schedule and require longer retention times by adding too much moisture, and which can result in significant quantities of site runoff requiring collection and treatment.

At the same time, there are several vendors of distinctly different proprietary, in-vessel systems in the marketplace, all willing to provide co-composting systems and equipment components. Table 1, below, identifies some of the major systems currently available in the U.S., with corporate sponsors generally participating in public procurements.

With different systems, developers of projects can expect to encounter different amendment requirements,

[1] Note: grass clippings have a high moisture and Nitrogen content, and will therefore be limited in the amounts that can be introduced into a process, and must be supplemented with other, more desirable amendments.

TABLE 1 TYPICAL IN-VESSEL COMPOSTING SYSTEMS

VENDOR/COMPANY	TYPE OF SYSTEM
International Process Systems (Wheelabrator)	Agitated Bed Reactor
Royer Industries, Inc.	Agitated Bed Reactor
Ashbrook-Simon-Hartley	Horizontal Plug-Flow Reactor
American Bio Tech	Vertical Plug-Flow Reactor
Taulman Composting Systems	Vertical Plug-Flow Reactors

material handling systems, vessel design, and approaches to managing the composting process. Anticipating the differences between the systems and providing a well framed request for proposals can help in the procurement process.

Equally important, but an area often overlooked, is the need to provide for the proper handling and management of the composting amendment materials, namely the yard wastes.

SIZING FACILITY PROCESSING CAPACITY

Two distinct options may be presented to developers for sizing the throughput capacity of an in-vessel system to manage sludge and yard waste:

(a) To size the facility to meet the current and projected volumes of sludge to be produced, plus the minimum required amount of yard waste/amendment necessary to provide good composting conditions,

(b) To size the facility to meet the total quantities of sludge, plus all projected volumes of yard wastes available in the project service area.

For urban areas, where property owners dispose of the majority of yard wastes produces, and which enjoy a well-organized collection program, more yard wastes may be available and delivered to the facility than would be strictly necessary for use as an amendment for sludge composting purposes. (Note: records on the amount of yard wastes generated and collected in the service area may be incomplete, and planners may need to rely upon estimates, based upon per capita generation rates. One source is the U.S. EPA, and their published municipal solid waste characterizations [1]. As additional information, the author reviewed [2] the reported generation rates for the Town of Fairfield, Connecticut, and found approximately 108 lb per capita per year of leaves and grass clippings were collected, and over 100 lb per capita per year of brush and wood wastes were received at their composting site.) As a result, planners should deliberately approach this decision.

Sizing the facility for more capacity than needed or desired will result in unnecessary capital cost. Consequently, it is important to identify the processing goal for the facility, and to project the quantities of material to be managed. From a planner's perspective, project developers may benefit from sizing the facility for the amount of sludge projected to be generated (plus the corresponding required amounts of amendment). Generally, alternatives for management and disposal of yard wastes may be found, and this strategy will result in minimum capital cost.

As a related issue, waste water treatment plant operators should consider upgrading their facilities to increase the solids content of their sludges, since this will reduce the volumetric sizing of the composting facility. Sludge with a lower percent solids content will require more bulking agent/amendment to achieve the same composting condition (percent moisture), thus requiring a larger capacity facility than one processing the same number of dry tons per year, but at a higher percent solids, as-received. These issues involve not only the technical requirements of the facility, but also policy considerations, such as the desired future capacity of the facility.

MATERIALS MANAGEMENT/HANDLING

Planners should also insure that sufficient space is available to properly handle, manage and store the sludge and yard waste deliveries to the facility.

Yard Waste

Due to the seasonal nature of yard waste generation, considerable space needs to be allocated to storage of this material. In particular, leaves (which can represent between one-third and one-half of the total yard waste deliveries) will arrive during a 2–3 month period in the fall. (Note: consider banning the use of plastic bags in yard waste collection programs, since this material is not degraded in the composting process and detracts from product value.)

Although sometimes presenting operational challenges to the operator (clogging), it is recommended the leaves be processed through a tub grinder prior to composting, in order to produce a uniform size material, and to process woody yard wastes that may be co-mingled. Wood wastes that arrive can be stockpiled as-received, or processed with a tub grinder to reduce the amount of storage space required.

For use as a planning guide, a facility designed to process approximately 4000 dry tons per year of sludge should consider providing 10–12 acres of space for yard waste receipt, processing and storage. From an annual quantity perspective, a compost system which utilizes yard waste as its sole amendment (sludge bulking agent) may consume approximately 2.5 tons of yard waste for each wet ton of sludge (at 18–20% solids.)

Sludge

Sludge introduction into most composting systems will typically be on a batch-fed or part-time basis, and not continuous. Consequently, provisions may be necessary to temporarily store sludge delivered to the facility if the facility is regional and receives sludge deliveries by truck from other users, or if the facility is removed from the wastewater treatment plant site. Two practices may be employed: to accumulate the sludge in a special vehicle designed to mix the sludge and amendment materials; or to place the sludge into a storage bin or area, for subsequent metering into the process. Which of these two procedures best suits a given project application may be dependent upon the size of the facility, the operating schedule, and the proximity of the composting site to the treatment plant. The author prefers use of a bin system for regional facilities, since it allows for a design that eliminates double handling the material, the bin can be designed to contain odors, and it may be sized to accommodate truck traffic on an as-received basis.

Product Storage and Enhancement

The facility should provide for storage of at least one week's generation of compost on-site, and it is recommended the sponsor have available at a nearby location sufficient space to provide at least 3, and ideally 6, months storage of the compost product, where seasonal markets are relied upon, such as agricultural and landscaping customers.

Whether the compost product is screened prior to delivery to market will likely be a function of market needs, rather than one that relates to the compost system and its design. Insure that provisions are made in the layout of the facility to provide for addition of a product screen (trommel) if determined to be necessary at a later date.

SELECTING THE COMPOSTING PROCESS

Several different types of in-vessel composting systems are offered, as previously identified on Table 1. Except for two, each of the systems identified represent different technological approaches.

TABLE 2 RECOMMENDED MAJOR IN-VESSEL SYSTEM SELECTION CRITERIA

CRITERIA	DISCUSSION
Experience	Has the proposed technology demonstrated successful operations at a scale comparable to the project?
Process Flexibility	Process Flexibility can be expressed from three different perspectives; a. can the system accept sludge at varying solids levels; b. can the system incorporate yard waste of varying moisture content levels, and texture, and; c. does the system allow for changes in the operating schedule, such as modified retention time, etc.?
Yard Waste Requirements	Does the system allow for utilization of sufficient quantities of all types of yard waste? Is it dependent upon use of compost product "recycle", and is this a requirement?
Monitoring & Controls	Does the system offer proven, reliable equipment and systems for the automatic monitoring, recording and control of temperature and air supply to the composting process? What is the anticipated retention time, under planned conditions, with the system? Has the process air handling system been properly designed, and is sufficient capacity and horsepower provided?
Interruptability	Can the system provide for ease of interruption of the composting process, in the event the operators wish to respond to contamination, or process failures, etc.. In such event it will be important to be able to segregate the questionable material, and to re-start the process?
Environmental Issues	Does the system allow the facility to be designed to provide for process and facility exhaust air collection and treatment?
Net Annual Cost	How does the annual amortized capital cost, together with the operating and maintenance expenses for each alternative system compare?
Expandability	Does the system allow for expansion, or increasing the amount of material processed? How is the expansion achieved, through modular expansion, or changes in operating procedures, such as reduced retention time?

Since the different technologies offer unique design approaches, the issuance of a well developed request for proposals is important in order to assure the sponsoring municipality it will obtain a properly planned facility. In approaching the procurement and selection of a system for a specific project, the criteria offered on Table 2 are recommended for use. These are the major issues to be considered, and are not meant to replace or to exclude a more detailed review of any specific system proposal. In undertaking a comprehensive system vendor proposal, it remains advisable that all process and materials handling systems be thoroughly reviewed.

Product Quality and Process Conditions

In order to provide assurance the compost product will be marketable, and to minimize the risk and liabilities that are associated with its use, it is recommended that public sponsors seek to insure the system meets the "PFRP" requirements (Process to Further Reduce Pathogens, as defined by the U.S. EPA). Although the requirements are under review, and may be changed in the future, at the time of this writing the essential requirement for composting systems is that the composting mass be brought to and maintained at operating temperatures of 55°C or greater for 3 days [3]. PFRP processes effectively reduce bacteria, viruses, and helmuth ova to below detectable levels. Various states have, or can be expected to have in the future, regulations which may expand on this basic requirement, and which will provide direction on how the material can be utilized, including miscellaneous requirements for tracking and record-keeping. New York State, for example, has a good example of specific regulations directed toward sludge composting programs [4].

Other than insuring the process has been completed in conformance with PFRP, another control factor is the need to monitor and maintain the moisture content of the final product. For ease of handling, and to maximize marketability of the product, it is recommended the product achieve a minimum of 50% solids at the completion of the composting process. Project sponsors are often concerned about the concentration of metals in the final product. Since this is a function of the metals content of the sludge, itself, and is not affected by the composting process, this is generally not a factor in procuring and selecting a system technology or vendor.

SLUDGE SYSTEM PROCUREMENT

As with the procurement of any representative solid waste facility, it is recommended that the request for proposals elicit detailed information regarding the proposed facility, sufficient to support selection of a firm for negotiations. For a sludge/yard waste composting facility, the following items should be called for, in particular, by the request for proposals:

(a) Proposed site plan for the specific project, and equipment layout.

(b) Process diagrams.

(c) Mass and energy balance diagrams.

(d) Description of the process control systems, with particular focus upon the method utilized to control temperature of the composting mass and the provision of sufficient oxygen for maintenance of the biological process.

(e) A description of how the facility will measure and control moisture in the composting mass.

(f) Description of the blowers to be utilized for providing process air, the number of zones in the compost system, and the horsepower rating of each unit.

(g) Proposed method of collecting and treating spent process off-gases.

(h) Method and equipment proposed to manage the receipt of incoming sludge and amendment, its mixture, and introduction into the process equipment.

Special Considerations

In addition, the following issues require special consideration in the procurement of a sludge-yard waste compost project, as distinguished from other typical solid waste systems:

(a) Amendment specifications, types and quantities.

(b) Process retention time.

(c) Facility processing capacity.

The types and amount of amendment materials (yard wastes) available to the compost system may impact system selection. Certain vendor technologies are designed to accept only processed wood chips as the sludge amendment/bulking agent. In the event the project is intended to accept and process leaves and grass clippings in quantity, then such a system would not meet its intended needs. As a result, it is recommended that your procurement document clearly identify the types of yard wastes which are to be managed, in addition to sludge, and the target quantities for each. Since some systems are sensitive, and respond differently to varying types of yard waste (moisture levels, bulk density, etc. will change dramatically from leaves and grass clippings, to wood chips), it is advised that any test of the system, intended to serve as a performance/acceptance test at the end of construction, include separate trials with each of the types of yard waste intended to be processed.

The intended retention time (the period of time the sludge/amendment composting mass is in the system) of the processing system should also be provided in the procurement document. If the intent is to have a largely stable, mature product, which has been subjected to 20 days of controlled composting environment, then the document should state this as a minimum requirement. If not, then vendors may respond by providing a system offering control of the composting activity for a minimum of time (say to meet the PFRP status only), and then expect the operator to be responsible to manage final curing of the compost mass outside the controlled environment of the system design. The incentive to provide such an approach results from the capital cost savings that result (the system would be smaller), and the desire to be the lowest cost proposer. However, this does not provide a system which will meet the needs of the project sponsor.

Facility processing capacity can be stipulated in the procurement document in tons per year, per week, as wet or dry tons of sludge. Once the proposals are received, it will be necessary to check the volumetric capacity of the system, as compared to the desired capacity of the system, and taking into consideration the mass balance of the specific technology, and the representative bulk densities of the amendments to be used. This analysis will be important to insure that the system is truly able to process the desired quantities of material.

Regional Considerations

Many future sludge composting systems will be designed to serve more than one treatment plant, which may involve one or more municipalities. In approaching such a regional facility, consideration should be given to the following issues, which may impact design or operational plans:

(a) Sludges from different wastewater treatment plants may have different solids contents, requiring different amounts of amendment.

(b) Different municipalities or regions may contain concentrations of industries, and certain sludges may represent greater risk of contaminating the compost product, and interfere with good marketing programs and cost effective use of the product. If this is the case, it may be desirable to be able to segregate this material, and separately process it. Certain process systems are likely to be more compatible with this goal.

SUMMARY OF FACILITY DEVELOPMENT PROCESS

An attempt has been made to present the development process, and associated issues and decisions, in schematic form, presented on Fig. 1. Project planners are advised to proceed through the initial project definition stage, and then to procurement of the vendor and process best able to meet the minimum goals of the project, at reasonable cost.

It is understood that developers are rarely presented with an opportunity to optimize all features of a project. Even for those circumstances where the site is initially presented as a given, the project planner is advised to follow the path presented, as a means to verify whether the predetermined site is adequate to meet the goals of the project.

CONCLUSIONS

Co-composting of wastewater treatment plant sludge and yard wastes can represent an environmentally acceptable method of managing these two streams. Numerous technologies are offered for disposing of this material, offering different approaches to managing the compost process, and material flow. Public sponsors should carefully approach the development of project, and selection of specific systems, to insure their specific needs are met.

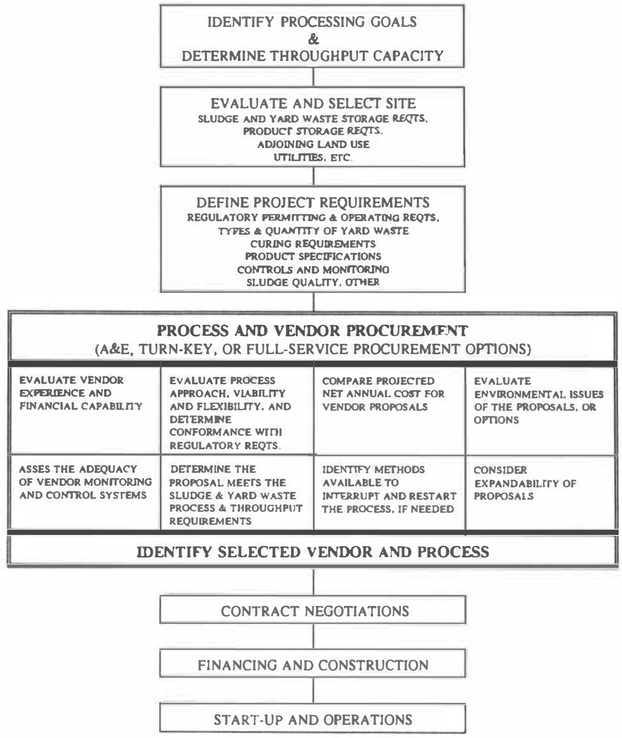

FIG. 1 PROJECT DEVELOPMENT SCHEMATIC (Sludge and Yard Waste In-vessel System)

Special issues to consider in planning your co-composting project include selection of the appropriate technology, planning facility space requirements, sizing the facility, and materials receipt and processing.

In selecting and procuring the system, issues to be considered include but are not limited to process flexibility, provisions for monitoring and controls, interruptibility of the process, environmental issues, net annual cost and expandability.

REFERENCES

[1] "Characterization of Municipal Solid Waste in the United States: 1990 Update," NTIS #PB90-215112. Washington, D.C.: U.S. Environmental Protection Agency, June 1990.

[2] "An Overview of Wastewater Sludge Disposal Alternatives for the Wallingford Project Area," prepared for the Connecticut Resources Recovery Authority, by Project Management Associates, Inc., dated May 25, 1990.

[3] "Environmental Regulations and Technology, Control of Pathogens in Municipal Wastewater Sludge," EPA/625/10-89/006, Cincinnati, Ohio: U.S. Environmental Protection Agency, Center for Environmental Research Information, September 1989.

[4] "6 NYCRR Part 360 Solid Waste Management Facilities, Title 6 of the Official Compilation of Codes, Rules and Regulations, Subpart 5," New York State Department of Environmental Conservation.