Bulking Agent Selection in Sludge Compost Facility Design

The authors propose recycled compost as an alternative to wood chips as a bulking agent, and urge more research "in demonstrating this approach for both economic and environmental reasons."

T.G. SHEA, Ph.D., J. BRASWELL, and C.S. COKER
PRC Toups Corporation
Rockville, Maryland

BULKING AGENT selection is a critical factor in the engineering of sludge composting facilities incorporating the aerated-static pile method for the reasons that:

(1) The selected agent must serve to "balance" the mix being composted in terms of moisture and nutrient composition, and must impart free air space and porosity to the mix to ensure uniform air flow.

(2) The selected agent impacts on the quantities of materials handled and, if the replacement cost is such, mandates the recovery by screening to minimize overall net cost.

(3) The selected agent itself may decompose biologically in the process, not only increasing the quantity and cost of makeup but also serving as a substrate for certain microorganisms with undesirable characteristics.

Fig. 1. Example of sludge-wood chip mix with acceptable porosity and free air space. (Photo courtesy of Washington Suburban Sanitary Commission.)

(4) The selected agent may itself be a commodity as well as a byproduct, and as such be subject to price escalation far greater than the current rates of machinery and labor cost inflation.

Such has been precisely the case with the selection of wood chips as a bulking agent for sludge composting facilities in the Washington, D.C. Metropolitan Area and elsewhere. Briefly, wood chips are partially consumed in the composting process, and as cellulolytic matter, serve as a primary substrate for *Aspergillus fumigatus*. Considerable controversy exists about the generation, dispersal and containment of this spore-forming fungus, from both the regulatory and engineering viewpoints. The predictive relationships are not yet available with which to estimate the rates of generation of *A. fumigatus* as a function of composting plant type and size. Nor would these be of much value at present because there is little definitive information available with which to predict the attenuation of airborne *A. fumigatus* emissions with distance from the source, and to associate the levels at a critical distance with public health risk.

Added to the preceding is the rapidly escalating cost of wood chips. Recent bid experience in the Washington Metropolitan Area has shown that bulk purchases of wood chips will cost $9 to $10 per cubic yard, or two to three-fold greater than previously estimated in project economic planning. At this price, wood chips alone can account for almost 60 percent of the unit cost of composting, making it mandatory for economic reasons that wood chips be eliminated from aerated-static pile composting if it is to be cost-effective in the longer term.

The proposed alternative to wood chips as a bulking agent is recycled product compost. This approach has been used successfully for years in connection with windrow composting by the Los Angeles County Sanitation Districts, but there are several issues to be resolved through demonstration of the concept in the humid climate setting before it will be a proven approach. The key to successful composting with recycled compost as a bulking agent resides in engineering the capacity to manage the moisture content of the compost produced so that, upon recycling, a sludge/recycled compost mix having a moisture content not exceeding 50 percent is placed on the composting pad. The issues to be resolved through demonstration pertain to defining the proper mixing technique and aeration requirements, i.e.,

(1) The mixing technique must develop enough porosity and free air space in the mix to ensure uniform aeration without excessive head loss (Figure 1).

(2) The aeration system must have enough capacity and flexibility to permit rapid heat-up and pasteurization to take place (using lower rates during the first seven to 10 days), followed by higher aeration rates to promote some or all of the requisite drying.

It is recognized that the technical issues above are weighty, but as demonstrated in the analysis that follows, there are substantial rewards to be gained. It is also recognized that the 40 to 45-inch annual rainfall along the

Table I
COMPARATIVE MATERIAL FLOWS THROUGH FACILITIES - 100 WET TONS/DAY SLUDGE INPUT AT 20%

NODE[1]	Operation Description	Alternative "A" Wood Chip Recycle Tons/Day	Alternative "A" Wood Chip Recycle Cu. Yd./Day	Alternative "B" Compost Recycle Tons/Day	Alternative "B" Compost Recycle Cu. Yd./Day
1	Sludge input	100.0	111.2	100.0	111.2
2	New wood chip input for mix	18.7	74.7	—	—
2	Compost Input for mix	—	—	167.0	352.0
3	Recycled wood chip input for mix	65.5	187.2	—	—
4	Mix output	184.2	300.0	267.0	420.0
5	New wood chip input for pad bed	9.3	37.3	9.3	37.3
6	Compost input for composting pile cover	26.7	62.7	29.8	62.7
7	Composting pile input	220.2	400.0	306.1	520.0
8	Output from composting pile	173.4	400.0	222.0	467.0
9	Output from prescreen drying	140.3	294.0	—	—
10	Product compost	74.8	166.2	25.2	53.1
11	Screened wood chips	65.5	187.2	—	—

Note: [1]The node numbers correspond to the encircled numbers in Figures 2 and 3.

Eastern seaboard may simply be too much "added water" to be removed from an open-air static pile composting operation in this region; in this regard, the added cost of enclosed composting may be offset by the savings in wood chip and related screening costs once static pile sludge composting with recycled compost bulking agent is demonstrated.

Two configurations for the aerated-static pile composting of raw sludge were evaluated in an economic comparison of wood chips and recycled compost as alternative bulking agents. Both alternatives incorporate the following common features:

(1) Composting, curing, and product compost and bulking agent storage, as open-air operations.

(2) Front-end loaders with oversized buckets, as the workhorse for material transfers.

(3) High aeration capacity is provided in each case (permitting up to 1500 cubic feet/dry ton/hour, or about three-fold greater than recommended).

(4) Wood chips are used as the composting bed in each case.

In Alternative "A", using wood chips as the bulking agent, sufficient screening capacity was provided to support the screening of the annual production of compost within an effective 6-month screening season, as has been the experience at Beltsville. No screening capacity was provided in Alternative "B", using recycled compost as the bulking agent, and it was assumed that the wood chips used in the composting bed were lost in process in this alternative.

Process flow diagrams for Alternatives "A" and "B" are presented in Figures 2 and 3 and comparative material balances for each are presented in Table 1. The material flows are estimated on the basis of raw sludge inputs of 100 WTPD (wet tons per day) at 20 percent solids. Some critical observations from the estimated material flows are:

(1) In Alternative "A", the new and recycled wood chip requirement amounts to an estimated 300 cubic yards per day per 100 WTPD, approximately 190 cubic yards of which are recovered as screened chips. The new wood chip makeup requirement each day amounts to about 110 cubic yards, or approximately 37 percent of the daily requirement.

(2) In Alternative "B", where new wood chips are used only for the composting pad bed, the daily make-up requirement is 37 cubic yards, or one-third that for Alternative "A".

(3) Approximately 53 cubic yards of compost are produced daily in Alternative "B", as compared with about 166 cubic yards daily in Alternative "A", the difference being primarily due to unscreenable wood chip fines.

At a wood chip cost of $9 per cubic yard, the above difference in new wood chip make-up represents an added cost of nearly $7 per wet ton of sludge processed by Alternative "A". This differential is increased by several dollars per wet ton when the additional costs for the screening operation and product haulaway are factored in, not to mention additional costs for disposal (valid in many areas until markets are developed). Additionally, with the reduced quantities of wood chips required in Alternative "B", and the attendant elimination of screening operations, emissions of dust, noise and *A. fumigatus* from the operation are greatly reduced.

The preceding illustrates the economic incentive for moving to recycled compost as a bulking agent, and it is recommended that those interested in furthering the composting of raw sludge by the aerated-static pile method work jointly and expeditiously in demonstrating this approach for both economic and environmental reasons. ■

Fig. 2. Alternative "A" (Wood Chip Bulking Agent)

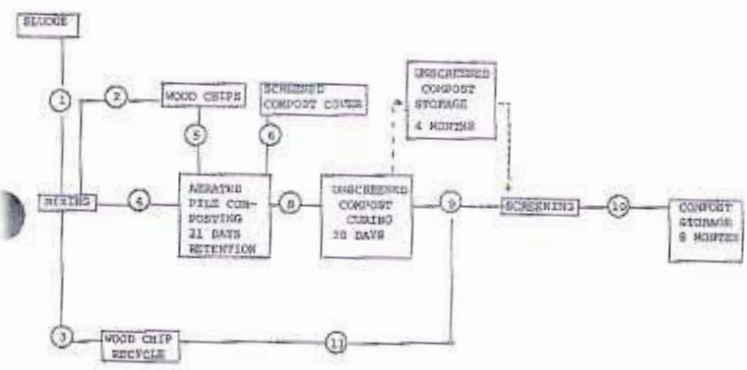

Fig. 3. Alternative "B" (Recycled Compost Bulking Agent)