Co-composting of Municipal Solid Waste (MSW) and Residual Digested Wastewater Biosolids (RDWB): Optimization of Parent Material Proportions.

To the City of Rapid City, Department of Public Works

by

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Background:

The City of Rapid City, SD, is in the process of constructing the facility within which municipal solid waste (MSW) will be co-composted with residual digested wastewater biosolids (RDWB). The full-scale facility is due to come on-line during the spring of 2003. It is desirable to develop a working understanding of the composting process as applied specifically to RWDB and MSW generated by the City of Rapid City. Some experience exists nationally and internationally with regard to the co-composting of MSW and RDWB, but this certainly cannot adequately define the exact mixture of MSW and RDWB that would lead to an optimum compost product for Rapid City, SD.

Objectives:

Determine the optimum proportions of MSW, RDWB and other potential additives for production of the optimally stabilized compost product.

Investigate the presence and character of noxious off-gasses potentially emanating from the co-composting process.

Appraise the quality of the finished compost product in light of applicable hazard metrics.

Approach:

Literature review

The literature, both engineering and scientific, will be searched for pertinent existing information and experience regarding the co-composting of RDWB and MSW to determine reasonable bounds for the nature and proportions of the components. The use of other additives, specifically bulking agents, will be investigated with regard to industry experience. The composting process itself will be thoroughly understood from the standpoint of the specific technologies to be employed by the City of Rapid City in its future facility. The quantities and components of potential off-gasses from similar composting operations will be researched. The destruction of potentially pathogenic bacteria in present in MSW and RDWB will be thoroughly researched. Both state and federal regulations for classification/use and metrics employed for evaluation of RDWB-MSW compost will be thoroughly understood.

A preliminary literature review has been accomplished to-date that has yielded one laboratory scale experiment employing 120-liter reaction vessels to simulate an in-vessel composting system. These experiments were successful from the standpoint of attaining adequate composting temperatures and production of a stabilized product. Further literature review and consultation with City of Rapid City staff will enable the design of experiments whose results will assist the staff of the Materials Recycling Facility and Regional Wastewater Reclamation Facility to understand the desired mix of MSW,

RDWB and other ingredients for production of a satisfactory compost product from the future co-composting facility.

Experiments

Batches of MSW and RDWB will be created in varying proportions in 55-gallon containers. As stated above, at least one previous study has demonstrated that insulated 120-liter reactors can be successfully employed in co-composting studies. This investigation would employ 55-gallon drums, packed with 40-45 gallons of compostable material. The drums would be provided with an insulating jacket, a means to control air input through temperature sensing, and a means to collect off-gasses produced. The laboratory within which these experiments would be housed is equipped with a separate ventilation system, lockable doors keyed for restricted access, and ample space (~10' x 25') for housing up to 16 co-composting reactors. The purchase of a data acquisition system would be essential to provide a system to accept input from a thermocouple situated within each reactor and open or close a solenoid valve on the inlet air line to the reactor. The open and close temperature set-points would be programmable using VisualBasic. A RS 232 data link and software would be desirable to record the real-time temperature condition and valve status in each of the reactors over the entire time period of the experiments. A PC (Pentium II, 450 MHz) is available to be dedicated to this purpose. The reactors themselves would be arranged such that daily (5 working days per week), each of the drums would be disconnected from the DAS and air supply lines, inverted to redistribute the compost and tumbled for a time period (several minutes) to allow mixing of the contents. The laboratory is equipped with a device that will conveniently allow for this tumbling operation. The mixing is intended to simulate the process planned for the co-composting facility wherein a conveyer system picks up each trough of compost once per working day and deposits it several feet closer to the outlet end of the trough. A schematic diagram of the proposed experimental arrangement is included as Figure 1.

Batches of MSW, suitable for co-composting will be prepared by the staff of the MRF. Each prepared batch will be sampled using a statistically valid method to obtain sixteen samples virtually identical to the overall batch and to each other. A means will also be devised, in conjunction with the staff of the wastewater renovation facility, to create batches of RDWB of character, including conditioning chemicals, similar to that to be employed in the co-composting process. A small gravity thickener, a gravity filter or a drying bed are preliminary options under consideration for dewatering the digested sludge. Through literature review and consultation with national/international experts and the staff of the MRF, the exact proportions of MSW and RDWB as well as the nature and proportions of other desirable additives will be determined for the experiments. The batches of mixed MSW and RDWB will be mixed together either at the MRF or at the wastewater plant, whichever location would be deemed most convenient, and transported in the 55-gallon drums to the SDSM&T laboratory.

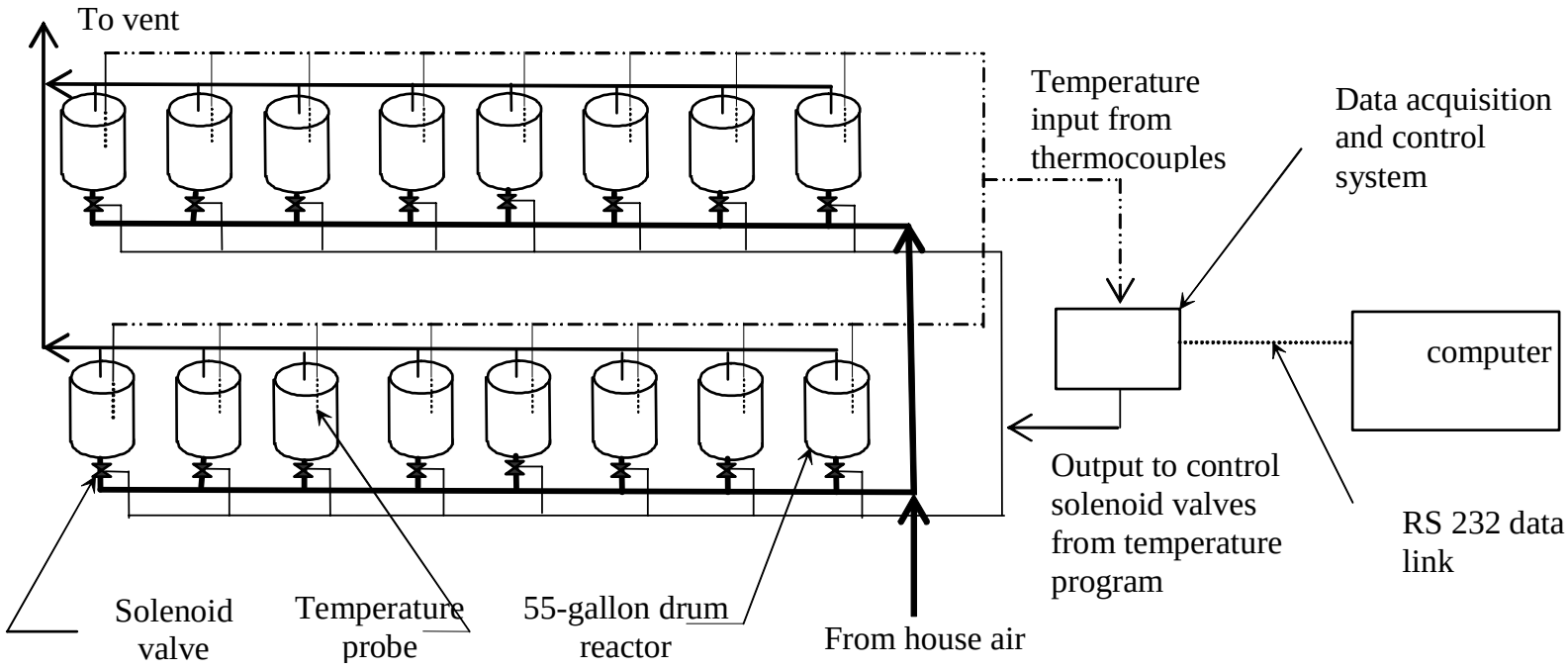

Figure 1: Schematic diagram of proposed co-composting experimental arrangement.

A detailed experimental program would be prepared based on knowledge gained from the literature review, consultation with individuals who have published in the MSW composting area, and consultation with City of Rapid City staff. This research and these consultations would also identify the specific compost products the City of Rapid City would wish to produce for specific local and regional markets. Several sets of experiments would allow the investigation of the means to produce numerous products. Primary composting experiments would be conducted over a 29-day period, matching that of the planned process, during which SDSM&T personnel would be solely responsible for the daily handling and monitoring of the system. Finishing of compost would be accomplished using means that would approximate conditions anticipated during the finishing stages of the composting process. Depending upon the availability of the processing equipment at the MRF, several experimental cycles could be accomplished during a 10- to 11- month project period.

During this experimental period off-gasses could be collected for assay to determine the content of odorous gasses as well as the progression of the composting process. Composted materials could also be sampled at intervals during the process to monitor progress. The exact assays necessary to mark the progress of the composting process would be determined based on the literature review and after consultation with the staff of the MRF. Certain capabilities are available through the SDSM&T department of Civil and Environmental Engineering, the SDSM&T Engineering and Mining Experiment Station or through other SDSM&T departments. Assay capability not available through SDSM&T would necessarily be sought from private laboratories. Rather than suggest a listing of specific assays with this proposal, it is suggested that upon more thorough review of the literature, after consultation with the staff of the MRF, and in consideration of assay costs a more detailed definition of desired assay work would be developed in conjunction with the development of the detailed experimental program.

The initial background research for this project would be completed in June and July of 2002. Experiments would be designed during July and early August of 2002. Experiments would be initiated during August of 2002. The planned composting of Rapid City's MSW-RDWB will involve a 29-day primary composting cycle followed by a several-week finishing cycle. It is anticipated, again depending upon availability of MRF equipment for preparing MSW for these experiments, that up to four experimental cycles for primary composting can be completed in conjunction with this proposed project. All primary composting experiments would be completed prior to the end of March, 2003, to allow for finish composting of the final batches and assembly of a final report prior to the middle of May, 2003.

Interpretation of Results

Data from off-gas production can be obtained continuously from the experiments while that relative to the suitability of compost for public use must wait for the completion of each set of experiments. Literature review will reveal the specific metrics with which the MSW-RDWB compost will be compared. Specific metrics of the finished compost will most probably include but not be limited to volatile solids contained in the solid product, properties of extracts of water derived by contact with the product compost, and pathogenic bacteria present in the finished compost.

Schedule:

A schedule of activities for the proposed work is presented in Table 1.

Table 1
Proposed Work Schedule
Co-composting of Municipal Solid Waste (MSW) and Residual Digested Wastewater Biosolids (RDWB): Optimization of Parent Material Proportions.

Work Item	2002							2003				
	June	July	Aug	Sept	Oct.	Nov	Dec.	Jan.	Feb.	Mar.	Apr.	May
Literature review												
Experimental Design												
Primary composting experiment 1												
Compost Finishing experiment 1												
Data interpretation & experimental design												
Primary composting experiment 2												
Compost Finishing experiment 2												
Data interpretation & experimental design												
Primary composting experiment 3												
Compost Finishing experiment 3												
Data interpretation & experimental design												
Primary composting experiment 4												
Compost Finishing experiment 4												
Preparation of final reports												

Note: Broken lines represent efforts expended prior to official approval for project.

Budget:

Two MS-level students would be assigned to this project. Their responsibilities would include: background literature review; development (under the guidance of Prof. H. Mott in conjunction with City of Rapid City staff) of the detailed experimental program; coordination with City of Rapid City staff of the initiation of the experiments; day-to-day conduct of the experiments; and preparation of MS-level theses (or comparable final reports) documenting the experimental program, presenting results obtained, and interpreting the results. These two students would be supported solely through SD Water Resource Fellowships during the summer of 2002. Support for the academic year 2002/2003 would come from a combination of SD Water Resource Fellowships and graduate research assistantships (GRAs) funded through this project. The breakdown would be 1/3 SDWRF and 2/3 GRA. Equipment, supplies and materials necessary to the

project would be purchased by the City of Rapid City, unless a decision would be made to capitalize on the educational discount (leading to substantial cost savings to the project) afforded to SDSM&T by the supplier of the data acquisition/control system and associated software. In this event a budget item including this equipment and software would be included in the contract between SDSM&T and the City of Rapid City. An itemized budget is given below in Table 2. Arrangement of the experiments in the SDSM&T laboratories would be accomplished by SDSM&T personnel assisted by Department of Corrections personnel assigned to the MRF and directed by the SDSM&T CEE department technician.

Table 2: Proposed Project Budget

Direct Salaries - MS Students	SDSMT	City of Rapid City	total
fall 2002 - 2 students @ $2118/semester	$1,412	$2,824	$4,236
spring 2003 - 2 students @ $2118/semester	$1,412	$2,824	$4,236
total Direct Salaries	$2,824	$5,648	$8,472
overhead on direct salaries	[4]*$1,130*	$2,259	$3,389
fringe benefits on direct salaries	$90	$181	$271
tuition remission: 36 credits at $257.85[1]	[4]*$3,094*	$6,188	$9,283
Total direct labor and associated costs	$7,138	$14,276	$21,415

(1) Graduate assistants are entitled to reduced tuition. The difference between the reduced tuition and that normally assessed must be borne by the project by which the graduate assistant is funded. The graduate out-of-state tuition rate is $290.75 and the graduate assistant rate is $32.90. The tuition remission rate is therefore $257.85.

A contract would be arranged between the City of Rapid City and SDSM&T to provide GRA support and associated costs listed above.

The following equipment and supplies would be purchased for the project by the City of Rapid City			
data acquisition & control system[2]		$2,140	$2,140
Excelinx data recording software[3]		$395	$395
55-gal. HDPE drums - 16 @ $55		$880	$880
solenoid valves - 16 @ $25		$400	$400
Thermocouple probes 16 @ $25		$400	$400
miscellaneous wiring		$200	$200
miscellaneous piping		$200	$200
materials for laboratory arrangement		$100	$100
subtotal Equipment & Supplies		$4,715	$4,715
Total project costs	$7,138	$18,991	$26,130

[2]If this equipment were purchased through SDSM&T, a 20% educational discount would apply, reducing the cost to $1712.

[3]If this software were purchased through SDSM&T, a 50% educational discount would apply, reducing the cost to $197.50.

[4]Items shown in italics are costs normally borne by projects but are not actually assessed from SD Water Resource Fellowship funds.