A SIMPLIFIED PROCESS FOR METAL AND NONCOMBUSTIBLE SEPARATION FROM MSW PRIOR TO WASTE-TO-ENERGY CONVERSION

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Discussion by
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The paper presents an interesting preprocessing approach for use in conjunction with mass burn incineration. The companion paper presents the very favorable results of the use of the system in conjunction with incineration. Description of the system and equipment is well done; however, several questions come to mind.

(1) The preprocessing system has the capability of processing 18-20 ton/hr on routine basis. Is it possible to scale-up the equipment and system to the 50-60 ton/hr range, or would multiple processing lines be required to achieve this rate?

(2) What is the installed cost of the 18-20 ton/hr system?

(3) What are the system economics strictly from a materials recovery standpoint?

(4) What are the overall facility economics (preprocessing and energy recovery) and how does this compare with mass burn only?

The authors are to be congratulated for a well written technical paper. However, some economic information as requested would greatly enhance it and make it a much more valuable contribution.

Discussion by
Bob Lilly
Averill Park, New York

"A SIMPLIFIED PROCESS FOR METAL AND NON-COMBUSTIBLE SEPARATION FROM MSW"! Such a title is sure to catch the attention of designers and operators of RDF Steam Generating Plants.

Our experience at New York State's RDF Steam Generating Plant in Albany convinces us that such a method must be found and utilized. This paper describes a novel operating system, one that removes metals and noncombustibles from Municipal Solid Waste.

The resulting fuel product from this system should improve combustion quality and reduce equipment wear and maintenance. Improved steam generating plant operation should more than compensate for the fuel preparation costs. The New York State RDF Steam Generating Plant at Albany uses a single shredded MSW with one step magnetic separation. Glass, stone and nonferrous metals remain in the fuel. The RDF is burned on a spreader stoker. The plant is in successful full time operation. Our experience has demonstrated that a little extra processing of RDF will greatly reduce the maintenance and down time problems. These are equal in importance to the improved combustion characteristics that can be expected.

At present, one of the two steam generators is shut down for 24 hr every second week for preventive maintenance. Maintenance includes removing aluminums that have melted and solidified in the stoker catanary and repairing of the chute and fuel distributor plates eroded by sand and glass in the fuel steam. A cleaned fuel, as described in this paper (plus one additional step for RDF sizing) would eliminate this down time and thus add an additional 250 ton/week burning capacity to the plant.

The authors are to be congratulated on the development of such an ingenious process. The future commercial availability of a "simplified process" as described in this paper will be another step forward for Energy Recovery from Municipal Solid Waste.
Discussion by

Salil K. Bose
Technical Director
Resources Recovery (Dade County) Inc.
Miami, Florida

At the outset I wish to thank you for giving me the opportunity to participate in this discussion. The unit operations of the front-end separation of the Sumner County plant are simple and would be ideal for small capacity plants.

Having the magnets in the refuse feed homogenizer has its merits as the ferrous metal is exposed to the magnets for a longer time and for more number of passes. However, the magnetic system itself could be improved upon and NRT, I was told, is actively considering it.

The heavies, i.e., the glass and grit separation, is done reasonably well by this system and from this data on the percent ash in the fuel (14.6%), one has to conclude that the glass and grit removed is more than adequate. I had the good fortune of visiting this facility and was particularly impressed by the aluminum recovery system. The aluminum recovered is clean and free from any contamination and therefore should be able to command a good price in the market.

However, I must hasten to add that this system is capable of processing only household refuse and not trash the likes of which we receive and process in Dade County. Trash, as you know, is the most difficult entity in the solid waste to process, owing to its total lack of consistency, as it contains trees, garden clippings, white goods, including stoves, refrigerators, and in addition, unfortunately, there is quite a bit of putrescible garbage comingled with trash. This is one of the reasons that solid waste plants must be designed to handle both trash and garbage.

Since the capital cost and the power consumption (3 kWh/ton) are both low for the front-end separation systems, I would like to conclude by saying that it is in order to have front-end separation for all future plants. The advantages of a prepared fuel are many and this has been discussed in great detail in the subsequent paper. The results of Drs. Kenny and Sommer's work are self-explanatory.

Discussion by

Anthony R. Nollet
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Albany, New York

Drs. Garry Kenny and Edward J. Sommer should be commended for at least three things:

(1) They have come up with a clever invention.
(2) They have presented their results in an understandable fashion.
(3) They have established that minimal preparation results in a better fuel for mass-burn systems, and greater steam output.

Our firm has built a transportable version of our Rotary Drum Air-Classifier (RD ACT™), and we are currently testing it in Albany in a two-stage test program.

(1) We are testing it on the single-shredded output of the Albany ANSWERS Plant – after magnetic separation to produce an improved RDF.
(2) We will test it using raw waste as the feed.

The early first stage tests to date seem to parallel the results reported in this paper. The ANSWERS magnets remove about 4% by weight of the incoming material. The Rotary Drum Air-Classifier is dropping about 6% by weight to the Heavy Fraction. The Light Fraction RDF, which consists of about 90% of the incoming materials, seems to increase steam production by about 8% in the State of New York boilers in which the material is being burned. The steam undergoes an enthalpy change of 1050 Btu/lb in the boilers. The regular non-air-classified output of the ANSWERS Plant produces about 3.29 lb of steam per pound of product. When the air-classified shredded RDF is fired, the boilers produce about 3.56 lb of steam per pound of product.

The 94%/6% “split” is much higher than we had predicted. Maximum feed rate observed so far (we’re conveyor limited) is 42 ton/hr, and power usage is about 4.5 kWh/ton.

Formal second-stage tests on raw waste have not yet begun. Very crude early tests indicate that we will achieve a slightly lower Light Fraction yield, but we will drop more glass to the Heavy Fraction, as the material will not have been shredded as the first processing step.

We would like to ask NRT how they avoid damage to their two discharge conveyors from large items like kitchen sinks, Christmas trees, and large pieces of lumber? How do they prevent wrapping the conveyors with “snake” like long wide typing ribbon?

We do caution against heavy investment in an aluminum recovery system. New York State passed a Beverage Container Bill last year, and the aluminum cans have virtually disappeared from our waste stream in Albany.

We have observed some aluminum foil and aluminum lids in the ash produced by burning our shredded light fraction. Perhaps light-gage aluminum recovery could more easily be practiced by screening the ash.
AUTHORS' REPLY

To Kenneth Woodruff

The authors appreciate Mr. Woodruff's contribution in pointing out the usefulness of providing more economic information with regard to the materials recovery system described in the paper. The system, which was built at Gallatin as a demonstration system, has in the last year become a commercially viable operating system, a somewhat unique situation in the solid waste industry.

In response to the first question, the Gallatin system can process 15 TPH while maintaining the reported material removal efficiency: surge rates of 30 TPH can be processed with reduced removal efficiency. Scale-up to 30 TPH capacity can be accomplished by increasing the size of the primary separator (RHF) from 16 ft in length to 30 ft and the diameter from 9½ ft to 12½ ft. Increasing the capacity of the aluminum system is relatively straightforward. The width of the aluminum concentrator detector array would be increased as would the magnet size of the eddy current separator, (or two magnets could be employed). Since in this system material is removed from inside the RFH via conveyors which extend into the RFH for one half of its total length, (slides at Gallatin), 30 ft is considered a maximum practical length for the RFH, (15 ft and 7½ ft unsupported conveyor lengths).

At 30 TPH and 90% availability (current availability of the Gallatin system) this translates to a 650 TPD capacity per process line. It is our opinion that process requirements of say 1000 TPD, (50-60 TPH), are best served by employing two process lines for the redundancy provided and the reduction in component sizes, (motors, conveyor belts, etc.), that must be dealt with during repair.

The installed cost for a 20 TPH system, which would utilize an RFH with a 20 ft length and a 10½ ft diameter, will of course depend on a number of factors such as required input and output conveyor lengths, local aluminum and ferrous markets, (shredded or baled product required?), local erection service rates, etc. In general, however, an engineered system with all conveyors, separation equipment, computer monitor system, electrical wiring, erection at elevation and start-up would cost approximately $1,200,000, or about $2800/TPD of capacity. This can be compared to current mass burn plant costs of $60,000 to $100,000/TPD of capacity.

The economics of the system from strictly a materials recovery standpoint are as follows. Aluminum sales provide the highest income. It may be expected, as aluminum production costs are tied to energy costs, that the value of aluminum containers will stabilize in the range of $800-$1000/ton, and keep pace with inflation. In areas with container legislation the value of the containers is two to four times this amount while the reduction of the containers in the waste stream is 50% to 80%. Providing enlightened legislation allows for redemption of containers derived from waste, aluminum revenues may be equivalent to that from non-legislated areas. The national average aluminum content in waste is approximately 0.8%, of this, approximately two-thirds are containers, (the other aluminum value is less: ranging from $200 to $400/ton). For a national average aluminum content then, the value of the aluminum is $4.50 + $0.90 or $5.40/ton of waste. Using the aluminum separation system efficiencies from Gallatin the recovered aluminum revenue would be $4.00 per ton of waste.

Revenue derived from ferrous metal sales has varied from $20/ton to $70/ton. Our contract at Gallatin for the ferrous is for $27/ton, FOB Gallatin. At this price, and assuming 4% ferrous recovery, the value of the ferrous derived from the waste is $1.08/ton. Thus the metals revenues per ton of waste are $6.48 for an average situation. The cost of operating the Gallatin materials recovery facility are currently $3.00/ton for all associated costs to the facility. This includes the salary of an extra man who performs testing and R&D activities at the plant. This cost also includes approximately 60 hr extra idle time per month due to the energy recovery plant crane downtime, as well as an 11 TPH average feedrate, due to the crane, as opposed to the 15 TPH plant capacity. A 50% improvement in these two areas would decrease operating costs to $2.00/ton of processed waste. The capital costs for the plant at the 200 TPD level are approximately $2.00/ton. This in an average aluminum content area the metals revenue would provide a net profit of $1.08/ton of processed waste, or break even with no ferrous sales.

It should be noted that there are other benefits derived from the recovery facility operation. Sale of the ferrous metal results in a reduction of the overall waste stream by 4-5%, (the density of empty Fe containers is about the same as a solid waste). For mass burn operations, the ash volume is reduced by about 50%, and the potential for heavy metal/ash reactions is reduced by the 80-90% metals removal. If the glass/graft fraction can be traded for transportation, (as an aggregate or an inert dense media), an additional 8-12% of the waste volume is not required to be landfilled or dealt with in the combustion unit.

The following comments are made in response to Mr. Woodruff's pertinent question concerning the overall economics of combining this type of materials recovery facility with a mass burn energy recovery plant. The discussion by Mr. Robert J. Lilly implicitly shows that mass burn plant maintenance, and off-line time, is significantly reduced by the process steps of Fe removal and subsequent shredding. Removal of the abrasive glass/graft fraction would provide additional benefits by reducing main-
tenance on their ANSWERS plant fuel chute system. The logic here, which derives from operating experience, is to put the inevitable system wear where repair can be accomplished without cooling down a system, and where downtime costs $4.00/ton, (i.e. in the material recovery system), rather than $35.00/ton, (revenue from energy sales derived from waste combustion at Gallatin), of waste processed.

The total cost of the described materials recovery facility is on the order of $4000/TPD of capacity ($2800 + $1200 for building, site, etc.). Assuming the cost of the energy recovery plant is $80,000 per TPD of capacity, then the materials recovery section represents 5% of the total project cost. The quantity of material removed by the recovery system is 12-15% by volume, thus the energy recovery plant volume capacity can be reduced by that amount. If one assumes that this would lower the energy recovery capital cost by 5-10% then the cost of the materials recovery facility is paid for at the outset. Data from Gallatin shows that on a long term basis the pounds of steam produced when burning processed waste is consistently 8% higher than for burning raw waste, on the basis of weight of waste received, (20-25% higher on the basis of waste burned). Since the energy revenue is about $35/ton of waste, (based on Gallatin experience), preprocessing increases the energy revenue by $2.80/ton of waste.

The Gallatin facility shows a 20% increase in availability when burning processed waste; assuming half that figure, a 10% increase in availability, preprocessing would add another $3.50/ton of waste. Without quantifying other potential benefits (reduced life cycle costs from less thermal cycling of the combustor and reduced landfill costs), it is apparent that the described preprocessing system, built in conjunction with an energy recovery system, can produce a net revenue increase of $9.38/ton of waste, (revenue less operating costs) as compared to mass burn alone. The reason these figures are so positive, when past experience shows most RDF/combustion facilities not to be cost effective, is the low capital and operating cost of the recovery facility. If the preprocessing capital cost is 10-20% of the energy plant and requires $10-$15/ton to operate, the results are a net loss of revenue.

To Bob Lilly

The comments by Mr. Robert J. Lilly are greatly appreciated. His experience with preprocessed fuel at the Albany, New York facility parallel the experience at Gallatin. The removal of the glass/grit and aluminum fraction from the waste before burning at Gallatin significantly reduces the number of clinker “doughnuts” that are formed in the rotary combustor; the clinkers that do form when burning processed waste are much more porous than those from raw waste and are more easily broken up for removal. It may be well to point out that removal of the glass, grit and ferrous metal before a shredding operation would very likely reduce wear on the shredder and certainly lower the potential for shredder induced explosions.

To Salil K. Bose

Mr. Bose addresses several points in his discussion of the paper. The authors appreciate his observations in view of his extension experience with the world’s largest operating, preprocessing and energy recovery facility.

With regard to the magnet system, we are currently preparing to test a new magnet cleaning system which will eliminate the need for the magnet “scraper” assembly.

The aluminum system, although now providing aluminum can recovery of approximately 75%, is currently undergoing a final development effort. The targeted efficiency is 80% recovery without handpicking. Currently the handpicker, while removing the oversize bulky wastes, retrieves about 10% additional aluminum after the system removal.

Mr. Bose is correct in pointing out that the system does not “process trash”. However, we have experienced minimal problems with feeding the system trees, white goods, grass clippings and the like. The handpicker removes the large objects from the return conveyor which conveys the fuel back to the storage pit. Glass, grit and some ferrous metal is removed by the system during this process. If the trash were shredded before being fed to the system we would expect separation of a majority of the ferrous and heavy noncombustibles as provided for municipal waste: although a reduction in the glass separation would likely occur due to pulverizing of some of the glass with subsequent entrainment in combustible matter. We certainly agree that more attention should be given to the problem of handling “trash”, if for no other reason than the effect its bulk has on reducing available landfill volume.

To Anthony R. Nollet

Mr. Nollet provides some interest data on steam production increase with materials removal which agrees rather closely with the Gallatin experience. We look forward to his reporting results from the tests in progress on the RDAC. Is the 4.5 kWh/ton power required for processing at ANSWERS reported for the entire preprocessing line or that consumed by the RDAC alone?

With regard to Mr. Nollet’s questions concerning the materials handling conveyors at Gallatin, wrapping of long
material has only been experienced at the tail pulley of
the input conveyor. This was remedied by installing a
cover consisting of an 8 in. pipe forming a short sided U
around the back of the tail pulley. Damage from heavy
objects falling onto the return conveyor is avoided by
utilizing a “rock box” orientation adapted from the min­
ing industry. The slide which feeds the return conveyor
forms a pile of material at the end of the slide, thus heavy
objects are cushioned by the stalled material before mov­
ing onto the belt. We have replaced two idler rollers at this
location with approximately 50,000 tons of waste having
been processed. Incidentally the crane bucket (weight ap­
proximately 5 tons), has been dropped on the input con­
veyor numerous times with no damage thus far.

Recovery of aluminum from the ash is likely not to be
economic since the aluminum melts during residence in
the combustion unit and fuses with other waste compo­
nents. This problem has been observed in at least one post
separation operation.