The tests referenced in the paper were conducted at the Sumner County (Gallatin) facility from August 1 to August 19, 1983. During this period there were chronic problems with the ancillary equipment, particularly with the bottom ash removal system, and the electrostatically augmented baghouse. These problems adversely affected the operation of the combustor-boiler.

One of the salient conclusions of these tests (page 614) was that the efficiency of the combustor-boiler could be increased up to 8% by the use of processed fuel. If this is the case in normal operation, it would tend to make the economics of fuel processing more viable for mass burning waste-to-energy facilities.

Because this efficiency increase is significant, there should be some positive correlation between the efficiency and the degree of fuel processing during normal operation.

The combustor-boiler efficiency index is the output divided by the input. For this evaluation, the input is the total waste received at the pit, after the removal of large bulky uncombustible items. This is the gross waste stream wholly or partially processed by NRT. The output is the gross steam generation.

When the fuel is processed, the combustor-boiler efficiency index is not a function of the gross steam generation per input unit of fired (net) waste. As an example, assume that 100 lb unprocessed gross waste will generate 300 lb of stem. The resulting efficiency index is 3.00 lb of steam per pound of gross waste. If fuel processing removes 11 lb of material from this fuel stream, the resulting fired waste is 89 lb, the gross steam generation is 300 lb and the pounds of steam per pound of fired waste is 3.37. This does not represent an increase in combustor-boiler efficiency. The processing of the finite stream of gross waste did not increase the steam production.

Monthly plant records were reviewed for 1983 and for the first quarter of 1984 to determine the pounds of steam generation per pound of gross waste. NRT records were reviewed for the same period to determine the percent of this gross waste that was processed.

The monthly values for the pounds of steam per pound of gross waste vs the percent of gross waste processed by NRT, were plotted to determine if any relationship was evident. The points were scattered, and indicated no positive or negative relationship.

The normal pit capacity is 600 tons. The average daily burn is 116 tons. If there was a significant difference for a particular period between the gross waste received and the gross waste (processed or unprocessed) burned, this difference could account for the monthly value scatter. There are no records maintained to indicate the approximate pit inventory at the start of each month.

To reduce this possible inventory effect, the data was reduced from monthly to quarterly values. This reduces the probable maximum difference between the amount of gross waste received and the amount of gross waste burned for a particular period to approximately 3%. These values are shown, labeled with the applicable quarter, on the attached graph.

The data points indicate some degradation of efficiency as the percent of processed waste increases. If these data
points are arbitrarily biased up to 3% due to possible inventory differences, they would fall close to the average line, which indicates that there is no change in efficiency as a function of the percent of waste processed.

It is recognized that there are certain errors in weighing materials and in measuring and integrating steam flows. However, the results are based on relative differences in 15 sets of values of an extended period, so the degree of total error should be small.

We have not found any evidence that fuel processing increases efficiency for the Sumner County mass burning waste to energy facility during daily commercial operation.

The O'Connor Combustor corporation position is that the Water-Cooled Rotary Combustor-Boiler System has mass burn capability. Any system that removes non-combustible material from the gross waste must be evaluated on an economic basis.

Discussion by

Kenneth L. Woodruff
Resource Recovery Consultant
Morrisville, Pennsylvania

An excellent paper which goes a long way in dispelling the myths of mass burn system reliability, efficiency and as being totally "proven". To my knowledge, this is the first time that prepared fuel and mass burn have been compared side-by-side on an equivalent basis. I believe these results deserve wide publicity and with some additional testing may well lead to renewed interest in the prepared fuel approach in the U.S.

I have a few questions and comments as follows:

1) The paper indicates modifications to the Materials Recovery System were expected to be made in late 1983. Have recovery efficiencies improved and if so, how have
they impacted steam production?

(2) The test program reported was for a 19 day period. Has a controlled test of this nature been repeated, if so, far what period of time and are the results comparable to those reported?

(3) The mass burn unit (No. 2) operating without refuse preprocessing showed extremely poor availability. I believe this is indicative of problems to be expected in mass burn systems handling a diverse waste mixture and points out the necessity for preprocessing.

(4) The high levels of lead and cadmium in the fly ash from combustion of unprocessed waste appears to be a characteristic of mass burning. This information has not been widely publicized, although it has been found to be true at various mass burn facilities.

(5) Have tests been conducted or are they planned to compare dioxin emission levels for mass burn versus prepared fuel firing?

(6) What is the Btu content of the material removed from the waste in preprocessing? What percent of the Btu's in the raw waste is available in the furnace?

The authors are to be commended for a fine paper. I look forward to further information being made available from the project and the possibility of duplicating this effort at other mass burn facilities.

Discussion by

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

The nineteen days test run at the Gallatin plant confirms overwhelmingly our belief that prepared fuel system is the technology for all future plants. The Gallatin facility is unique in the sense that this is probably the only plant in the country which can simultaneously adopt both the mass-burning and the prepared fuel technology at the same facility. The results speak for themselves when both these technologies were put to test.

It is interesting to note that the unit #2 which ran on unprepared fuel during the test run had only 58% availability. But prior to the test run and after the test run, the same unit has an availability of above 80% using prepared fuel. The unit #1 which ran on prepared fuel had an 80% availability prior to, during and after the test. The emissions, particularly with respect to particulates CO and hydrocarbons, were considerably lower for the unit burning prepared fuel. The excess air was lower and the steam flow higher for the same system. In fact, the prepared fuel unit shows all the desirable characteristics of a good combustion system. However, this study would have been complete if data were obtained on the fusion temperature of ash of both these systems. The fusion temperature of the prepared fuel system ash runs between 2100-2300°F and therefore can reap the benefits of running the furnace at elevated temperatures, thereby eliminating any dioxin problems.

Another noteworthy feature about the Gallatin plant is the failure of its' baghouses. They have now been replaced with electrostatic precipitators.

Based on the findings of Dr. Kenny and Dr. Sommer, if best available control technology is to be the prime consideration for all future plants, then the decision would be unanimous.

Discussion by

Robert J. Lilly
Averill Park, New York

Below are some of my comments. They seem to be more of a review of our experiences here in Albany than a discussion on the paper. The point I am trying to make is that some processing of MSW before burning is a necessity in mass burning as well as RDF burning.

How can we, who for years have been designing steam generating plants for:
 Coal — a good fuel but requires crushing, cleaning, sifting, etc. or;
 Oil — an ideal fuel but requires fuel additives
expect to burn MSW — a far from ideal fuel — as it comes from the truck?

AUTHORS' REPLY

To John T. Healy

The authors appreciate Mr. Healy's discussion of our paper and agree with him on several points. As he states, there were problems with ancillary equipment during the short term test of August 1 to August 19, 1983. The data shows that these problems, though present, were significantly reduced when burning processed waste.

We concur with Mr. Healy that an 8% increase in steam generating efficiency is significant and there should be positive correlation between efficiency and the degree of fuel preprocessing during operation. Mr. Healy's first and second paragraphs, taken together, imply that an 8% increase in combustor-boiler efficiency is indicated (when burning processed fuel) by the results of the 19 day test in August 1983. This is erroneous in that the 8% gain in combustor-boiler efficiency detailed in the paper is derived from long term continuous observations during normal operation over the time period of March 1982 through April 1983 as per Fig. 23, p. 613 in the Conference Proceedings.

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Mr. Healy states that “When the fuel is processed, the combustor-boiler efficiency index is not a function of the gross steam generation per input unit of fired (net) waste . . . .” We agree with this statement and with his subsequent discussion on the matter as clearly shown by our representation in Fig. 22, p. 613, of pounds of steam per pound of waste for both waste received into the pit prior to preprocessing and for waste burned in the combustor after preprocessing. We refer Mr. Healy to Figs. 22 and 23 and to text in the paper (left column, p. 614) for clarification of this point.

The remainder of Mr. Healy's discussion centers upon data he presents to show steam generation efficiency when burning preprocessed solid waste in a mass burn incinerator. It is well to keep in mind that the corresponding measurements presented in our paper constitute only a small portion of the data presented in the paper. Observations over the past several years have been carefully compiled, and in addition to steam generation efficiencies show correlations of materials preprocessing with respect to stam flow rates, furnace temperature profiles, excess air, incinerator availabilities, continuous emissions, particulate emissions (including lead and cadmium), ash burnout, etc. All these factors should be considered when judging the effects of preprocessing upon combustion. Before Mr. Healy concludes that he has “not found any evidence that fuel processing increases efficiency for the Sumner County mass burning waste to energy facility” we recommend he consider the full data base presented in the paper.

With regard to Mr. Healy's data presentation, the particular data set in our paper corresponding to his discussion is shown in Figs. 22 and 23 on page 613 in the Conference Proceedings. The data set we show covers the period from March 1982 through April 1983 and displays pounds of steam per pound of waste burned and per pound of waste received correlated with percentage of waste processed for noncombustibles removal. This is the full data set which was available at submittal time for the Conference Proceedings.

Mr. Healy has chosen to display his data averaged into yearly quarters and to include later available data up through March 1984. This approach should show results similar to our method which averages all months within
intervals of percentage material preprocessed. However, Mr. Healy has chosen to leave out a major portion of the data base, that is, operating data for the year 1982. This portion of the data base is significant in that it includes nearly all available data on the Sumner County waste-to-energy plant during actual mass burn operation, that is, operation on unprocessed solid waste. The materials preprocessing facility came on-line in mid-August 1982, giving nearly 9 months of continuous operation on unprocessed waste up to that time. The data span used by Mr. Healy included only two months operation on unprocessed waste (October and November in the 4th quarter 1983) and this particular portion of the data, as presented, is skewed as discussed below.

Mr. Healy did not correct his data for pit inventory. Although he is correct in saying that pit inventory should somewhat average out over a yearly quarter, such is true only under normal circumstances. It happens that on September 13, 1983, an accident with the overhead crane that feeds the materials processing facility left that crane out of service for some weeks thereafter. The incineration plant, after a year of operation on processed fuel, had to adjust to burning only unprocessed waste. The adjustment was not fully accomplished until October, the result being a pit inventory going into October of over 1000 tons. Assuming a normal pit inventory of 275 tons (one-half the pit capacity), there was a carryover into October of over 700 excess tons of unprocessed waste which is approximately 20% of the waste burned in a normal month’s operation. It happens coincidentally that October is the first month of the fourth quarter and so the data shown by Mr. Healy is significantly skewed for the third and fourth quarters of 1983.

We have taken Mr. Healy’s approach using quarterly averages and plotted the complete data set from the second quarter of 1982 through the 1st quarter 1984 adjusting for pit inventory between the third and fourth quarters of 1983 (December 1981 and the 1st quarter of 1984 have been omitted, a allowing that time for plant start-up). The resulting graph clearly indicates an increasing relationship of pounds of steam generated per pound of gross pit waste (that is per pound of waste received into the pit prior to preprocessing) with increasing percentage of preprocessing. The line drawn through the data points is the linear best fit by the method of least squares and exhibits a slope of 0.0033 lb steam/lb waste per percentage point increase in preprocessing. The intercept of the line with the 100% preprocessing ordinate (i.e., all waste being preprocessed) is at 3.11 lb steam/lb waste indicating an 11.9% increase over the value of 2.78 lb steam/lb waste at the 0% intercept (i.e., no preprocessing). Thus from the data it can be concluded that a gain in steam generating efficiency of up to 12% is observed when burning preprocessed waste in the mass burn incinerator.

It is interesting to note that the data shown in our paper in the Conference Proceedings shows an 8% increase in lbs steam/lb waste with preprocessing. The inclusion of additional data for the last three quarters of 1983 and the first quarter 1984 updates this value to a 12% efficiency increase using Mr. Healy’s analysis method. We have verified this result by analyzing the expanded data set in the same manner as followed for the graphs shown in the Conference Proceedings.

We agree that the experience at Sumner County shows the water-cooled rotary combustor/boiler system to have mass burn capability. The experience also shows plant operation to be significantly improved when burning processed fuel in a mass burn system. Our paper documents these effects which are likely representative of the effects of preprocessing on all types of mass burn systems. Mr. Healy states that material recovery processes should be evaluated on an economic basis. It is important that all incineration plant benefits in addition to values of recovered materials be evaluated when establishing the economic bases of material recovery systems.

To Kenneth L. Woodruff

We wish to thank Mr. Woodruff for taking time to review our paper and for his encouraging remarks concerning the importance of the work we are doing. In answer to his specific questions:

(1) Various modifications were made to the materials recovery system in late 1983. These included installation of additional glass/grit removal flights in the Rotary Fuel Homogenizer, upgrading the aluminum concentration system by improving the response of the metal detection system and increasing the operating power of the eddy current sorter, and widening the wheel bands and wheels of the Rotary Fuel Homogenizer. As a result of these modifications the recovery efficiencies throughout the process have been improved and system reliability increased. Glass/grit removal increased from an average 5.4% of the incoming waste to 9.6% of the incoming waste. Aluminum beverage can recovery increased from 62% to 76%. Availability of the Rotary Fuel Homogenizer increased from 79% to over 90%.

The impact of increasing the recovery efficiencies upon steam production has not been directly assessed as yet. Preliminary observations indicate that incineration line performance has improved, but with many changes going on in the incineration plant itself since the beginning of 1984, it is difficult to attribute refined performance changes to any particular events. We have, however, seen direct changes in the amount of MSW processed by the materials recovery facility and the aluminum revenues generated.
An additional controlled test similar to the 19 day test has not at this writing been scheduled. We anticipate that additional tests of this nature will be done in the future.

We have not conducted nor scheduled tests comparing dioxin emission levels for mass burn versus prepared fuel firing. Tests of this type would be very interesting and could help dispel fears concerning dioxin pollution by solid waste incineration. Due to improved combustion control and higher furnace temperatures achieved when burning prepared fuel and considering the removal of discarded pesticide containers, etc., in preprocessing, we would expect to see lower levels of dioxin production when burning prepared fuel.

The combustible content of the glass/grit fraction has been measured to be in the 10-20% range. The translates to a loss of combustibles from the fuel stream of approximately 1-2%. We estimate the combustibles lost to the ferrous fraction to be an additional 0.5% of the incoming MSW. By these measures 97.5-98.5% of the incoming raw waste is available for incineration in the furnaces after preprocessing. Our long term measurements over two years of operation have shown a net 6-10% increase in steam generation efficiency, losses to the preprocessing steps included, when burning processed fuel as compared to burning unprocessed MSW. Thus the loss of Btus in preprocessing is more than offset by efficiency gains in the incineration process.

To Salil K. Bose

The author's appreciate Mr. Bose's comments on our paper. Mr. Bose is correct in pointing out that the Gallatin facility is probably the only facility in the country which can simultaneously operate on prepared fuel and unprocessed solid waste. This has afforded the opportunity to closely study comparative operation of a mass burn facility on the two fuels over long periods of time.

These studies are continuing and beginning in September 1984 will be partially supported by a grant from the Department of Energy Small Business Innovation Research Program. One area of research under the grant program will be to identify and detail the mechanisms during combustion which contribute to the efficiency gains observed during the long term observations reported in the paper.

Mr. Bose suggests the study would be made more complete by profiling the ash fusion characteristics of the fuels. This is one of the areas we plan to study under the DOE/SBIR research program along with determining the toxicity of ash from the two fuels.