THE SEMASS SHRED-AND-BURN TECHNOLOGY: A WELL–PROVEN RESOURCE RECOVERY SYSTEM

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The authors describe a well-designed modern resource recovery facility in a thorough and well-presented manner. However, there are several questions about the plant which remain unanswered or require clarification.

(a) How do the authors feel this system, including on-line maintenance, labor, and capital costs of the refuse processing equipment, compares to mass burn or more refined refuse derived fuel systems?

(b) It appears that the boiler and turbine are being overfired by approximately 25% or that they were designed for capabilities much higher than originally expected. Please clarify the original rating or design capacity of the boiler and turbine. With the current conditions and equipment, what is the limiting factor to obtaining higher refuse throughout and power output?

(c) Was the steam-coil air preheater which was eliminated in the design of the third boiler replaced with another type of air preheater, and if so what type? What is the temperature of the preheated combustion air?

(d) More information about the refuse, such as the percentage that is residential or commercial or a detailed composition, would be helpful.

AUTHORS' REPLY

(a) Without going into the details of cost comparison of the SEMASS system with a typical mass burn because, as you know, these costs can be highly site-specific, we believe that the Shred-and-Burn costs are highly competitive. There is no pit and there are no cranes, which are very high maintenance items. At SEMASS, the multiple front-end-loader operation ensures practically 100% availability of the feed operation. The boiler grates and the combustion control system are relatively very simple, as described in the paper. Factors affecting the relative economics include:

(1) Front-end ferrous is recovered from the shredded MSW through a single magnetic separation stage for selling to the scrap market.

(2) Bottom ash, of less than 6-in. particle size (with the exception of occasional clinkers), is recovered in a dry state from the boilers and processed to recover the remaining ferrous material as well as the non-ferrous. Both of these streams have a very good market value because they are relatively clean and free of organic material.

(3) The remaining bottom ash fraction called Boiler Aggregate™ is used as a daily cover in the landfill with ongoing efforts for permitting it for beneficial use as a substitute material in asphalt and construction blocks.

(4) About 50% of the total ash (see Fig. 8) is flyash and that is where heavy metals tend to concentrate. This fraction is stabilized as described in the paper and disposed off separately from the Boiler Aggregate™.

(5) The combustibles fraction in the unprocessed bottom ash was last tested at 0.5%, which is very low and is a feature of the Shred-and-Burn Technology.

(6) MSW is conveyed to the shredders on conveyor lines, which allows for manual inspection and removal of environmentally undesirable and banned materials such as car batteries, yard waste, and other hazardous materials. Prior to this stage, however, waste is first inspected on the tipping floor as it is being unloaded from the trucks.

The SEMASS Shred-and-Burn system is also very competitive with the RDF systems because at SEMASS there is only a single shredding and a single magnetic separation stage, as opposed to the multiple RDF stages including shredding, magnetic separation, screening, air classification, etc., which means high O&M costs. Materials rejected in the front-end processing RDF systems could range up to 25% by weight of the incoming waste stream as waste "residue" to be disposed off in a landfill, as compared with less than 3% at SEMASS (see Fig. 8). Also, the residue in RDF systems may include high combustible content, which is wasted to the landfills.

(b) The boilers and turbines are not being overfired by 25% at SEMASS. Approximate design ratings are as follows:

(1) Base Plant and Expansion Boilers: nominal 280,000 pph steam, and 300–315,000 pph continuous with design margin.

(2) Base Plant Turbine/Generator: 60 MWe gross at 620,000 pph steam.

(3) Expansion Turbine/Generator: 30 MWe gross at 310,000 pph steam.

The plant is normally operated at the boiler design rating of 280,000 pph steam ±2% for all three boilers. At these conditions the gross power generation is 82 MWe, at ambient temperatures of 60°F, and at PRF throughput rates ranging from 35 to 42 TPH per boiler depending upon the fuel heating value.

The major limitation to the maximum PRF throughput will occur due to the design capacity limitation of the air cooled condensers, Base and Expansion. When the ambient temperatures will exceed a certain level the steam load setpoint will have to be reduced, resulting in lower PRF feed rates, to maintain the maximum allowable turbine exhaust pressure of 9-in. mercury beyond which the turbines will trip. These limitations can be addressed, however, through technical and economical evaluations of capital improvements in the air-cooled condenser capacities.

(c) The fin-tube steam-coil air heater was eliminated from the third boiler altogether because of plugging and corrosion concerns associated with dust present in the combustion air withdrawn from the receiving building for odor control. The combustion air ducting was added for all three boilers as part of the expansion modifications. The elements were removed from the base boilers at the same time as the new unit was under construction.

The temperature of the preheated combustion air ranges from 450 to 550°F.

(d) Through most of the year the waste arriving at SEMASS is very typical of northeast U.S. About 45% is residential and the remaining commercial. In the peak of the summer season we do get a lot of food waste, due to the tourist-based Cape Cod communities.

Discussion by:

Charles R. Tripp
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Long Beach, California

The authors' paper is well organized and concise in its description of the SEMASS Facility. The overall description of the design features, which are incorporated in the MSW processing is easily followed, as are the descriptions of the combustion and ash handling systems. In some instances, a more detailed explanation of design features, operational experiences, and design modifications could have been made.

The original SEMASS Facility came on-line in 1989. It incorporated two boiler trains and a turbine generator. A third boiler train and an additional turbine generator were added in 1993. It is obvious from the paper that the operators and designers have incorporated design changes in the third boiler train which were not found in the original facility. These features were refinements of the original facility design. In order to better understand these refinements, more technical detail is required.

For example, it is my understanding that the original SEMASS Facility design had no significant storage of processed refuse fuel (PRF). Consequently, MSW processing was performed on a 7-day/week, 24-hr/day basis, utilizing one of the three available shredding lines. Was the PRF storage area increased to accomodate the current operational mode which is 12–14 hr/day utilizing two shredders? If the PRF storage area was enlarged, did this impact operations and maintenance costs?

The co-combustion of up to 10% by weight of automobile shredder residue (ASR) with MSW is an interesting operational concept. Although ash and stack testing results are being presented in another paper, it would have been interesting to have commented on whether there were any operational impacts to the fly ash stabilization system due to the increased concentration of lead which is typically found in ASR.

Another interesting design feature is the source of force draft combustion air which is supplied from the refuse storage building. This concept has been used in mass burn facilities for years in order to mitigate odor and dust. Was this a modification to the original facility design? If so, how was the refuse storage area originally ventilated?

The description of NO_X control on boiler No. 3 was rather basic. Technical informaton could have included NH_3 slip levels at different boiler loads. Does a visible plume exist when trying to achieve high NO_X removal? Has there been any impacts to the SO_2 monitoring systems due to SO_2 scrubbing by NH_3 in the CEMs sampling lines? Are there any design concepts incorporated in the CEM sampling system which will prevent this phenomena?

Although SEMASS is a privately owned and operated waste-to-energy facility which typically does not disclose financial information, it would be very informative to the waste-to-energy community to do so. Operation and maintenance costs, along with the $250 million capital costs of this facility, are needed to perform cost comparisons and evaluate the trade-offs and benefits of this technology.

The facility production numbers which were presented are very commendable. The graphs and tables show how well the plant performed even though there were boiler tube wastage problems and a major plant expansion during the first five years of operations.

It is obvious from the continued successful operation of SEMASS that this facility is one in which all members of the waste-to-energy community should be proud. All personnel involved with this facility should be commended for their successful contributions.

AUTHORS' REPLY

We would like to thank Mr. Tripp for commending our operations. We have forwarded his comments to our operations team who express their appreciation for his kind remarks.

The technical details that Mr. Tripp is interested in are difficult to present in a paper such as this. We basically wanted to introduce the SEMASS concept as a viable alternative to the conventionally used systems. However, we have outlined the major areas in which design modifications were implemented in the expansion. More nuts-and-bolts type of details can be discussed, perhaps, on a personal level.

In going from base to expansion, a 50% increase in the waste throughput capacity took place; correspondingly a 50% increase in the receiving building floor area was provided. However, all of the area increase was dedicated, surrounded with push walls, to PRF storage. This means that with the expansion we ended up with no increase in the MSW storage area. This is by design. We want to shred the incoming raw MSW as soon as possible and convert it into fuel. Part of the reason for doing so is to control odors because after shredding, MSW looses its strong odor. The other reason is noise control during the night by minimizing night-time shredding, which means we would have to increase the shredding hours during the day time. The current normal practice is to shred the incoming waste within a 24-hr period and from 7 A.M. to 11 P.M., Monday through Saturday. I think it is safe to say that the operation and maintenance costs associated with the MSW and PRF areas have increased by 50% over the pre-expansion period.

We have not noticed any increased lead concentrations in the flyash since we first started using ASR in 1991. There has been no noticeable impact on the flyash stabilization system either. More details on our experience with ASR can be found in the referenced publication.

The receiving building was originally ventilated through roof vents. Back in 1989 we discontinued the use of these vents for odor control, and in early 1990 we provided ventilation through a "dilution/dispersion" stack system. This system was discontinued when the combustion air ducting was installed in early 1993 as part of the expansion modifications.

The specified maximum NH_3 slip for the NO_x control SNCR system is less than 20 ppm. However, during performance tests, slips of less than 10 ppm were measured. We have achieved 50% NO_x reduction at a NSR of 1 although normally we operate at NSR from 0.1–0.2 and 10–20% reduction. We have not observed any visible plume at these conditions. The SO_2 analyzer only receives a gas sample that has passed through the NH_3 converter which converts it into NO and the possible reaction between SO_2 and NH_3 is eliminated.

Any costs information other than that provided in the paper can be discussed for specific project applications by contacting the authors of this paper.

Discussion by:

Klaus S. Feindler
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We enjoyed reading your paper in the *Proceedings*.

Pages 301 and 302 are of particular interest to us with regard to heavy metals emissions. The information presented by you in Tables II and III is excellent. However, neither the particulate nor the PCDD/PCDF are given in a format consistent with that for the heavy metal species which are in lb/MMBtu.

Therefore, we would like you to send us the corresponding conversions for each of the test runs.

Your assistance is greatly appreciated.

AUTHORS' REPLY

For Table II:

(a) Particulate, to convert from grains/dscf (corrected to 12% CO2) to lb/MMBtu, multiply by 2.2.

(b) PCDD/PCDF, to convert from ng/dscm to lb/MMBtu, multiply by 9.6 x 10^{-10}.

For Table III:

(a) Particulate, to convert from grains/dscf (corrected to 7% O_2) to lb/MMBtu multiply by 2.1.

(b) PCDD/PCDF, to convert from ng/dscm to lb/MMBtu multiply by 9 x 10^{-10}.

GENERAL UPDATE

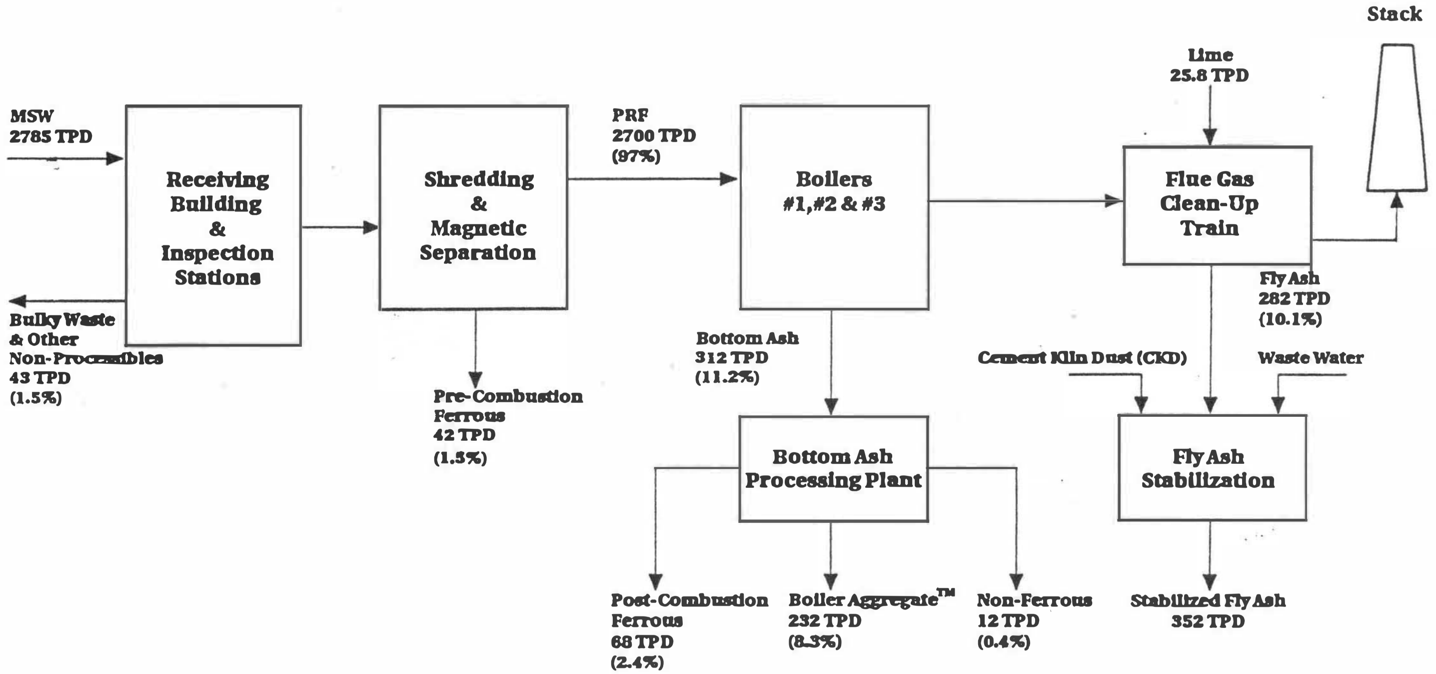
• Page 295. "Features of the Shred-and-Burn System." About 13% of gross electrical generation is used in the plant to meet the auxiliary power needs of the facility.

• Page 298. "Combustion Air System." The operating excess air rate ranges from 70 to 90%.

• Page 298, "NO_x Control." A 50% urea solution is used in the SNCR system. Because of the low baseline NO_x in the range of 150–200 ppm, corrected to 7% O_2, urea solution flow rate is normally at its controlled minimum of 3 GPH. The SEMASS stack permit limit is 180 ppm on a 24-hr average basis, which is readily met at this minimum flow.

• Page 302, Fig. 8. "Plant Material Balance." The revised Fig. 8 with the updated numbers for the bottom and flyash is presented herewith.

FIG. 8 PLANT MATERIAL BALANCE
(Based on Boilers #1 & #2 1993 Operational Data)



Notes:
1.) Data for Boilers #1 & #2 has been extrapolated by 50% to obtain data for Boilers #1, #2 & #3. The numbers will be updated once yearly data for Boiler #3, which came on-line in April 1993, becomes available.

2.) Cement Kiln Dust (CKD) is a waste by-product of the cement industry.

3.) Lime (CaO) is injected in the slurry form $Ca(OH)_2$. Dry CaO tonnage is shown.

4.) The propriatary waste water and CKD streams are not shown.