Discussion by

Harvey D. Funk
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The authors have presented an interesting and brief history of the inherent problems with the original process design of the Monsanto Enviro-Chem “Langard” solid waste pyrolysis and resource recovery system in Baltimore, Maryland. The paper once again illustrates the engineering and technical difficulties in scaling up a small pilot plant to a large production facility.

As described by the authors, steps have been taken so far to correct some of the process problems. With the remaining problem areas still to be corrected and the possibility of other problems yet to be identified, it will be interesting to see whether this process can be considered technically and economically viable. Not only the additional capital cost of the modifications and the loss of revenue during downtime, but also the reduction in capacity with its corresponding loss of revenue must certainly have an adverse effect on the overall economics of this project.

Discussion by

David B. Sussman
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I enjoyed reviewing the paper by Miro Dvirka and Bill Harrington very much. This paper is one of the best discussions of the Baltimore project this reviewer has seen. It outlines what a determined City can do with the correct expertise. The paper points out the fact that solid waste is a unique material and transferring technology developed for other industries is not always easy. The plant was designed and built by a developer who had very little experience with solid waste processing. Consequently, it did not work well. After the developer “gave up,” solid waste experts were able to modify the process so that it complied with established solid waste design criteria and after a long shake down period was made to work. This project reinforced the idea that the solid waste processing industry has a great deal of expertise and when new technologies are developed, that expertise must be utilized.

In general, I agree with all the points made in the paper. However, there are some that need clarification. Monsanto did not close the plant in February 1977. Because of their inability to predict project success, they recommended to the City that the plant be shutdown. The City did not agree with Monsanto’s recommendation, and released Monsanto from their contract and took over the modification of the plant themselves. The feed ram throats were originally water cooled, but the cooling system did not work and the water cooled ram throats were replaced with stainless steel units. These did not work well either and the City had to make numerous modifications to the second set of throats. A third set of ram throats is now being considered.
Discussion by

Arthur J. Helmstetter and Rick A. Haverland
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This update of the operating status of the City of Baltimore’s Resource Recovery Facility is valuable because it may help to squelch the exaggerated rumors of the demise of this facility. The efforts of the City and its consultants in making the system operate are to be commended. However, the presentation format of the paper weakens and defeats the strong and important central theme, which is “what was done to make the system operate.” Before addressing the central theme, the reader must wade through the first two-thirds of the article which restates the most familiar “war story” in recent solid waste processing history (see Ref. [2] of the article). In addition, the overall antagonistic attitude towards the system designer has no place in a technical paper. The following is our perspective on some of the authors’ comments in the order of their presentation.

BACKGROUND INFORMATION

The authors state that Monsanto conducted numerous unsuccessful attempts to achieve even partial capacity sustained. This is a judgment, since during the period of late 1976 and early 1977 there were numerous operating periods that extended in excess of 15 consecutive days. Presently, the plant is being operated consecutively for only 5 days.

The authors state that “the anticipated environmental benefits claimed by the designers, but not clearly defined, include apparently substantial reduction in particulate emissions.” These advantages were clearly defined as reduction in particulate emissions, improved system control, and reduced capital and operating costs. The U.S. EPA felt that the advantages were sufficiently attractive to invest $6 million to demonstrate this mode of operation for solid waste incineration.

The rotary kiln has also proven itself to be a flexible piece of equipment capable of handling the substantial variations in composition typical of municipal solid waste. The design capacity of the Atlas Storage Bin was 2000 tons (1815 Mg) rather than the 1000 ton (907 Mg) capacity stated by the authors.

Apparently, the authors do not recognize as acceptable the considerable amount of data collected by Monsanto, Systems Technology Corporation, TRW, and Environmental Elements Corporation in their statement that the theoretical balances could not be verified. The actual balances for the system in the same form as the theoretical balances presented in the paper are shown in the attached table.

INITIAL OPERATION

FEED RAMS

Contrary to the authors’ statements, the original ram feeders were designed to be water cooled. The tubes for these ram feeders were damaged beyond repair when the cooling water was mistakenly shut off. During normal operation of the kiln, the ram feeder tubes are subjected to a temperature in the range of 1500 F rather than the 2000 F temperature stated by the authors.

ROTARY KILN REACTOR

The rapid deterioration of the kiln refractory lining during the early operation could be attributed to a number of causes beyond those presented by the authors including the following: Improper installation of the original refractory, thermal stress due to water which leaked from the ram feeders, high temperature fluctuations in the kiln due to process upsets which occurred early in the start-up, and discontinuities in the refractory caused by the installation and removal of the metal flights within the kiln. It appears that Monsanto had solved the major kiln refractory problems before leaving the project because the existing refractory, installed by Monsanto, has lasted for over 2 years.

AFTERBURNER/GAS PURIFIER

The original afterburner was designed for an operating temperature of 2000 F (1093 C) but was operated in the range of 2350 to 2600 F (1288 to 1430 C) to maintain fluid slag conditions. This fact was the major contributor to the refractory failure.

GAS CONDITIONING SYSTEM

The low pressure scrubber actually did reach its design efficiency, but the input particulate loading was higher than design.
**INPUTS**

- Waste Feed: 1.00 Ton, 8.02 Btu/t
- Combustion Air: 6.26 T/t, 0.16 Btu/t
- Fuel Oil: 0.03 T/t, 1.26 Btu/t
- Water: 3.09 T/t, 0.27 Btu/t
- Electric Power: 0.00 T/t, 0.20 Btu/t
- Equipment Fuel: 0.00 T/t, 0.05 Btu/t

**TOTAL**

10.38 T/t, 9.96 Btu/t

**OUTPUTS**

- Steam: 1.94 T/t, 4.63 Btu/t
- Exhaust: 7.04 T/t, 1.65 Btu/t

**LOSSES**

- Wastewater: 1.00 T/t, 0.15 Btu/t
- Residues: 0.32 T/t, 1.32 Btu/t
- Surface Heat Loss: 0.00 T/t, 2.30 Btu/t
- Other Heat Losses: 0.00 T/t, 0.27 Btu/t

**TOTAL**

8.36, 5.69 Btu/t

**ACTUAL ENERGY AND MATERIAL BALANCES**

(T/t — Ton of Material Per Ton of Solid Waste Input)

(Btu/t — Million Btu’s Per Input Ton)
PRESENT OPERATION

We question the fact that weekend shutdowns are required because of lack of redundant subsystems in the unmodified portion of the plant. Our experience on site is that these weekend shutdowns permitted the City operators "breathing time," a luxury which is not afforded to operators of industrial facilities.

CONCLUSIONS

The authors refer to the Baltimore System as a pyrolysis system which may be misleading. The pyrolysis concept envisioned by Monsanto was abandoned in the early stages of the system startup during which time oil prices doubled. Despite the fact that combustion air is added to the rotary kiln, the Baltimore facility continues to be mistakenly referred to as a pyrolysis system. To argue the merits of the pyrolysis concept based upon the Baltimore experience simply clouds the issue. The Baltimore system is actually a starved-air incinerator. Therefore, clarification of what the authors mean by a "modified pyrolysis system" as opposed to "theoretical pyrolysis" may help to correct this misunderstanding.

A complete technical, economic, and environmental evaluation of the Landgard® Demonstration plant is available from the U.S. EPA in a four-volume report (SW175C) entitled "A Technical and Economic Evaluation of the Project in Baltimore, Maryland."

AUTHORS' REPLY

To Harvey D. Funk
No comment.

To David Sussman
The Authors appreciate Mr. Sussman's clarification of the point brought up in the discussion.

To Arthur J. Helmstetter and Rick A. Haverland

1. The author's comments on the background of the plant were offered as an indication of the potential pitfalls for designers of systems who do not have extensive experience in the design of solid waste combustion systems. No antagonism was implied or intended; only basic facts as we saw them. Without presenting the facts as they are, the paper would have been another "whitewash" and would have been in direct violation of the ASME Solid Waste Processing Division policy, established by the Executive Committee resolution with regard to true and factual reporting.

2. We have seen no records, neither has the City of Baltimore, that indicate a successful continuous waste firing period "in excess of 15 consecutive days" and do not believe that this position can be substantiated from the records. The present 5 day waste firing period is an operating procedure established by the City to allow the weekly shutdown for system cleaning and maintenance required for a facility offering little or no redundancy in process sub-systems.

3. With regard to the "anticipated environmental benefits," none have been realized. The original statement stands.

4. The failure of the Atlas storage bin was in the conceptual design, not necessarily related to the rated capacity.

5. The paper dealt with the conditions at the time of the system redesign and although the raw data was requested at the time, it only became available when published.

6. The water-cooled feed chutes were proven unsatisfactory and replaced by Monsanto well before the authors' involvement and the previous discussion by Mr. Sussman clarified this point. However, we do take issue with the discussers' statement that temperatures to which the feeder tubes are subjected are in the range of 1500 F, not the stated 2000 F in the paper. While the original and continuing operating conditions contemplate kiln exhaust gas temperatures in the 1300 F to 1500 F range, it is well known by waste combustion system designers that flame temperatures in the range of 2000 F to 2500 F are experienced in a solid waste combustion system. The authors stand by their statement of temperatures to which the feeder tubes are exposed in view of the radiant heat effect and the experience with the movement of the combustion zone up and down the length of the kiln during various periods of the operation.

7. We believe the cause of earlier kiln refractory deterioration would not have significantly lengthened the paper and that reasons offered by the discussers are an over-simplification of the problem and its ultimate solution. The maintenance of the kiln refractories is a well known factor.

The two year refractory life implied by the discussers has to be corrected to reflect the fact
that the actual operating time was shorter than the
down time within that period.

8. The authors offer no comment except to
point out that the primary point of major “after­
bruner/gas purifier” refractory failure occurred
opposite the point of entry of the pyrolyzed gases
and was believed to be caused not only by the
high gas temperatures resulting from introducing
combustion air in the entry duct, but also by the
abrasiveness of the particulate in the gas stream
and the extremely high gas velocities experienced
at this point.

9. We believe that the discussers’ comments are
self-explanatory.

10. The doubts in the discussers’ minds concern­
ning the need for redundancy of subsystems
indicates lack of actual operating experience.
Refuse fired steam generating plants and, for that
matter, fossil fuel fired steam plants have generally
an availability factor of 80 percent. The downtime
factor can be mitigated by multiple system com­
ponents. The drawbacks of a single line process
train have been established long ago.

The “breathing time” considered by the dis­
cussers to be a luxury to the City operators, not
enjoyed by industrial facility operators, is an issue
that is far more complicated than the discussers
suggest. Herein lies one of the major difficulties
with the project. Because of the differences in
municipal and industrial financing, most designers
address their designs to the individual financing
potential.

For example, in municipal design, the original
capital cost is usually readily available through a
bond issue or the capital budget, while main­
tenance costs come from the annual general fund
operating budget and are subject to the vagaries of
municipal budgeting. For this reason, redundancy
of systems, a significant inventory of spare parts
and operating schedules that allow for maintenance
by operating forces are usually established. An
associated consideration, with solid waste, is that
extensive downtime cannot be covered by ware­
housing. The waste continues to come.

On the other hand, industrial financing fre­
quently offsets limited initial capital costs with
more readily available maintenance money from
product sales. Under this arrangement, funds can
be established to provide for major repairs that are
required on a larger than one year schedule. On
the other hand, any budget money not used at a
municipal facility in a given budget year cannot be
 carried over into a future year but must be return­
ed to the general fund to pay other municipal
debs. Not only can the money not be carried over
to the next year’s operating budget, but a reduction
in a given year’s operating budget normally causes
the following year’s budget to be cut by the
amount returned.

The other point indicated above is that most
industrial facilities are manufacturing processes
which offer warehouse capability when production
exceeds sales and provides a source of supply
when unscheduled down time is required for
maintenance and repair. If the surplus is not
available from the warehouse, delivery schedules
are automatically delayed and the customer accepts
the inconvenience or fills his needs from the com­
petition. The inability to fit this concept to solid
waste disposal requires either system redundancy
or an operating schedule which derates the plant
to accommodate the limited system availability.

11. It is interesting to the authors that the
pyrolysis terminology is being questioned by the
discussers because of the basic terminology of the
demonstration grant application. In order to
preserve the grant funding, everyone associated
with the project was cautioned to use the term
“pyrolysis”, when discussing the project, and past
attempts to clarify the issue by use of the term
“modified pyrolysis” were stymied.

Under the modifications discussed in this paper,
the original operating concept of using the kiln as
the pyrolyzer and burning the resulting gases in a
secondary combustion chamber has not changed.
The method of secondary combustion changed.
We see no other deviation in the originally offered
combustion system. The remaining modifications
were primarily associated with derating the sys­
tem and the provision of air pollution controls to
meet the State of Maryland requirements.

The term modified pyrolysis was used by the
authors in an attempt to finally stop the general
consideration of the Baltimore project as text
book pyrolysis which it is not nor ever was, regard­
less of the semantics of the demonstration grant
application.

**GENERAL**

The primary purpose of the paper was to indi­
cate areas of basic design that offered pitfalls to
the uninitiated and to update the project modifica­
tions. It was previously stated, and is repeated,
that the authors believe the project accomplished
the basic goals of a demonstration project. The
paper was intended to indicate areas which neces-
sitated redesign to salvage the facility for a degree
of beneficial use to the City of Baltimore in its
solid waste management program.