# ASME/US BUREAU OF MINES INVESTIGATIVE PROGRAM ON VITRIFICATION OF COMBUSTION ASH/RESIDUE: FINDINGS AND CONCLUSIONS

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**Discussion by:**

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The authors and the organizations supporting the ash vitrification research are to be heartily congratulated for their fine work. Perhaps vitrification is a viable answer to vilification of Municipal Waste Combustors (MWCs)? Clearly, for this to be so the process must "work" at an acceptable level of reliability and effectiveness and must be affordable.

Therefore, I strongly concur with the authors' conclusion that tests for "24 hr/day for 3–5 days" are necessary. Considering that refractory life is difficult to predict in the laboratory and that continuous operation has been a challenging objective (often unmet for other "slagging technologies"), such tests are, I suggest, mandatory prior to arriving at the conclusion of "operational feasibility" as claimed by the authors.

The economic presentation was greatly appreciated, although the "Appendix D, Table 2" supporting data on "Other Costs" should be incorporated in the "Discussions" volume since these elements constitute as much as 25% of the total cost. If this is problematic, a brief discussion of the nature of the "Other Costs" would be appreciated.

## AUTHORS' REPLY

We agree with the salient points made by Mr. Niessen. We were all greatly relieved to find that the refractories held up so well considering the many starts, burps, interruptions, and upset conditions encountered during the operating trials with the different residues even before the 100-hr continuous operating campaign. Once mechanical problems are resolved for continuous feeding and continuous tapping of the furnace, the residues from a single source maintaining reasonably steady state conditions should be obtainable. As with all furnace systems, this will prolong the life of the refractories as well as other components of the system.

As mentioned in the paper, the owning, operating, and maintaining "cost projections" by the Bureau of Mines of similar equipment systems for practical commercial melting capacities appears in Table 2 of Appendix D of the report.

The "Other Costs" indicated in the summary chart included:

| Residue Capacity | tons/day dry basis | 300 | 150 | 50 |
|---|---|---|---|---|
| Payroll Overhead | (35% of payroll) | $4.90 | $6.87 | $14.91 |
| Operating Supplies | (20% of maintenance) | 2.53 | 2.98 | 5.95 |
| Indirect Costs | (40% of direct labor) plus maintenance) | 7.90 | 10.56 | 22.44 |
| Taxes | (1% total plant cost) | 2.82 | 3.10 | 5.90 |
| Insurance | same | 2.82 | 3.10 | 5.90 |
| Total "Other Costs" | per dry ton residue | $20.97 | $26.61 | $55.10 |

**Discussion by:**

Donald A. Oberacker
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Cincinnati, Ohio

I feel that organics or toxic organics should have been addressed because of their importance in terms of groundwater contamination.

What was done with the baghouse dust as far as disposal? What were the results of the PCDD/PCDF analyses of the air emissions from the thermal oxidizer stack testing?

## AUTHORS' REPLY

The scope of this ASME/Bureau of Mines Investigative Program was to demonstrate that *mineral matter*, metals, and inorganic residues from a variety of modern waste combustion sources, can absorbed or dissolved into a molten mass "fixed" by vitrification into an amorphous glass-like form so that these materials will not leach into the ground water, so that the new dense material can have beneficial use and avoid landfill.

The furnace was a melter, not a combustor. Fume was minimized by not employing any fuel oil or gas, sealing the furnace from air infiltration, and requiring that all ash/residues have less than 5% carbon.

The intent was to have the fume solids collected in the exhaust system recycled to the furnace, and if necessary provide additives so that mineral oxides formed would be absorbed and retained in the melt products, as is commonly practiced in the glass industry. This was done during the melting program for Residue A. For the other melting programs, the small quantities of solids removed from the system were eventually landfilled, along with the surplus residue feedstock and surplus vitrified products.

Testing for dioxins at the discharge of the thermal oxidizer indicated that they were well below the local permissible limits.

This activity is described in considerable detail in the Program Report, which is now available from ASME Center for Research, Washington, D.C.

**Discussion by:**

Paul Queneau
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Mr. Wakamura (Takuma Co., Ltd.) briefly described Daido's Japanese operations using electric furnaces to vitrify MSW ash. Can you comment on how your pilot findings compare with those of Daido?

## AUTHORS' REPLY

The reports of Daido's "pilot" plant operations and performance gave us much encouragement with our program. However, our objectives were somewhat different. Their published reports and verbal comments were always confined to vitrifying grate ash. They did not wish to discuss their experiences when trying to melt combined grate ash and flyash products or flyash products alone. The focus in the U.S. is on flyash products or combined products; therefore that was the direction we had taken. We did have a run with only fly ash products as-received as well as after being pelletized and with additives, and of course all the other runs were with combined grate and flyash ash/residues. Although we did encounter some problems, we feel that they are not insurmountable.

We have not encountered any reports on their experiences with the two 250-TPD grate ash vitrifying furnaces they have placed into operation in Tokyo (Ohta) to serve the two new adjacent MSW WTE facilities.

Follow-up on activity at ASME/Bureau of Mines Vitrification Facility.

(a) The Idaho National Engineering Laboratory (DOE-INEL), one of the ASME/Bureau of Mines investigative program sponsors, have engaged the Bureau to conduct vitrification tests on simulated radioactive low-level buried "mixed" wastes. To suit the nature of the wastes, the vitrification facility was modified based on lessons learned during the ASME/Bureau of Mines program. During the 5-day INEL campaign in July 1993, more than 50,000 lb of five categories of these simulated wastes and oils (with additives) from the INEL Radiation Waste Management Complex were vitrified.

Additional tests to be conducted in 1994 will focus on as-stored materials containing significant amounts of combustibles which will require a redesign of the furnace air pollution control system, since the furnace train was originally designed to operate only as a melter, not a combustor.

(b) Southern California Edison (SCE), Rosemead, California is developing a test program with the Bureau to vitrify residues from a fluid bed utility boiler burning refuse derived fuels (RDF). Vitrification tests on the combustion residues will be conducted during the same period in 1994 as the INEL tests described above. The RDF fluid bed combustion residues will be mixed with serpentine as a surrogate for asbestos, another SCE waste. In addition, high calcium-bearing electroplating wastes will be added, expecting to form a low-temperature, easily tapped molten product.

(c) The Bureau will be conducting test runs for

Westinghouse Hanford to demonstrate three-phase electric arc furnace vitrification of simulated high sodium content, low-level radioactive liquid wastes currently stored at the Hanford site. The liquid wastes will be mixed with an organic reductant and with specific absorbent materials all compounded so-as-to produce glass products containing at least 25% waste oxides. The compounded wastes and additives will be compacted into pellets for feeding the furnace system. The test objectives are to produce a readily vitrified glass product that taps readily at low temperature, retains volatile alkali and heavy metals, surrogate radionuclides, and is resistant to weathering and leaching.

GENERIC ASH/RESIDUE VITRIFICATION O&M COST ESTIMATES

| | | | |
|---|---|---|---|
| Vitrification Plant Capacity — dry residue | 300 TPD | 150 TPD | 50 TPD |
| 20% moisture residue | 350 TPD | 175 TPD | 60 TPD |
| Owning & Operating Cost $/ton dried residue | $155 | $130 | $206 |
| Cost $/ton 20% M residue | 98 | 110 | 174 |
| Add to Tip Fee /ton MSW at combustion plant basis: 10–20% residue | $10–25 | $11–28 | $18–45 |

Cost basis: System power usage approximately 840 kWh/ton dried residue at $0.05 kWh.
Individual residue furnace systems with stand-alone APC systems.
No credit allotted for beneficial value of vitrified products.
No credit allotted for landfill cost avoidance.
ASME/U.S. Bureau of Mines Economic Analyses — 1992.

POTENTIAL MARKET VALUE — VITRIFICATION PRODUCTS — 1994

| | |
|---|---|
| Crushed aggregate | $12/ton |
| Fritted for air blast grit | 45/ton |
| Cast block or tile | 150/ton |
| Spun into high temperature mineral wool isulation | |
| Loose form / bulk blowing | 200/ton |
| Blanket form | 1000/ton |
| Vacuum-formed products | 1500/ton |
| Board — medium density | 2000/ton |
| Vitrification metal product as scrap | 75/ton |