

Narrative Summary

**New Systems Research Task
Vendor and Literature Technology Survey**

Below is a summary of technologies and products for diverting waste from municipal landfills from a technology survey conducted by ATG. Two review articles are included at the front of the compilation of source articles. The first is titled "Advanced Thermal Processing Alternatives for Solid Waste Management" and the second "Challenging the Status Quo: Innovations in MWC Ash Management." The first article, a summary of work sponsored by the U.S. Department of Energy, reviews seven thermal processes for municipal waste, including two vitrification systems. The second article reviews demonstrated disposal options for ash from municipal waste combustion sources.

1. Sorting – Catenation, Inc., Green Bay, Wisc.

Catenation Inc. operates sorting systems that can process 70 million pounds each year of plastic colored or natural HDPE, producing HDPE mixed bales; PET and HDPE; 1-through-7 mix; and mixed PET. Custom-made, high-speed, computer-driven vision equipment scan and sort every plastic bottle by recycling category. After sorting, the material is granulated, washed and blended into 40,000-pound loads that have the same appearance and properties front and back.

2. Grinding and Recycling Vinyl Products – Nicos Polymers & Grinding, Easton, PA

Nicos Polymers & Grinding, Easton, Pa., uses a proprietary separation technology to divert more than 25 million pounds of vinyl scrap from landfills each year. The company recycles a wide stream of vinyl waste including vinyl-backed carpets and floor mats and reinforced vinyl garden hoses. The company also recycles flooring, roofing membrane and blister pack. Scrap from vinyl siding will be ground for recycling at a Habitat for Humanity International (HFHI) conference.

3. Automated Sensor for PEN/PET Separation – Magnetic Separation Systems, Nashville, TN

Magnetic Separation Systems, Nashville, TN is working with Amoco Chemicals and Shell Chemical Co. to develop a technology to automatically sort bottles containing polyethylene naphthalate (PEN) polymers from bottles containing polyethylene terephthalate (PET).

Separating bottles containing PEN content would be useful because of Pen's higher commercial value and because it would allow reclaimers the ability to control the level of Pen in the PET, as needed for some recycling. PEN polymers are used in fabricating containers for drugs, food and beverages. The PEN content in plastic bottles ranges widely, from 5 to 100 percent.

A first generation PEN sensor was field tested at throughputs of 1,500 to 2,500 pounds per hour for four types of baled containers with various PEN contents. During these tests, the sensor sorted bottles in MSS' BottleSort equipment at 80 to 85 percent efficiency. Manual labor systems using fluorescent light as an aid typically reach only 75 to 80 percent efficiency.

The PEN sensors are being improved before a second phase of demonstrations, which begin in August at Wellman. The objective of the next demonstration is to attain sorting efficiencies of 90 to 95 percent similar to those achieved by optical systems already in commercial use.

4. Split Recycling Containers – Visalia, CA

According to Tom Baffa, waste services manager for Visalia, the city finished converting to once-weekly-collection for 26,000 households in April 1996. In its first full year of city-wide residential operation, ending in April 1997, about 1/3 of the tonnage diverted was from the recycle side of the split container; the other 2/3 comes for a separate yard waste collection program. Visalia has also begun testing split containers on some commercial routes. Because of the significantly different waste stream, Visalia is considering using the container to collect wet and dry streams, or some other combination, instead of the typical garbage and recyclables.

5. Recycling of Wine Bottles – Evergreen Glass, Inc., Stockton, CA

Evergreen Glass Inc., headquartered in Stockton, CA, is beginning operation of a high-volume, state-of-the-art facility to recycle wine bottles by washing them and making them reusable. This is expected to provide fresh, new, revenue-enhancing alternatives to the refuse-removal industry. Evergreen plans to process 9 million cork-finish bottles in its first year and more than 40 million bottles by its fifth year.

6. Secondary uses for Glass Cullet – Glass Packaging Institute, New Jersey

According to the Glass Packaging Institute, there are several options or secondary uses for recycled glass, known as cullet. Secondary uses include a wide range of applications and markets. The following were taken direct from the Institute's website. 1. Abrasives: finely ground container and non-container glass may be used in sand blasting. Abrasives have no silica, so they will not cause silicosis. 2. Aggregate substitute: container and non-container glass may be used in concrete, roadbeds, pavement, and parking lots. They can be used as a drainage medium, as backfill, or for landscaping. 3. Bead Manufacturing: melt container and non-container glass into rounded glass pellets or beads and use in reflective paint for highways, as well as in cleaning metals. 4. Decorative Applications: cullet may be used in ceramic tiles, picture frames, costume jewelry, and some household items. 5. Fiberglass: recycled glass may be used in the manufacture of fiberglass. This industry is the second highest volume user of post-consumer glass. 6. Frictionators: recycled glass may be used to make frictionators for lighting matches and firing ammunition. 7. Fluxes/Other Additives: glass powders may be used as lubricants, core additives and fluxes in metal foundry work and fabrication, as well as flux/finers in the ceramics industry.

7. Gasification and Vitrification – ATG, Inc., Richland, Washington

ATG's SAFGLAS system is a proprietary process that has thermally destroyed millions of pounds of organic material and stabilized the remaining inorganic material via vitrification in a solid glass. This end product eliminates the need for further treatment such as compaction to prevent dispersion or stabilization to pass the EPA's Toxic Characteristic Leachate Procedure (TCLP) for acceptance at the disposal site. Volume reductions are similar to incineration and have been in excess of 200:1. In addition, the SAFGLAS process is a more versatile thermal destruction technology and has processed a wider variety of heterogeneous waste streams than can be introduced safely into conventional incineration systems.

The unique flexibility of the SAFGLAS follows from the simultaneous destruction and stabilization of the waste. This allows SAFGLAS to handle difficult to treat heterogeneous waste streams such as dry wastes (i.e., plastics, paper, wood, cloth, etc.), ion exchange resin, aqueous liquids and oils, filter media, and difficult to process sludges.

8. Gasification and Vitrification – Seiler Pollution Control Systems, Dublin, Ohio

Sieler Pollution Control Systems Inc. has been on the cutting edge of toxic and hazardous waste processing for more than 10 years. Applying science to theory, Seiler developed an innovative technique that transforms hazardous wastes into non-hazardous recyclable materials through high temperature vitrification (HTV).

After several years of research, developments and testing, Niklaus Seiler headed a team that constructed the first pilot High Temperature Vitrification system in 1988. Since the initial start-up, significant refinements have been made in the system's electronics, linings and controls. Diverse hazardous materials have been successfully processed and tested over the years. Some of the materials tested were paint sludge, hydroxide sludge, slag's, electroplating sludge, incinerator ash, asbestos, sand blasting residues, lead glass, ammunition, battery wastes, neon lights, hospital wastes, contaminated oils, toxic sewage sludge, shredder light fractions from car shredders chemicals, mercury containing pesticides and many others.

Seiler expertise in waste treatment is evident in the ever-growing number of patents the company now owns. These include patent rights for: inductive medium-frequency vitrification systems; a barrel burnout installation for barrels with solidified waste; a double-piston pump; a hydraulic dosing pump for solid and highly viscous waste flows; a recycling system for lead batteries; and pyrolytic destruction of aluminum from aluminum/plastic compound foils.

9. Refuse Derived Fuel – Toyota Motor Corp., Toyota, Japan

Power generation from Refuse Derived Fuel(RDF) is an attractive utilization technology of municipal solid waste. To explain behavior of RDF fired fluidized bed incinerator, RDF was continuously burnt in a 30 X 30 cm bubbling type fluidizer-bed combustor. It was found that 12 kg/h of RDF feed rate was too high a feed rate for this test unit and that the corresponding CO level was higher than 500 ppm. However, 10 kg/h of RDF was an acceptable feed rate and CO level was kept under 150 ppm.

Secondary air injection and changing air supply ratio from the pipe grid were effective for the complete combustion of RDF. It was also found that HCl concentration in flue gas was controlled by the calcium component contained in RDF and its level was decreased with decreasing the combustor temperature.

10. Glass Melter – SIA “Radon”, Moscow, Russia

“Synroc-glass” material was obtained from incinerator ash and Synroc additives by melting at 1350-1500°C. Waste oxide content in the waste form reached 30-35 wt.%. Material contained both vitreous and crystalline phases.

11. Vortex Slagging Furnace – Tsukishima Kikai Co., Ltd. (TSK), Tokyo, Japan

Two commercial plants use the Vortex Melting system to incinerate sludge and treat ash. About 90% of inorganic sludge fed into the system was immobilized as slag, and heavy metals were immobilized in the slag with no leaching effects. The slag can be recycled into materials for construction and other effective uses.

12. Refuse Derived Fuel Supplement – Toyota Motor Corp., Aichi-ken, Japan

Conventional methods of power generation from waste have been limited by the degree to which the steam pressure and temperature in the energy recovery boiler for can be increased, due to the effects of the corrosive compositions of waste that attack the furnace casing. In the present study, coal and waste were premixed and incinerated, then evaluated for their combustion characteristics, with the aim of achieving a method that ensures high temperature, high pressure, and sufficiently stable steam recovery.

Since identifying combustion characteristics of the waste is critical to increasing energy recovery efficiency and consequently improving power generation efficiency, a two-furnace construction for the combustion furnace was employed. This led to a highly effective solution to the problems found in conventional methods. Coal and waste are premixed and incinerated while stably recovering steam at high temperature and high-pressures.

13. Metal Separation Plant – Hewlett-Packard Co., Palo Alto, CA

Hewlett-Packard Co., Palo Alto, California and Noranda Inc., Toronto, have opened a metal separation plant designed to sort and recover recyclable materials from computers and other electronic hardware. Hewlett-Packard and the Micro Metallics subsidiary of Noranda say the new facility is unique in both its “size and ability to process a diverse stream of electronic hardware and other materials.” Potentially recyclable materials commonly found within the computer hardware to be processed include gold and silver as well as copper, steel and plastic polymers.

14. Metal Recycler - Tung Tai Trading Corporation, San Francisco, CA

Tung Tai Trading Corporation recycles the following materials at its plants in the People’s Republic of China:

- Electronic Scrap
- Telephone Relay/Scrap
- CATV/Coaxial Cable
- Transformer Cores
- Ballasts/Elec. Meters
- Insulated Cable
- Honey/Yellow Brass
- Birch/Cliff, Cu Bearing
- 6063 Ext./EC Wire
- Copper Clad/Laminate

15. Mercury Recycling (Fluorescent Tubes) - ATG Inc., Fremont, CA

ATG's Hazardous Lighting Waste Recycling Facility has recycled millions of fluorescent tubes and brokered thousands of PCB-ballasts and non-PCB ballasts. The system at the corporate owned Fremont Facility treats the fluorescent tubes by separating bulbs into the primary components of glass, mercury, and aluminum for beneficial reuse.

16. Mercury Recycling (Solid & Liquid Sources) – Bethlehem Apparatus', Hellertown, PA

Bethlehem Apparatus' mercury waste recycling provides customized solutions for solid and liquid mercury waste. The company's 29 retorts are preprogrammed to process over 200 different types of mercury wastes. The proprietary calomel processing system converts calomel into mercury/mercuric oxide and then into elemental mercury. The chlorine removed is then disposed of as a non-hazardous salt water. Recovered mercury is quadruple diluted, then sold to industrial users.

17. Roadside Erosion Control – California Integrated Waste Management Board, Sacramento, CA

The popularity of curbside green waste collection programs has led to the installation of organics processing facilities in an increasing number of municipalities. Grinding and mulching machines are used to produce wood chips and mulches for soil amendments, or as feedstocks for composting. Composting facilities range in size and approach from small static pile operations and large open-air windrow composting activities to enclosed in-vessel composting plants. Finding markets for mulch and composted materials is an ongoing challenge almost everywhere, but there are signs things are changing. In California the state's department of transportation has closed ranks with the California Integrated Waste Management Board and developed specifications for the use of mulched green resource for roadside erosion control.

18. Infrastructure Recycling – Svedala Industri, Pittsburgh, PA

Essentially the concept of infrastructure recycling involves the notion of processing redundant construction materials, such as concrete, brick, and asphalt from demolition sites in order to produce new construction materials of a quality equal to that of virgin materials. Another form of economic incentive is the prices paid for disposal of materials. In the Copenhagen region, for example, the cost of disposal for mixed demolition materials is approximately \$100 (U.S.) per ton. Whereas a "pure" consignment of waste concrete can be deposited with RGS 90 (for recycling) at a cost of only \$5 (U.S.) per ton.

19. Foamed Structural Lumber Products – Central Hudson Gas & Electric, New York

Fly ash, the residual that is captured from the flue gas stream when combusting waste or coal or other solid fuel, may be on its way to boosting economic growth in the Hudson Valley of New York. The New York State Energy Research and Development Authority (NYSERDA) is sponsoring a project with Ecomat Inc., Poughkeepsie, NY and Central Hudson Gas & electric to incorporate fly ash into foamed structural lumber products that will replace building materials in some applications. As indicated in SWANA's ash survey, WTE plants pay an average of \$40 per ton to dispose of their ash, a rate similar to what utilities pay nationwide. NYSERDA is hoping to demonstrate that "with a little innovation and forward thinking," economic growth problems and environmental problems can be solved simultaneously.

Ecomat established a pilot facility in Poughkeepsie to demonstrate its manufacturing of foamed thermoset structural lumber products. The products would be used to replace items currently made from wood. An advantage of fly ash lumber is that, unlike thermoplastic based lumber, it will not distort when exposed to sunlight, according to Ecomat executive vice president John Mushovic. The project will initially concentrate on ash from a single utility to keep feed stocks consistent. However, a successful demonstration could lead to exploring the use of other types of ash, including that from municipal waste combustors. The demonstration and report should be completed by fall of 1997.

The National Associate of Home Builders Research Center will test several prototype products for structural integrity and adherence to code. The most promising of the prototypes will then be developed and evaluated at the pilot facility. If successful, Ecomat will sell licensing rights to other building product manufacturers. Fly ash can also be used to manufacture zeolites for the chemical industry.

20a. Surface Coverings and Roadways – Bay Area Tire Recycling LLC, San Leandro, CA

Bay Area Tire Recycling LLC will soon be operating at the site of the Davis Street Transfer Station in San Leandro, California. The transfer station is operated by a subsidiary of Waste Management Inc., Oak Brook, Ill. The new tire recycling system can process up to 3,000 pounds of whole tires into tire chips per hour. The system can create pieces as small as ¾" in size and remove the steel contained within the tires in a single pass. A further step in the process can reduce the rubber to #40 mesh rubber powder. Bay Area Tire Recycling hopes to find markets for the recycled rubber as modified asphalt, playground safety surface material, and in running tracks and other sport playing surfaces.

20b. Surface Coverings and Roadways – American Ash Recycling, Nashville, TN

American Ash Recycling recycles ferrous and non-ferrous metals recovered from Municipal Solid Waste Combustor Ash. Remaining components of the ash are formed into aggregate and sold for commercial reuse. In Holland, AAR and its affiliates have constructed six MSW ash recycling facilities that recycle approximately 95% of the ash. In Sumner County, Tennessee, AAR mined over 50,000 tons of combined ash and recovered and sold 2 million pounds of ferrous and over 170,000 pound of non-ferrous metals.

Currently, AAR is mining 100 tons per hour of MSW ash in Nashville, TN. Between August 1993 and February of 1994 the Nashville mining plant produced 29,700 tons of aggregate and sold 24,685 tons of that aggregate for applications, including asphalt manufacture, roadbed, structural fill, and pipe bedding. Now, instead of consuming landfill space, over 80% of Nashville's ash is converted into a valuable construction aggregate, approximately 13% of the ash is recovered as high-grade metals, and roughly 5% of the ash is separated as unburned materials and returned to the incinerator.

21. Orchid Potting Mix – JaiTire Industries, Denver, CO

Two Colorado companies have come up with a technological twist on the rustic used tire-as-flower planter motif. Fantasy Orchids, Louisville, Colo., and JaiTire Industries, Denver, have announced the development of a potting medium for orchids derived from recycled tire chips.

Allied Technology Group

Epi-grow consists of recycled tires and uses the properties of rubber to create a superior medium for young orchids, according to Stan Gordon of Fantasy Orchids and Cornelia Snyder of JaiTire. "I saw an increasing need for a new potting medium and when I heard of JaiTire's work with crumb rubber as a top dressing, we started to work with recycled tire chips," says Fantasy Orchid's Gordon. "We tried several different chip sizes, many of which proved unworkable, but after a year and a half (we) have a product which we are proud to offer to the serious orchid grower."

Orchids grow naturally on trees, cliffs, or virtually any surface while extracting much of their sustenance from the air instead of from the soil. Commercial and hobby growers have traditionally used bark, coconut husks or other natural products as potting mediums.

22. Controlled Landfilling – Yolo County Department of Public Works, Davis, CA

Yolo County Department of Public Works is demonstrating a new, unconventional landfill management strategy known as “controlled” or “enhanced” landfilling to manage solid waste at its Entral Landfill outside Davis, CA. The overall objective is to manage landfilled solid waste for rapid completion of total gas generation and maximum gas capture.

Landfill decomposition, or methane generation, is accelerated by improving conditions for biological processes. This is accomplished through carefully controlled additions of both water and leachate. Test cells are covered with gas-impermeable membranes to contain landfill gas and prevent its emission to the atmosphere. Permeable layers of shredded tires cover the waste in both cells to serve as a conduit for gas to reach various collection points. This “controlled” landfilling technology is expected to offer an important advance in landfill operation, enabling low-cost mitigation of methane emissions, maximization of beneficial energy capture, an ultimate landfill volume reduction, and a long-term reduction in waste management costs.

23. Alternative Daily Covers: Commercial Products – RMT, Inc., Austin, Texas

The single most valuable asset of a landfill is the airspace available for waste disposal. Efficient use of this asset can translate directly into increased profitability, lower operating costs, and longer service life of a landfill. The application of a soil daily cover, typically 6 inches thick, can account for 5% to 33% (or more) of a landfill’s design capacity, depending on cover thickness, waste filling rates, and operation practices. Accordingly, daily soil cover can result in a significant loss in revenue. As a result, alternative daily covers (ADCs) are becoming increasingly popular of use in landfill application. Several types of ADCs are available commercially:

1. reusable tarps
2. thermally degradable membranes
3. spray-applied slurries
4. spray-applied foams.

24. Alternative Daily Covers: Waste Products - RMT, Inc., Austin, Texas

State regulators have approved a variety of waste ADCs for use at municipal and/or non-hazardous waste landfills. They include:

- Hydrocarbon contaminated soils
- Municipal solid waste incinerator ash
- Municipal wastewater treatment plant sludge treated with lime (biofix process)
- Municipal water treatment plant sludge
- Paper mill primary clarifier sludge
- Paper mill bark ash
- Dredge spoils
- Processed (i.e., 2-inch minus) C& D waste
- Sand from foundry castings
- Auto-fluff (“soft residues from automobiles recycling/grinding operations)
- Tire Chips

25. Shredding - Svedala Industri, Pittsburgh, PA

Svedala hammermill shredders and accessories have processed a variety of materials, including:

- Aluminum cans
- Aluminum sheet
- Copper bearing material
- Tubing, pipe, sheet, siding
- Engines, transmissions (assembled or stripped)
- Construction and demolition debris
- PET-bottles
- Asphalt
- Concrete
- Refuse derived fuel

Waste Streams and Materials Processed by New Systems

No.	System	Appliances	Electronic Components	White Goods	Yard Wastes	Batteries Fl. Lamps	Oil	Tires	Construction & Demolition	Food	Plastics	Glass	Tin Cans	Biosolids	MWC Ash	Landfill Operations	Recycling Collection	Restricted Soil
1.	Sorting										X							
2.	Grinding and Recycling Vinyl Products										X							
3.	Automated sensor for PEN/PET separation										X							
4.	Split Recycling Containers																X	
5.	Recycling of Wine Bottles											X						
6.	Secondary uses for Glass Cullet											X						
7.	Vitrification of Ash - SAFGLAS		X		X	X	X	X		X	X	X	X	X	X			
8.	Vitrification of Ash - SEILER		X		X	X	X	X		X	X	X	X	X	X			
9.	Refuse Derived Fuel				X		X	X		X	X			X				
10.	Glass Melter														X			
11.	Sewage Sludge - Vortex Slagging Furnace													X	X			
12.	Refuse Derived Fuel Supplement				X		X	X		X	X			X				
13.	Metal Separation Plant		X															
14.	Metal Recycler		X	X														
15.	Mercury Lamp Recycling					X												
16.	Mercury Recycling - Solid and Liquid Sources					X												
17.	Roadside Erosion Control				X													
18.	Infrastructure Recycling								X									
19.	Foamed Structural Lumber Products														X			
20.	Surface Coverings and Roadways							X							X			
21.	Orchid Potting Mix							X										
22.	Controlled Landfilling							X								X		
23.	Alternative Daily Covers - Commercial Products	X						X	X					X	X	X		
24.	Alternative Daily Covers - Waste Products							X	X						X			X
25.	Shredding	X		X	X		X	X	X		X	X						