

SOLID WASTE MANAGEMENT IN AKRON, OHIO: A FULLY INTEGRATED RESOURCE RECOVERY SYSTEM IN OPERATION

RAY KAPPER
City of Akron, Ohio
Akron, Ohio

DAVID B. SPENCER
wTe Corporation
Bedford, Massachusetts

JAMES F. PATIN, JR.
Dow Chemical
Granville, Ohio

ERIC EXLEY
Fairfield Service Company
Akron, Ohio

ABSTRACT

This paper presents the performance and operating results of a fully integrated solid waste management system which is in operation today in Akron, Ohio. The overall system involves RDF combustion, recycling, composting, and landfilling. The projects all represent public/private partnerships between industry and the City which could be a model arrangement for other communities throughout the United States. In 1988, the Recycle Energy System (RES), an RDF combustion facility, exceeded its rated capacity of 1000 tons/day (TPD) (909 tpd) of municipal solid waste for the first time in its 10 year operating history. The RES produces steam, hot water, chilled water, and electricity. A Materials Recycling Facility, placed in service in April of 1989, processes commingled recyclables (ferrous metals, aluminum, glass, plastics, and paper) received from the City's curbside collection program. An innovative Plastics Recycling Facility takes the mixed plastics which have been separated from the other recyclables and separates them from each other by individual resins. A composting plant, operational since November 1987, processes sewage sludge mixed with sawdust and shredded bark, producing 40,000 tons of compost per year. The final component, the landfill, receives the ash residue from the RES as well as 350 TPD (318 tpd) of nonprocessable municipal, commercial, and industrial solid waste directly.

INTRODUCTION

The City of Akron, Ohio has one of the most flexible, fully integrated solid waste management systems in the United States. Akron is in the unique position of being able to demonstrate how recycling, composting, incineration, and landfilling work together. Further, all of these system elements have been designed, built, and are operating through public-private partnerships—the integration of the City's Department of Public Service and private industry. Through its contractual arrangements, the City maintains direct control of essential public services, while benefiting from the technology and incentives of the private sector.

As shown in Fig. 1, the elements of Akron's solid waste management system are the Recycle Energy System (RES), the Materials Recycling Facility, the Compost Facility, and the Sanitary Landfill. These elements are regional facilities having the capacity to handle much larger quantities of wastes than are generated in Akron alone. They have been built to meet the long term growth needs of the greater Akron area.

Incineration

The City of Akron owns and oversees the operation of the Akron Recycle Energy System (RES) which is the nation's first RDF plant to use a dedicated boiler. The plant receives 1000 TPD (909 tpd) of municipal, commercial and industrial solid waste and produces

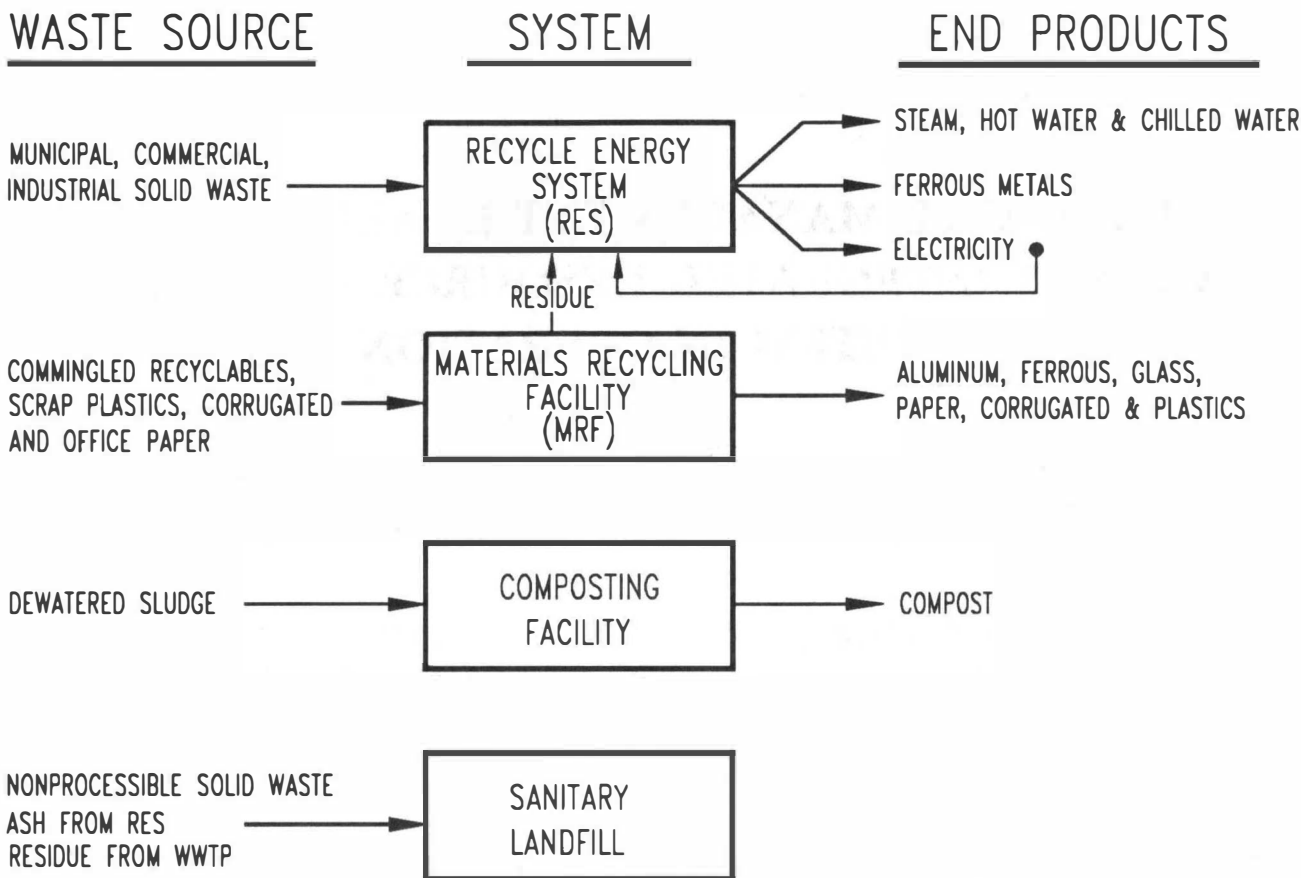


FIG. 1 ELEMENTS OF AKRON'S SOLID WASTE MANAGEMENT SYSTEM

energy in the form of steam, hot water, chilled water and electricity. Waste is delivered from Akron, three surrounding communities, and from about 60 private haulers within Summit County. Seasonal service is provided to some cities in adjacent counties. The City owns its own steam distribution network as well as hot and cold water distribution systems. Furthermore, about 4 MW of electricity is cogenerated at the plant to meet internal electric needs of the RES. Ferrous metals, about 50 TPD (45 tpd), are recovered and sold. As backup capacity to the RES, the City purchased a combined oil-fired and coal-fired power plant from BF Goodrich. This facility, like the RES, is operated by wTe Corporation, under subcontract to the Akron Department of Public Service.

Recycling

A Materials Recycling Facility (MRF), privately owned and operated by wTe Corporation, has been

placed in service to process 5–10 tons/hr (9 tph) or 80 TPD (73 tpd) of commingled recyclable containers and 15 tons per hour (14 tph) or 120 TPD (110 tpd) of paper and corrugated. With the public relations support of Keep Akron Beautiful and the financial support of Goodyear Tire and Rubber Co. and Uniroyal/Goodrich, the City of Akron, through its Public Service Department collection crews, collects recyclables from about one-quarter of the City (i.e., 12,000 homes) and delivers them to the MRF. Corrugated boxboard is delivered by private commercial haulers. At the centralized MRF, paper, corrugated, clear glass, amber glass, green glass, ferrous cans, aluminum, and mixed plastics (including HDPE, PET, PS, PVC, PP and other rigid plastics) are sorted, processed, and shipped to market. At the present time, much of the sorting is accomplished by hand. By mid-1990, an automated plastics processing system will be installed to separate commingled plastics into various resin types. This plastics recycling facility is part of a technology

development program cosponsored by Dow Chemical and wTe. Any residue remaining at the MRF is delivered to the RES.

Composting

The City of Akron constructed a Composting Facility which was designed to process 73 dry tons per day (66 dt/day) of approximately 21% solids sludge per day, based on a two-shift operation, 7 days per week. The plant is currently operating on a 5 day per week, one shift basis processing approximately 25 dry tons (23 dt) of sludge per day. The process employs the Paygro technology. The treated sludge is combined with bark and sawdust to make compost. The system produces 467 cu yd (357 m³) of compost per day which is marketed to topsoil blenders, nurseries, and landscapers. Fairfield Service Company operates the plant and markets the output products under subcontract to the City.

Landfilling

Finally, the City owns and operates its own sanitary landfill under the direction of the Department of Public Service. The landfill receives and places 350 TPD (318 tpd) of municipal, commercial, and industrial solid waste as well as ash from the Akron RES, and ash, grit and screenings from the wastewater treatment plant. The economic merit of ash processing and/or ash stabilization and recycling is being studied. Tires, which are shredded all year long, are stored at the landfill and burned at the Akron RES during the coldest months of the winter when steam demand is greatest and waste supply is lowest.

AKRON RES: A SUCCESSFUL RDF COMBUSTION FACILITY

The Akron Recycle Energy System (RES) has completed its third full year of operations under the control of the City's Department of Public Service. Significant improvements have been made in its performance. Numerous safety improvements have been implemented. 1988 marked the first year the RES surpassed its design capacity, averaging over 1000 TPD (909 tpd) on a 5 day per week basis (TPD-5) throughout the year.

Background

In late 1970, the City of Akron, Ohio initiated an innovative solid waste disposal program to control the

future costs for waste disposal as well as to supply low cost, reliable energy for its downtown area. Emphasis was placed on preserving the environment and aiding the conservation of natural resources through the generation of energy from municipal solid wastes. Part of the reason for building the RES was to replace a coal-fired steam plant operated by Ohio Edison which provided steam to the downtown central business district and was scheduled to close.

In 1979, construction of the Akron Recycle Energy System was completed and operations commenced for the nation's first refuse-derived fuel (RDF) dedicated boiler, waste-to-energy facility. Initial capital cost was \$54.5 million, \$42.2 million for construction and the remainder for contingencies and debt reserve funds.

Because the Akron project was novel, many aspects of it were untried. As a result, numerous problems were encountered—primarily with the RDF preparation and materials handling systems. Production was far below design capacity, and operating costs increased considerably beyond those anticipated. There was insufficient income to cover operating costs, let alone to cover required debt service payments. Changes to the operation involved both a change in operator and a capital investment to correct plant deficiencies at an additional cost of \$24.4 million. \$11.4 million was for construction and the balance was to pay certain operating costs, past due debt service, and bond costs.

After reconstruction, the RES experienced several explosions in the RDF processing area, and, in December 1983, the plant experienced a very serious explosion which essentially shut down the RES for nearly 3 months. In December 1984, a second severe explosion occurred which resulted in the deaths of three workers and caused the Akron RES to shut down for nearly 10 months. It resulted from the unauthorized disposal of 80 tons (73 t) of highly volatile hazardous wastes. The explosion was unrelated to RDF processing. Ignition occurred at the boiler face.

In October 1985, the operation of the RES was resumed as a "public enterprise" under the direct control of the City. The plant is currently enjoying the largest sustained period of uninterrupted service in its 10 year operating history. Steam deliveries have been continuous and 95% of the steam generated is from firing RDF as compared to 50–60% in past years.

System Description

Figure 2 illustrates the overall system design of the RES. Refuse is delivered by packer trucks, dump trucks, and transfer trailers to a receiving area. Up to 200 loads per day are received. Operating personnel

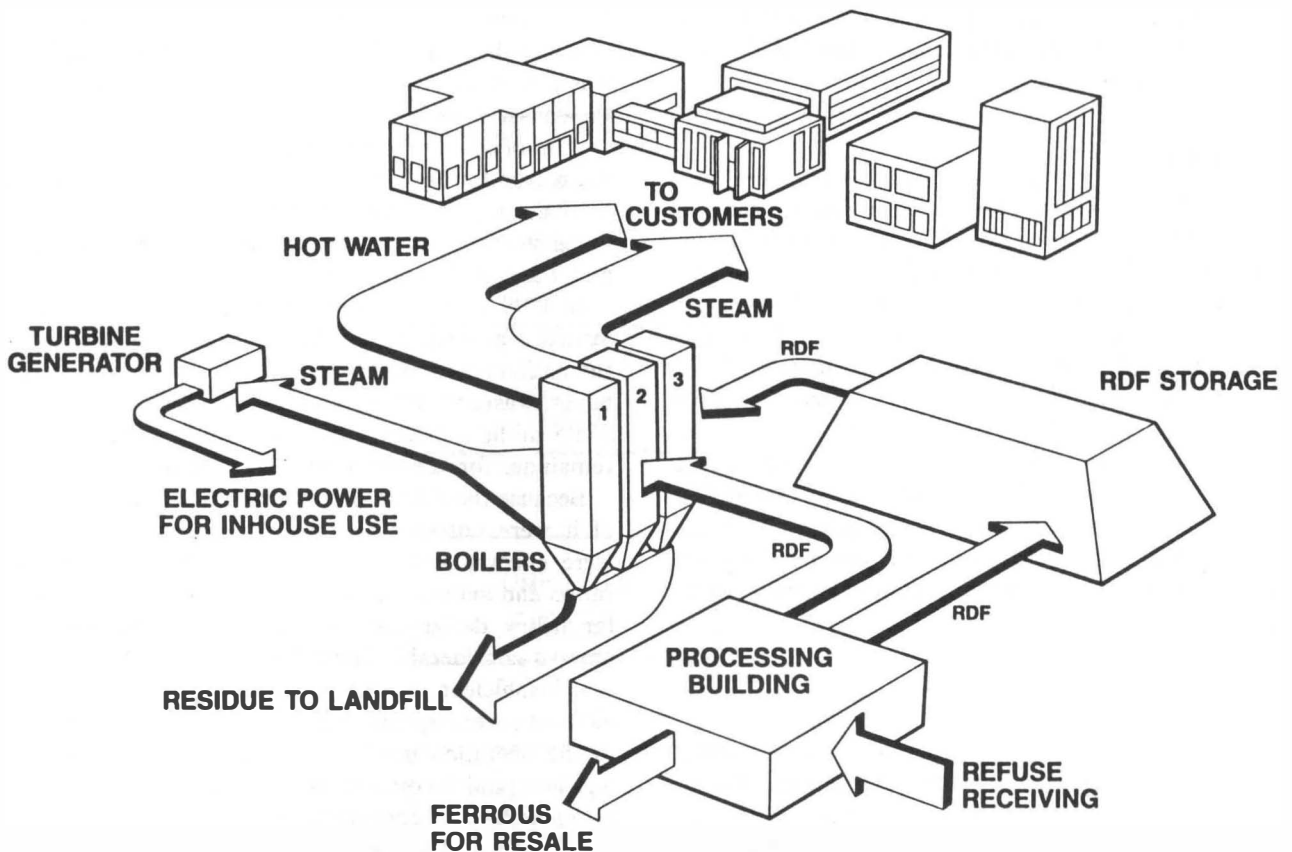


FIG. 2 OVERALL SYSTEM DESIGN — AKRON RECYCLE ENERGY SYSTEM

inspect each load of waste as it is dumped into the pit to be sure it does not contain hazardous material.

The facility's major components are: two 1150 hp (1118 kW) shredders; a two-stage drum type magnetic separator, miscellaneous conveyors and an ash handling system; three 125,000 lb/hr (56,690 kg/h), saturated steam, gas/RDF fired boilers; two four-field electrostatic precipitators; and two 2 MW turbine generators which produce electricity for in-plant use. Exhaust steam from the turbines is used in the deaerator tanks, and to make hot water. In addition to in-plant use, hot water is sold to local businesses and a condominium complex adjacent to the plant.

The Akron RES includes an 18 mile steam distribution network through which steam is provided to about 130 commercial businesses, office buildings, hotels, and apartment complexes in the Central Business District; and to Akron City Hospital, the University of Akron, and Uniroyal/Goodrich (formerly BF Goodrich). The City assumed ownership of the BF Goodrich steam plant in November of 1987. With this

plant as backup, the reliability of RES steam service and the ability to service a much broader customer base has been assured.

During 1988, the RES added chilled water capability with the completion of a new 2500 ton absorption chilled water production and distribution system.

Waste Availability and Fuel Contracts

Waste is furnished to the RES under several different tipping fee schedules and service contracts. The waste supply contracts have been devised to "match" waste supply to energy demand. Figure 3 illustrates the amount of waste received at the RES through 1988.

The City's winter steam load often approaches 400,000 lb/hr (181,400 kg/h); therefore, use of the least expensive fuel is an economic necessity. Rather than purchase gas to meet this demand, it is much more cost effective to receive and process waste.

Fuel needs beyond those which can be met by the available waste supply sources come from tires and

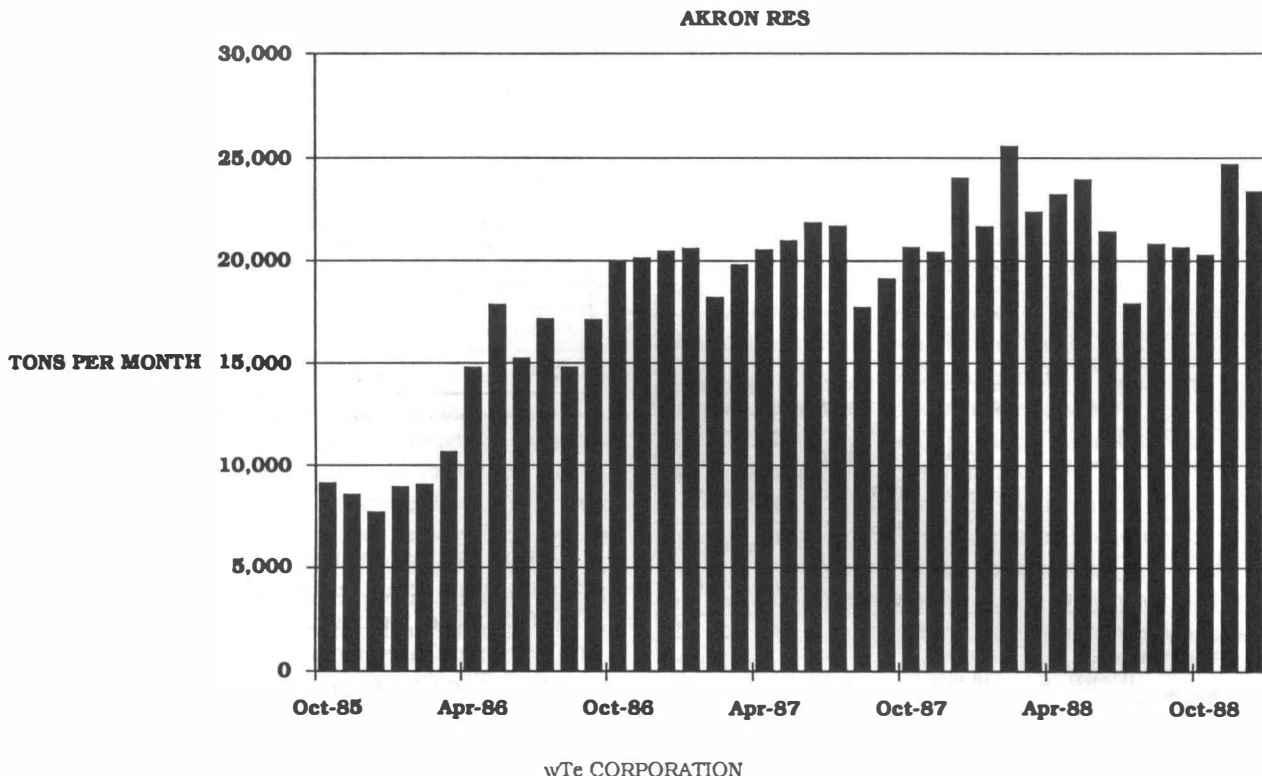


FIG. 3 WASTE RECEIVED

natural gas. Tires are tipped and processed in a tire shredder previously located at the Hardy Road Sanitary Landfill. Shredded tire chips can be a high quality storable fuel which have in the past been supplied on demand and burned at a rate of one ton of tires per ten tons of MSW.

Future plans are to maintain waste supply at the 1000 TPD (909 tpd) design level. The City has implemented a new tipping fee schedule: \$16/ton for Akron waste and \$39/ton for non-Akron waste. This represents a significant increase over 1988 tipping fees of about \$12/ton. To insure adequate waste supply, the City has now implemented flow control; a policy which was tested in the Supreme Court and decided in favor of the City, but was never previously implemented.

Production

RES production levels are shown in Table 1. In 1988, the RES processed a total of 265,913 tons (241,740 t) of waste, averaging 1020 TPD (927 tpd). The amount of steam sold in 1988 was 1,671,280 Mlb (757,925 t),

a 170% increase over 1986. The reintroduction of Uniroyal/Goodrich as a steam customer was a major factor in achieving this sales growth. In addition, a steam reservation agreement was reached in August of 1987 with Ohio Edison to purchase steam which had previously been vented to the atmosphere during periods of low steam demand. Currently, the only steam that is not sold is used to generate power for in-plant use and normal system losses.

Operating Cost

RES operating costs over the past 3 years have increased. However, when presented on a cost per unit basis, costs have decreased. In 1986, operating costs were \$56.81/ton of waste processed. In 1988, this cost was reduced to \$42.90/ton. In addition to costs associated with processing increased waste quantities, additional costs were incurred as the result of taking on operation of the BF Goodrich steam plant as backup to the RES. Table 2 gives a comparison of costs for the 3 years.

TABLE 1 AKRON RES — PRODUCTION SUMMARY

	1986	1987	1988
Waste Processed @ RES	186,243	245,639	265,913
- Solid Waste (tons)	183,456	242,688	262,148
- Tires (tons)	2,780	2,951	3,765
Tires Shredded (tons)	5,626	5,554	3,750
Steam Generated (Mib) (tonnes)	1,754,695 (797,589)	1,769,411 (804,278)	1,986,454 (902,934)
Steam from RDF (%)	75	94	94
Steam Sold (Mib) (tonnes)	612,000 (278,182)	744,100 (338,227)	1,671,280 (754,673)
Hot Water Sold (MMBTU) (kJ)	2,998 ⁶ (3,163x10 ⁶)	4,333 ⁶ (4,571x10 ⁶)	3,279 ⁶ (3,459x10 ⁶)
Chilled Water (tons) (kJ)	0	0	1,516,000 ⁶ (19,193x10 ⁶)
Ferrous Scrap			
- Landfilled (tons) (tonnes)	9,249 (8,408)	962 (875)	0 (0)
- Sold (tons) (tonnes)	0 (0)	8,585 (7,805)	9,900 (9,000)

TABLE 2 AKRON RES — COST SUMMARY

COSTS	1986	1987	1988
Plant Labor	\$3,278,000	\$4,007,000	\$4,282,000
Subcontracts & Materials	2,735,000	2,769,000	3,961,000
Utilities	1,320,000	1,540,000	1,818,000
Natural Gas	2,550,000	548,000	725,000
Project Administration & Management	699,000	489,000	644,000
TOTAL	\$10,582,000	\$9,353,000	\$11,430,000

Revenues

As shown in Table 3, revenues have steadily increased since the RES reopened. Tipping fees in 1988 of \$2,822,000 represent a 78% increase from 1986, primarily due to increased waste received. Steam sales also experienced a significant improvement during this period, increasing to \$6,066,000 in 1988 from \$4,803,000 in 1986, an increase of 26%.

TABLE 3 AKRON RES — REVENUE SUMMARY

REVENUES	1986	1987	1988
Tipping Fees			
- Solid Waste	\$ 1,582,000	\$ 2,191,000	\$ 2,822,000
- Tires	36,000	51,000	43,000
Sales			
- Steam	4,803,000	5,003,000	6,066,000
- Hot Water	21,000	45,000	38,000
- Ferrous Scrap	1,000	18,000	29,000
- Chilled Water	0	0	119,000
Miscellaneous	301,000*	2,000	13,000
TOTAL	\$ 6,744,000	\$ 7,310,000	9,126,000

* Includes an explosion insurance claim amount of \$167,000 plus income of \$134,000.

During the last quarter of 1986, the potential for revenue from scrap ferrous was realized. About 50 TPD (45 tpd) of ferrous metals produced at the facility are being purchased from the City under a long term contract. The City received over \$50,000 in cash payments since 1986 while offsetting an estimated \$185,000 in hauling and landfilling costs. During 1989, the City's share of revenues from ferrous sales have been contributed as tipping fees to process the City's recyclables at the MRF.

The 1989 Operations Plan estimates break-even economics for the first time in the history of the RES. Tipping fees were previously set at "market" rates rather than at rates needed to achieve "break-even" economics. Until now, operational losses have been subsidized through the City's General Fund. So far, neither the City nor the RES have made contributions toward retirement of debt (which was defeased by the City). It is anticipated that the majority of additional revenues will be derived through increased tipping fees and that debt service payments will begin to be made soon to retire past debts.

RECYCLING PROGRAM

In April 1989, Akron initiated a demonstration program for the curbside collection of commingled (mixed) recyclable materials including tin and aluminum cans, glass bottles and jars (clear, brown, and green), rigid plastics, and newspapers. The City has also begun a high grade office paper collection program in its municipal buildings. The principal goal of Akron's recycling program is to recover the maximum amount of valuable resources and reduce the City's dependence on its landfill. Recycling will also reduce

the wear and tear of abrasive noncombustibles (metals and glass) on the Recycle Energy System and will reduce the volume of ash remaining after incineration.

The MRF accepts and processes Akron's recyclables as well as commercial paper, corrugated fiberboard, and commercial plastics (variety of types). A unique feature of this facility is the Plastic Recycling Facility (PRF), a research, development, and demonstration project intended to provide an overall understanding of plastics recycling, including collection and separation, and refining materials for reuse. The private investment in the MRF/PRF is on the order of \$4 million.

The City of Akron, already a center of polymer innovation, will play a major role in protecting its home-grown polymer industry through ensuring that products produced there can also be recycled. Active recycling of plastics is viewed by Akron as a means of protecting jobs in the community which are dedicated to the manufacture of polymers. The emphasis of the program is on high grade applications for polymers wherein the value of the recycled polymers approaches that of the virgin resins. Those plastics that are too contaminated and cannot be easily recycled will be burned to recover their energy value—as was done before the PRF was placed in service.

Recycling Through Energy Recovery

A survey was conducted by the Department of Public Service involving questionnaires and personal interviews with a representative sample of the families participating in the recycling program. The survey indicated that 35% participate in the program weekly, with another 25% participating every 2 weeks. Approximately 53% of those polled feel that recycling is very important to them.

In the City's view, combustion of paper and plastics which are contaminated or for which there is a zero or negative commodity market, is another form of recycling and another way of preserving the life of its own landfill. This view is supported by the citizens of Akron as shown by their response to one of the survey questions, "Is burning newspapers and making steam an acceptable method of recycling for you?" In response to this question, over 80% of those polled said "yes", with approximately 8% stating that it was not an acceptable alternative. The remainder were undecided.

Given the fact that the public perceives paper as comprising about 50% of the waste stream and that much or all of it is recyclable (which it is not due to

contamination by food waste, wax or plastic coated containers, tissue, etc.), this is an important survey in that it leads one to believe that there is hope for incineration as an alternative for those materials which are not economical or practical to recycle.

Collection

The initial phase of Akron's collection program involves less than one-quarter of the City, a group consisting of about 12,000 households. The program will later be expanded to accept recyclables from the balance of the City, including local industry, and other surrounding Ohio communities.

The City is measuring the participation of the community utilizing different types of home owner separation "containers". Some citizens were provided with 10 gal (45 L) containers, others were provided with 20 gal (90 L) containers. Still others were asked to put their recyclables out in homeowner-furnished trash bags (no special color or design) with a sticker provided indicating that the bag contains recyclable materials.

At first the City collected the recyclables using a pickup truck pulling an "Eager Beaver" trailer. Although the trailer was designed with four compartments, some of the compartments were removed such that commingled containers were placed in one compartment and mixed newsprint was placed in the other. The partition was positioned to provide a balanced load between mixed rigid containers and paper.

Experience showed that this method of collection was very expensive for the City and required significant overtime. To handle the same MSW route as serviced by a compactor vehicle required the collection crew to work about 12 hr/day (versus 8 hr or less for the MSW collection crew). The trailer had to make frequent trips, nearly four per day, to the MRF due to the low density of the recyclables. Also, citizens who put their MSW and recyclables out to the curb the night before had their MSW picked up by the early to late afternoon, but sometimes recyclables were not collected until after dark. This created concern regarding whether the crew had forgotten to collect the recyclables. Customer complaints resulted.

In order to reduce collection costs, and reduce citizen complaints, the City ceased using the "Eager Beaver" and switched to a packer truck. Collection of all of the mixed recyclables including newsprint in a single packer truck was begun with delivery to the MRF where materials are sorted. Although the presence of loose newsprint with the commingled recyclables has



FIG. 4 AKRON MRF

ables has increased sorting time, new ways are being sought to optimize both sorting and collection so that the overall costs are minimized. Technologies are being investigated to accomplish this sorting without the need for handpicking.

The City of Akron also determined that the distribution of containers to the citizens increased the degree of citizen participation in the program. Statistics on this effect are now being compiled. However, the use of containers had the negative effect of increasing time for collection as compared to the time required to pick up recyclables in plastic bags.

Recycling Facility Planning

An important part of the Akron recycling program has been to demonstrate that siting a materials recycling plant can be like any other commercial business—it need not have an adverse effect on the community in which it is located. The Akron MRF occupies a modern, attractive 40,000 sq ft (3716 m²) building in Opportunity Park, a redevelopment area in downtown

Akron. The facility is adjacent to the Recycle Energy System, in the midst of a high rent commercial development area, and within 100 yards (91 m) of a residential community. A photograph of the MRF (with the RES in the background) is provided in Fig. 4.

Plastics Recycling

Given the recent trend toward packaging in plastic, a truly integrated waste management system calls for the development of an effective recycling program for post-consumer plastics. In 1987, plastic packaging was estimated to be 11%, or 6.9 million tons (6.3 million t) of the 62.4 million tons (56.7 million t) of packaging materials used in the U.S. It is widely recognized that recycling the plastic packaging component of the waste stream will be an important contribution to effective waste management. The recycling of plastics will not only divert a significant volume of materials from waste-to-energy facilities and landfills but also will generate revenue for recycling programs.

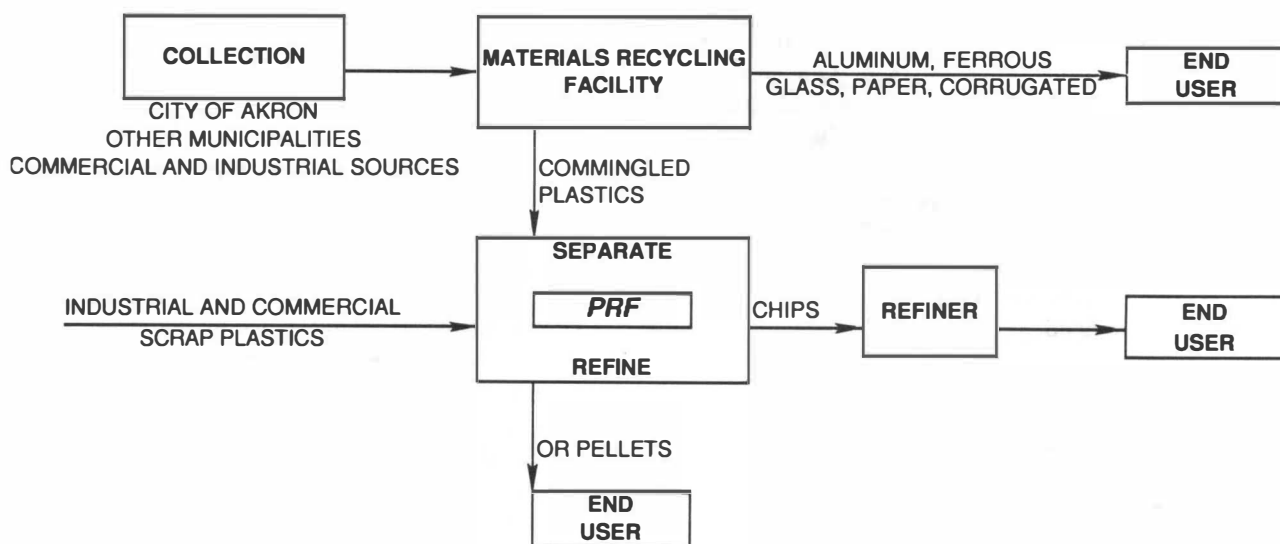


FIG. 5 AKRON RECYCLING PROGRAM

Akron's curbside collection program includes all rigid plastic containers including polystyrene waste generated at home. A review of curbside collection recycling programs across the country discloses that they have only recently started to include plastic containers. Even when the programs include plastics, PET (polyethylene terephthalate) soft drink containers and HDPE (high density polyethylene) milk bottles are the only packaging types typically included. These containers are collected commingled with other recyclables and are hand-sorted either at truckside during collection or at a central facility. There has been a reluctance to collect other plastic packaging because of the difficulties in sorting the materials into homogeneous streams that can be upgraded and reused, and the concern that adequate markets may not be available.

The objective of the plastics recycling program is to develop and demonstrate an effective and efficient separation technology which will make plastics recycling an attractive option for communities.

MRF/PRF System Description

An overview of the recycling program is provided in Fig. 5. The metals, glass, paper, and corrugated received at the MRF are now being hand separated and prepared for end-user markets. Although hand

separation of these materials may not be the most effective method, the small size of the initial collection program at this time does not support the installation of automated equipment.

The commingled rigid plastics recovered in the collection program include all bottles, wide-mouth tubs, trays, miscellaneous packaging, and polystyrene foam. The major polymer types used to produce post-consumer packaging are HDPE, PET, PS (polystyrene), PP (polypropylene), and PVC (polyvinyl chloride).

It is our initial objective to develop and install an automated system that can produce recyclable streams of PET, HDPE, and PS from the commingled plastic materials; these three polymer types make up well over half of the plastics used for consumer packaging. Hand separation would be minimized. We do not plan to install blending and repelletizing equipment in the Akron facility, but will utilize offsite compounders to perform the required preparation for reuse.

A number of technology approaches have been suggested for automating the separation of mixed plastics. Included are shape recognition, size screening, non-contact sensing, and density separations. Because the separation technology development time and funding is limited in Akron, initial focus has been on density separation supplemented by other technologies as appropriate.

The MRF feed material is about 5% plastics by weight. The compositional breakdown shows approximately 60% HDPE, 25% PET, and the remainder PS, PVC, and various other polymers. Our goal is to accomplish the separation to produce individual polymer types which have known markets. Also, we believe there are markets for mixed materials which are expected to be only a small percentage of the plastics collected. Finally, we will view all PRF rejects for their fuel value. Data show that we could recover about 80% of the plastics collected by concentrating on HDPE, PET, and PS.

THE COMPOSTING FACILITY

The City of Akron's Composting Facility accepts dewatered sludge from the City's 100 MGD (379,000 m³/day) wastewater treatment facility. The sludge is combined with sawdust and bark, and digested to produce compost. The City also has a leaf collection program separate from the municipal solid waste and mixed recyclables. At this time, leaves are not composted in the Composting Facility, but as part of the City's long term plan, such composting will be considered.

Background

The City of Akron Engineering and Public Utilities Bureaus began examining composting as a cost-effective method of sludge disposal beginning in 1978. A pilot study was conducted and the feasibility of composting sewage sludge generated at the Akron Wastewater Treatment Plant was demonstrated at the Paygro Composting Facility in South Charleston, Ohio. Based on the results of this demonstration, the City received 85% funding in construction grant money from the U.S. EPA in 1983. The Composting Facility, located in close proximity to the Wastewater Treatment Plant, was dedicated in late 1986 and, in that year, received the American Society of Civil Engineers "Outstanding Engineering Achievement Award." Routine daily operations commenced in November 1987.

The City of Akron generates about 50 MGD (189,500 m³/day) of wastewater. Approximately 20 MGD (75,800 m³/day) of wastewater is received from other communities within the County. After secondary treatment, most of the water can be discharged into the Cuyahoga River. However, about 0.2 MGD (758 m³/day) of 5% solid effluent is pumped to dewatering presses where the solids content is increased from 5%

to 21%. This equates to about 50 dry TPD (45 d tpd) of dewatered sludge.

Half of the dewatered sludge, about 25 dry TPD (23 d tpd), is burned in the City's sludge incinerator system. The dry ash is landfilled. This process consumes significant quantities of gas. Exhaust gases and moisture are discharged into the atmosphere after gas cleaning. At some point in time, the City may investigate introduction of these dewatered sludges into the RES as a means to save on fuel.

The other half of the dewatered sludge, also 25 dry TPD (23 d tpd), is introduced into the Composting Facility along with about 20 wet TPD (18 w tpd) of bark and 20 wet TPD (18 w tpd) of sawdust. By volume, one part of sewage sludge is added to one-half part each of bark and sawdust. A significant quantity of compost is kept in closed circulation. During the composting operation, the materials are combined to generate 55 wet TPD (50 w tpd) of compost. The finished product holds about 35% moisture. The balance of the mass is converted into mostly CO₂ and moisture which is driven off during the composting process.

A diagram of the overall wastewater treatment and compost system is provided in Fig. 6.

The Facility

The Akron Composting Facility itself is an integrated design. It contains sludge processing, component mixing, mechanical composting operations, and product handling functions under one roof. The layout of the facility is shown in Fig. 7. All composting operations, with the exception of long term storage and curing, are contained within a single large building which has overall dimensions of 1080 ft (317 m) by 240 ft (73 m). The building contains about 5.7 acres (23,067 m²).

The overall cost of the plant was about \$33,000,000 of which the City of Akron provided \$5,000,000 and the EPA provided the balance in the form of a construction grant.

Process Operations

The process utilizes the mechanical "Paygro" system for composting. The composting process is based upon an agitated bin system. Precompost mixture is loaded into long rectangular bins, or reactors, provided with air plenums through which air is blown to aerate the mixture. Composting begins and the contents are allowed to achieve composting temperatures of 140°F (60°C). After a period of 5 to 7 days, the mix is ex-

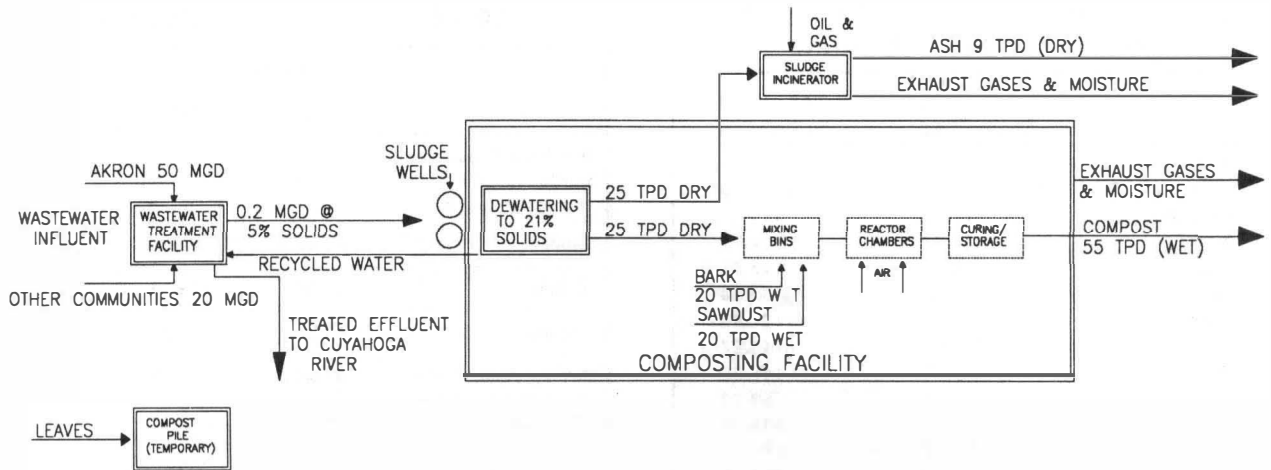


FIG. 6 WASTEWATER TREATMENT AND COMPOST SYSTEM DIAGRAM

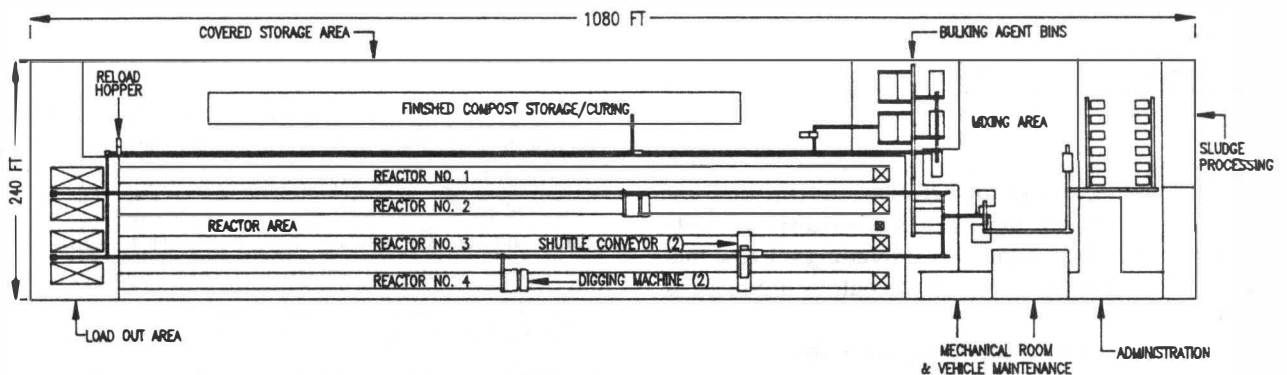


FIG. 7 LAYOUT OF COMPOSTING FACILITY

cavated from its initial loading location and reloaded into another portion of the reactor for additional composting. During this time, the contents of the reactor are remixed. This process is continued approximately once each week for between 14 and 21 days in order to achieve a stabilized product. The Akron facility has four reactors 730 ft (222 m) in length and 20 ft (6 m) wide with an operating depth of 10 ft (3 m). Each of the reactors is loaded with the weekly sludge allotment during the first four days of the week. The fifth day is used to perform routine maintenance, bulking agent movement, and product handling.

Discharged compost cures for an additional 90 days before it is sold. This allows for samples to be taken and lab results to be returned. Over 40,000 cu yd

(30,584 m³) of compost have been produced and sold each of the last two years.

One of the major advantages of composting is volume reduction. For example, on an annual basis, 50,000 cu yd (38,230 m³) of sawdust and bark are combined with 50,000 cu yd (38,230 m³) of sewage sludge in order to produce only 40,000 cu yd (30,584 m³) of compost. Thus, the volume reduction is 60%.

Economics

A comparison of the economics of the sludge incineration program for dealing with sludge to the economics of composting is provided in Table 4 for 1988 through mid-1989. The net cost per dry ton for the

TABLE 4 ECONOMIC COMPARISON — SLUDGE INCINERATION VS COMPOSTING

	Cost per Dry Ton	
	Composting	Incineration
1988		
January	\$329.48	\$277.20
February	312.68	511.80
March	276.63	266.61
April	218.29	145.61
May	214.42	181.23
June	203.09	147.65
July	250.83	144.27
August	199.48	147.25
September	160.36	253.33
October	241.27	305.68
November	200.57	283.83
December	411.72	231.52
1989		
January	224.97	304.62
February	286.47	246.35
March	288.30	262.49
April	252.14	174.99
May	197.00	249.92
June	223.33	232.43
July	268.05	178.68
Average	\$250.47	\$239.23

TABLE 5 COMPOSTING ECONOMICS

	Average Costs per Month		
	1987	1988	1989
Dry Tons Processed/ Month	942.0	649.2	683.2
Labor	\$ 45,008	\$ 49,664	\$ 54,935
Utilities	17,902	21,689	19,964
Polymer	10,767	7,325	7,212
Bulking Agents	44,977	34,168	31,697
Other Costs	48,814	59,977	66,819
Compost Sales	\$ 0	\$ 5,083	\$ 13,250
Net Total	\$167,468	\$167,740	\$167,377
Cost Per Dry Ton	\$ 178	\$ 258	\$ 245

multiple hearth sludge incineration system is \$240/ton (which does not include a landfill disposal cost) while the cost for composting, including all raw materials, after credits for sale of the output products, is \$250 per dry ton.

A comparison of composting costs for the past 3 years is provided in Table 5. Market income is also included. Composting costs on a dollars per dry ton basis are expected to reduce as production increases. The facility is operating at approximately 40% of full capacity in an effort to reduce odors. After an odor control system is installed, production will increase, but many overhead costs will remain the same. Costs could drop below \$200 per dry ton.

Compost Markets

Historically, composting projects have been criticized due to the lack of markets for the compost once it is produced. One of the obstacles of selling compost derived from sewage sludge is heavy metals. This is not the case in Akron. Compost from Akron has been approved for agricultural use by the Ohio EPA. This approval, combined with the recommendation of using a maximum 25% blend of compost due to its high organic matter content, has resolved many potential marketing problems.

The three major customers have been topsoil blenders, nurseries, and landscapers. Rich topsoil has approximately 15% organic matter. Topsoil blenders find compost beneficial because it contains 70% organic matter. By adding 20% compost to sand with no organic value, the mixture is 14% organic, full of nutrients, and able to retain moisture.

Nurseries are using compost in lieu of growing cover crops for organic matter, and landscapers are finding it easier to prepare a new lawn using compost as a soil amendment rather than adding large quantities of topsoil.

During 1989, 40,000 cu yd (30,584 m³) of compost were produced in the Akron facility. 100 percent of the output was sold at an average price of \$4.30/yard. This price for product varied depending on the quantity purchased. The range was from \$1.00/bushel (\$22/yard) for small purchasers to \$4.00 per cu yd where the purchaser bought 500 cu yd (382 m³) or more.

LANDFILL

Akron's Hardy Road Landfill is the only permitted landfill in Summit County. Operated by the City, it is the site of last resort for solid wastes which cannot be recycled, incinerated, or composted.

The landfill has been in operation for 19 years. The current life remaining is about 5 years based on the most recent estimates. If it were not for the Composting

Facility, the Materials Recycling Facility, and the Recycle Energy System, the projected remaining useful life of the landfill would be only 1.5 years. It is important to recognize that this is a very valuable asset which must be preserved.

The landfill currently receives 350 TPD of municipal, commercial, and industrial solid waste which are either bypassed from the Akron RES or which are nonprocessable and are disposed of directly at the landfill. Also, the landfill receives about 220 TPD (200 tpd) of incinerator ash residue from the RES. The residue from the Materials Recycling Facility is not taken to the landfill but is tipped at the RES so the MRF residue would appear as part of the RES residue. About 9 dry TPD (8 d tpd) of incinerated sludge ash is hauled from the City's wastewater treatment plant to the landfill.

The tipping fee charged at the landfill gate for waste collected within Akron's borders is \$40/ton. Tipping fees are \$60/ton for waste originating outside of Akron. The City is investigating leachate collection which would be piped about 300 yards (274 m) to the wastewater treatment plant if installed. Further, the City has installed gas wells and gas monitoring equipment at the landfill. Studies have been conducted to look at generation of electricity utilizing landfill gas, but with the recent price of gas, the project is not viewed to be economically viable at the present time. Currently, the gas is collected, but flared off at the landfill.

The City is awaiting issuance of new rules by Ohio EPA and U.S. EPA regarding regulatory requirements for incinerator ash disposal. At the present time, some degree of ash stabilization is provided and the residue from the Akron RES is co-disposed with commercial and industrial wastes delivered directly to the landfill.

SUMMARY

As Akron plans for the future, it has much to be proud of. The RES has been turned around and continues to operate safely, efficiently, and reliably—meeting both energy production and waste disposal demands of its customer base. The new Materials Recycling Facility processes Akron's commingled residential recyclables and higher grade commercial materials. The Plastics Recycling Facility will be established as a model for future commercial facilities throughout the country. Akron's Composting Facility has proven to be an ecologically sound and economical solution to sewage sludge solids disposal. These systems have had a significant effect on preserving the life of the Hardy Road Landfill, the final component of the waste disposal system. Akron presents a successful example of an integrated solid waste management program. It has the strong commitment of both the public and private sectors to the long-term disposal needs of the community.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of Randall A. Monteith and William Mullen of the City of Akron's Department of Public Service in developing and providing data for this paper.

Key Words: Commingled; Composting; Integrated System; Materials Recovery; Plastic; Recycling; Refuse-Derived Fuel