THE MONROE COUNTY COMPREHENSIVE RESOURCE
RECOVERY PROGRAM

RICHARD A. KENYON
Rochester Institute of Technology
Rochester, New York

ABSTRACT

This paper describes the development and current status of the Monroe County (NY) Comprehensive Resource Recovery Program and details the processes incorporated in the recently completed 2000 tons/day (1800 t/d) Resource Recovery Facility that forms the core element of the system. The paper also describes the design of the facility under construction at the Russell Generating Plant of Rochester Gas and Electric Corporation where the utility will burn a significant fraction of the refuse derived fuel produced in the resource recovery process.

INTRODUCTION

The first test run of municipal refuse through the recently completed Monroe County (NY) Resource Recovery Facility (RRF) took place on September 10, 1979. Ten days later the County officially dedicated the RRF, culminating a three year construction program preceded by nearly five years of planning, concept design, proposal review, engineering, public education and legislative debate. The County's comprehensive plan for waste management through resource recovery grew out of the increasing difficulty experienced by the City of Rochester and the towns and villages of Monroe County in establishing the necessary sanitary landfills to handle the area's burgeoning municipal refuse. The all too familiar story of city dumps, unpopular landfills, outmoded and inefficient incinerators and increasing disposal costs led the County Legislature to accept in 1972 the recommendations of the Rochester Engineering Society and the Monroe County Environmental Management Council to establish a county-wide waste management program based on the concept of optimum resource recovery. At that point in time there were no large scale resource recovery systems operating successfully in the United States. Water wall incinerators burning municipal refuse and producing steam for process work or heating had been used with some success both in this country and abroad. However, virtually all attempts at resource recovery through composting and/or fiber recovery coupled with removal of ferrous metals had proved to be technically and economically disastrous when employed on a large scale municipal basis in this country. The "Golden Garbage" concept of the mid-sixties had tarnished rather rapidly by the early seventies.

Following the commitment to undertake a county-wide waste management program based on, at best, uncertain resource recovery technologies, the Monroe County Legislature contracted with the Hercules Corporation of Wilmington, Delaware, to conduct a market analysis for the anticipated products to be derived from the solid waste stream. The study, requiring approximately one year, determined that marketable products could be derived from the refuse stream with technologies either then current or to be expected on stream in the immediate future. The Hercules report suggested a design concept utilizing an air classifier.
density separation process that followed an initial shredding operation. Subsequent steps in the suggested resource recovery scheme included further cleaning and sizing of the light fraction for use as either a supplemental fuel or as a feedstock for recycled cellulose fiber products. The heavy fraction, meanwhile, would be "mined" for recovery of various metals and, when the technology permitted, a glass rich fraction for use as either a building material or for the manufacture of recycled glass.

The positive tone of the Hercules report convinced the County Legislature to seek a reputable, multidisciplined company to guide the County through the implementation of a large scale resource recovery program. The Raytheon Service Company of Burlington, Massachusetts, was ultimately selected over several other respondents and awarded a three phase contract covering: 1. design and construction supervision; 2. start up and functional testing; and 3. minimum 5 year plant operation. The resulting Resource Recovery Facility, just now coming on stream, represents one of the largest and perhaps the most ambitious and sophisticated system yet built. The following paragraphs outline briefly the design philosophy employed as a cornerstone of the program, some details of the resource recovery process itself, and finally concludes with a description of the receiving, conveying and combustion facilities being built at the Russell Station of Rochester Gas and Electric Corporation (R G & E) to permit burning of some of the RDF output.

DESIGN PHILOSOPHY

The basic design philosophy of the Monroe County RRF has been to produce the highest quality recovered materials from the waste stream consistent with the available markets for such materials and dependent upon the availability of reliable technology for the production of these materials. Furthermore, the technologies utilized at any given point in time should offer the maximum flexibility for the addition of new technologies consistent with the overall system process as such technologies are proven viable on a large scale basis. The entire process needed to be cost effective, but the added opportunity to penetrate wider markets with a higher quality product that could challenge virgin materials was deemed to more than offset the greater process sophistication and cost. Two examples serve to illustrate application of this philosophy. Among the end products of the RRF process are a cleaned light ferrous product destined for the higher paying detinning market and a heavy ferrous fraction to be sold at a lower price as No. 2 bundled scrap. It would have been less expensive and certainly less complicated to have produced a single ferrous product for the scrap market. This, however, would have limited the options for marketing the product. In a similar fashion, it was decided to produce a clean, high purity mixed color glass cullet for the glass remelt market rather than a glass-sand-ceramic mix that might be used as a building material aggregate. The plant is expected to convert 90 to 95 percent by weight of the incoming waste stream to salable recycled products when fully operational. The rationale behind the program is simply to do a necessary municipal task better from environmental and energy points of view and to do so at about the same cost as the earlier landfill operations. While the potential exists for a net cost reduction through the sale of recovered materials, no one anticipates that the county will "make money" in the garbage business. Though energy was less a concern at the time of developing the initial RRF concept than it has become today, it is important to note that the plant saves through the production of RDF and other salable materials nearly ten times the amount of energy it requires for operation.

FACILITY DESCRIPTION

The Monroe County Resource Recovery Facility is a large, modern materials handling and processing plant housed in a totally enclosed structure that accepts raw municipal refuse from packer trucks, transfer trailers and other large open vehicles, and that operates with minimum environmental disruption in a growing industrial park area of the City of Rochester. Refuse trucks enter an enclosed tipping and receiving area and dump their loads in a deep pit that is 380 ft x 110 ft (116 m x 34 m) and that can hold a full 2000 tons (1800 t) of refuse in storage. Front end loaders are used to move the raw refuse from the tipping floor to one of the two infeed conveyors leading to the primary shredders. From that point on to final storage of the recycled products, all operations are automatically monitored and controlled.

Based on the anticipated raw refuse mix, the output of the RRF will have the composition as indicated in Table 1.
TABLE 1. RRF OUTPUTS

<table>
<thead>
<tr>
<th>Component</th>
<th>% By Weight (Approximate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refuse Derived Fuel (RDF)</td>
<td>66</td>
</tr>
<tr>
<td>Heavy Nonferrous</td>
<td>5</td>
</tr>
<tr>
<td>Ferrous Metals</td>
<td>7</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.35</td>
</tr>
<tr>
<td>Heavy Nonferrous</td>
<td>0.05</td>
</tr>
<tr>
<td>Mixed Color Glass</td>
<td>9</td>
</tr>
<tr>
<td>Sand</td>
<td>3</td>
</tr>
<tr>
<td>Landfill Residues</td>
<td>9+</td>
</tr>
</tbody>
</table>

The overall process in the RRF is comprised of four basic process modules: a baseline process, a residue recovery module, a ferrous refining module, and a nonferrous refining module. Each of these elements of the total system is discussed in some detail in the following paragraphs. Though not a part of the basic processing system, a water processing module comprises a fifth element in the system. This module treats process water used in the other modules to permit maximum reuse of process water and to reduce the plant's water requirements.

The baseline process consists of essentially an even dozen distinct devices (several duplicated for redundancy) as shown in Fig. 1. The two primary shredders, rated at 70 tons/hr (64 t/h) and driven by reversible 1000 hp (750 kW) electric motors, reduce the incoming waste to a fairly homogeneous mixture of less than 12 in. (0.3 m) maximum dimension for subsequent processing. Final size reductions are obtained in a series of subsequent shredding operations handling a single component of the waste stream.

In many ways the most unique element in the baseline processor (or in the entire system for that matter) is the rotary drum air classifier (RODAC). Four RODACs are included in the overall system, two for each primary shredder, each rated at 35 tons/hr (32 t/h) capacity. Previously used air classifiers have generally been of the vertical type, with or without zig zag passages. Control of the density separation point in these devices has often been difficult and the passages are susceptible to frequent clogging. Both of these problems appear to have been overcome in the RODAC. The coarse shredded waste is conveyed into the center of the 28 ft (8.5 m) long, 9 ft (2.75 m) diameter rotating drum and the breaking apart process continues as a result of the tumbling action within the drum as well as by the beating action of the vanes inside the drum. The heavy fraction gradually drops out of the input end of the drum due to gravity while the light fraction (ultimately the RDF) is carried to the downstream plenum chamber by the action of the moving air-stream. The light fraction is screened to remove entrained glass, grit and dirt and then is shredded to final size, nominally 3/4 in. (19 mm). Dust, removed in the various air cleaning steps, is added to the light fraction before the resulting RDF is pneumatically conveyed to the compactor building for storage and/or shipment.

The heavy fraction exiting from the input end of the RODAC first passes through a preliminary magnetic separator that extracts nearly 95 percent of the ferrous metal for subsequent final processing in the ferrous refining module. The reject fraction from the magnetic separator then passes through a large trommel screen where it is divided into two streams of similar composition but different size. The trommel undersize fraction passes through the 3/4 in. (19 mm) diameter holes in the trommel and carries with it most of the glass, broken into small pieces in earlier processing due to its brittle nature. This undersize fraction contains much sand and ground ceramic materials as well and is conveyed to the residue recovery module for further processing. The trommel oversize, containing the large pieces of heavy combustibles, putrescibles and the more malleable nonferrous metals in place of the glass-sand-ceramic mixture, is conveyed to the secondary shredder and the secondary air classifier. In this instance, the air classifier is a more conventional vertical zig zag type since the problem of clogging is largely eliminated by the approximately 2 in. (51 mm) size of the heavy residue. The light fraction removed from the secondary air classifier is returned to the vibrating screen. The screen output is divided between the RDF shredder and the residue recovery module as shown in Fig. 1. The heavies from the secondary air classifier are conveyed to a magnetic separator to remove the weakly magnetic materials from the remaining heavy waste. The metallic fraction is then conveyed to the nonferrous metal separator, like the RODAC, a somewhat unique device worth some additional description.

The nonferrous-metal-rich heavy fraction is allowed to slide down a series of interlocking inclined planes beneath which are placed a number of strong permanent magnets. The metallic particles, being electrical conductors, experience a sideward force as they slide downward cutting the lines of force of the magnetic field. The resulting
action progressively pushes the metallic fraction to one side of the separator while the non-metallic heavy combustibles remain undeflected on the input side of the separator. The metallic fraction is subsequently transported to the nonferrous refining module where the aluminum fraction is separated from the much smaller fraction of nonferrous, heavy metals (largely copper and zinc).

The ferrous refining module with its differential magnetic separator, ferrous shredder and final magnetic separator delivers a light and heavy fraction to separate ferrous metal storage containers and a final nonferrous fraction back to the nonferrous refining module. As noted earlier, the light ferrous fraction consisting largely of “tin” cans is destined for the detinning market while the heavy fraction, containing the shredded “white” goods (refrigerators, washers, etc.) is sold in the scrap market.

The residue recovery module is a series of jigging, washing, screening, milling, desliming, flotation and drying processes having as its single goal the separation of the mixed-color glass cullet from the sand/ceramic-glass mix. A light combustible waste material, suitable for burning, is withdrawn early in the residue recovery module. The remaining material is separated into the valuable glass fraction and a clean “sand” suitable for construction or road work.

The nonferrous refining module separates the aluminum from the heavier nonferrous metals by use of a heavy media separator that floats the aluminum out of the mixture within a ferro silicon suspension in water. Downstream screening processes followed by further magnetic separation of ferrous impurities and ultimately by a dryer process finally prepares the valuable aluminum for market.

The overall process is a good deal more complicated than outlined in the rather brief preceding paragraphs. However, the descriptions should provide evidence of adherence to the basic philosophy of producing the highest quality recovered or recycled products consistent with market economics and available technology. It should perhaps be pointed out at this juncture that a quite acceptable resource recovery system, producing lower quality products (mixed ferrous metal, RDF, mixed nonferrous metals, and a landfill residue) could have been constructed using the baseline processor alone. This would have represented, quite simply, the alternate design philosophy.

Since the light combustible fraction comprises approximately 66 percent by weight of the total waste products output, long term markets for its reuse will be a key factor (if not the overriding factor) in the ultimate success of the program. Monroe County has indeed been fortunate to have its local utility, R G & E, as an active partner in the development of the total resource recovery program. The utility has contributed both through the efforts of its individual employees who have served on numerous committees and task forces over the years as well as by its corporate decision to purchase RDF as a supplemental fuel for firing, along with coal, at its Russell Generating Station.
When fully operational, the Monroe County RRF will produce nearly 1320 tons per day (1200 t/d) of RDF. It should be pointed out at the outset of this discussion that, even under the most optimistic of conditions, R G & E will never be able to burn more than half of the RRF output of RDF as a supplemental fuel at Russell Station. The hope of the County’s planners and the utility is that tests to be conducted over the next few years may indicate that it is practical to approach a burn rate of half the RRF output of supplemental fuel. It remains a challenge for the RRF owners (Monroe County) and operators (Raytheon Service Company) to find other RDF users (such as the R G & E Beebe Station), to convert the RDF to more convenient fuel forms, or to seek other markets that will use the cellulose-fiber-rich RDF as a feed-stock for a recycled product such as cardboard, wallboard, building materials, etc. Additional markets for RDF are currently under study and analysis of pyrolysis, composting and densification processes will be undertaken.

Actual development of the required facilities at the Russell Station will lag completion of the RRF by perhaps eighteen months to two years. However, the designs are essentially complete and the following paragraphs outline the system characteristics and speak to the anticipated performance as actual burning commences.

**R G & E FACILITY DESCRIPTION**

The Rochester Gas and Electric Corporation’s Russell station comprises a base-loaded, four-boiler plant rated nominally at 235 MW electric. The four boilers, in the approximate age range of 25-30 years, are tangentially fired, suspension burning boilers utilizing pulverized coal. In many ways, except with regard to individual sizes, the R G & E boilers are similar in age and construction to the boilers at the Union Electric facility outside St. Louis, Missouri, where much of the early RDF test burns were conducted.

The County of Monroe will construct and own, on land leased from R G & E, a suitable receiving, storage and distribution system at the Russell Station to permit burning the RDF along with the pulverized coal. Provisions are available to transport the RDF from the RRF to the Russell Station either by rail or in over-the-road transfer trailers. In either case, the system to be developed on the R G & E site is as shown schematically in Fig. 2. The RDF will be conveyed pneumatically from the receiving building on one side of the R G & E property to the surge bin/splitter building immediately adjacent to the power plant proper. A drag conveyor will take RDF from the surge bin/splitter building whence it is transported pneumatically to the burn nozzles in each of the

![Diagram](image-url)
four boilers. Each of the existing boilers is to be fitted with two tangentially oriented RDF nozzles on opposing sides of the boiler. Provisions have been made to add two additional nozzles in each boiler, thus providing a nozzle in each corner, an array similar to that of the coal nozzles. The original plans called for the RDF nozzles to be above the existing coal inlets, but current thinking now places them below.

Although the use of RDF as a substitute fuel will likely increase both bottom ash and fly ash, with one exception, no major changes to precipitators, ID fans, or ash handling equipment is anticipated. The one exception is the addition of a bottom grate in boiler #3 to provide more complete combustion of the RDF thus reducing bottom ash.

The entire receiving and handling facility at the Russell Station is sized to permit a maximum utilization of RDF to no greater extent than 30 percent of the total thermal input to the power plant. It will be some time, however, before that level of RDF burn is achieved since much testing remains to be done to assess the long term effects of burning RDF in this particular system.

It would be virtually impossible to detail all of the agreement developed between RG & E and the County of Monroe relative to this project. Basically, R G & E will purchase, on a long term basis, RDF from the county in an amount to be determined by testing over a several year period but with a goal of maximizing the RDF fraction subject to acceptable levels of deleterious effects to the boilers and related equipment. The utility will pay for the RDF on the basis of its energy content at the equivalent prevailing rate for coal, but less any differential costs that are specifically associated with the RDF burning. In simple terms, R G & E, as a public utility will burn RDF as a supplemental fuel in such a manner that it neither increases nor decreases the cost of production of electric power from the Russell Station.

LANDFILL DEVELOPMENT

One element of the Monroe County comprehensive waste management and resource recovery program is the establishment of the necessary sanitary landfills to accept that portion of the RRF output that cannot be sold or otherwise used. With the completion of the RRF and the development of long term marketing arrangements, the county’s reliance on landfills will diminish markedly. The process through which landfill sites are identified and the satisfactory ones developed is no less painful and emotion-charged in 1980 than it was in 1970. The one 5 year interim landfill that was established in 1975 will be closed on schedule and the search goes on for one or two replacement landfills to serve through the end of this century.

SUMMARY

It remains to be seen the degree to which Monroe County has shown wisdom and foresight in making the hard decision to proceed with a large and sophisticated resource recovery program to solve the growing solid waste dilemma. The authors and architects of this innovative program are confident that their efforts will be rewarded and that the risks taken will have been warranted. In the unlikely event of complete system failure, the would-be detractors waiting in the wings would yet have the final word.

ACKNOWLEDGMENTS

The author is indebted in particular to two persons with whom he has worked in various capacities over the past eight years as the Monroe County Resource Recovery Program has moved from dream to reality. Mr. M. John Corson, PE (member ASME) has been responsible for the involvement of R G & E in the program. Mr. Corson serves R G & E as Assistant Chief Engineer and, like the author, first became involved through the Rochester Engineering Society’s early study of resource recovery on behalf of Monroe County. Mr. Howard F. Christensen has served Monroe County as the Director of Solid Waste since the County Legislature implemented its decision to move toward county-wide resource recovery. Mr. Christensen has been the principal overseer as the RRF has developed. It has been a privilege to work with and learn from these two men.

The information contained in this paper has been accumulated over the past eight years as a consequence of the author’s involvement in many facets of the Monroe County Resource Recovery Program. The author has served as chairman of both the Resource Recovery Technical Advisory Committee and the Citizens’ Advisory Committee on Resource Recovery, each appointed as official committees by the County Manager. Additionally, the author served as one of many members of the
Rochester Engineering Society’s “OPERATION RESOURCE” task force back in 1971-1972 where the original resource recovery concept first took flight.

Key Words
Aluminum
County
Ferrous
Glass
Public Utility
Refuse Derived Fuel
Separating