SOLID WASTE PREPROCESSING: THE RETURN OF AN ALTERNATIVE TO MASS BURN

STUART H. RUSSELL
Thermo Electron Energy Systems
Waltham, Massachusetts

ABSTRACT

Several resource recovery projects financed in the last 5 years incorporate preprocessing systems for fuel preparation and materials recovery prior to combustion. These projects represent a return to a system of resource recovery which experienced many technical problems in several projects built in the late 1970s and early 1980s. The purpose of this paper is to review the history of solid waste preprocessing, describe the technical advances employed in the new preprocessing systems, and discuss some of the reasons preprocessing is returning to popularity.

INTRODUCTION

This paper is not intended to be a scholarly treatment of the engineering and financial history and state of the art of solid waste processing technology. Such treatment can be found in a variety of good references [1, 2]. The intent of this paper is to offer some general observations about an apparently significant trend in the solid waste resource recovery business (i.e., the return to preprocessing), how this trend has developed, and what this trend means for the future of the business.

The term "solid waste preprocessing" as used in this paper refers to the precombustion processing of solid waste, as distinct from the more general term, "solid waste processing" which includes processing for materials recovery only, or for other reasons. Because of their profound technical differences, the group of pyrolysis technologies which produce gaseous and/or liquid fuels derived from solid waste are not included in this discussion, although they are, strictly construed, "solid waste preprocessing" technologies.

The term, "RDF" (meaning Refuse Derived Fuel) was not selected as the general term for this discussion. Although RDF has, in the resource recovery lexicon, come to mean any fuel product derived from the processing of solid waste, in this paper RDF will be defined more narrowly as a fuel designed to be burned in existing boilers originally designed to burn conventional fuel (mostly coal).

The term, "Dedicated Prepared Fuel" will be used here to refer to fuel prepared by processing solid waste which is burned (usually without mixing with conventional fuels) in new boilers specifically designed to burn this fuel. These different terms are used to distinguish between the different uses for the fuel rather than to distinguish between physical characteristics (unlike the ASTM designations which refer to all solid waste fuels as "RDF" in seven numbered categories of physical characteristics).

HISTORICAL PERSPECTIVE

Although various forms of solid waste preprocessing have been practiced since the 1930s, the first commercial scale facility utilizing municipal solid waste was constructed in 1972 in St. Louis, Missouri by the City of St. Louis and the Union Electric Company (partially funded by the USEPA). This 300 tons/day RDF type demonstration facility provided the basic design data on which most of the early preprocessing facilities were based [3]. Because the St. Louis facility utilized primary shredding, magnetic separation and air classification as its primary equipment, many of the other early preprocessing systems also utilized these basic elements.

Tables 1 and 2 list the early (pre-1982) preprocessing facilities in the RDF and Dedicated Prepared Fuel categories respectively. Not listed are solid waste processing facilities without energy recovery and any facilities which are not commercial scale, or which operated for only short periods for test or demonstration purposes only (such as the St. Louis facility).

There are a total of 23 facilities of the preprocessing technology built or financed prior to 1982; 11 of the RDF type and 12 of the Dedicated Prepared Fuel (DPF) type. A total of eight of these facilities (35%) are now shutdown. All but one of these nonoperating facilities are of the RDF type. Almost two-thirds of the RDF type facilities built pre-1982 were not operating in 1987, while only 1 of 12 DPF facilities has been shut down (Hempstead, New York).

Although not without problems, the remaining fifteen operating facilities have successfully remained in operation over relatively long periods of time (two of these facilities; Lakeland, Florida, and Madison, Wisconsin are currently operating on an intermittent basis). For example, the Hamilton, Ontario facility has been in operation for over 13 years. These successful facilities seem to have in common the following general characteristics.

(a) Simple, reliable solid waste processing equipment.

(b) New, dedicated combustion unit, or an existing combustion unit extensively modified to burn the fuel along with conventional fuels.

Many of the unsuccessful early preprocessing facilities attempted to use very complex processing equipment designs without extensive operating experience on solid waste. The Bridgeport, Connecticut, and Milwaukee, Wisconsin, facilities are good examples. These facilities were developed during a period of rapidly-rising costs of conventional fuels and a fear of supply curtailments. One of the primary purposes of these facilities was to manufacture a highly processed replacement fuel from solid waste. The failure of many of the early RDF facilities was related to the inability of the facility to reliably produce a uniform fuel product to the specifications promised to the fuel buyer, who, in most cases, was an electric utility company.

By contrast, the early DPF type facilities were developed primarily as solid waste volume reduction facilities with the energy production as a by-product. The facility in Hamilton, Ontario, is a good example. Its official name, "Solid Waste Reduction Unit" or

TABLE 1 RDF TYPE PREPROCESSING FACILITIES IN NORTH AMERICA PRE-1982[a]

Facility Location	Capacity (tons/day)	Year Started	1987 Status
Ames, Iowa	200	1975	Operating
Cockeysville, Maryland	1200	1978	Operating
Bridgeport, Connecticut	1800	1979	Shut Down
Chicago, Illinois (Southwest)	1000	1978	Shut Down
Lakeland, Florida	300	1982	Operating (b)
Lane County, Oregon	500	1979	Shut Down
Los Gatos, California	200	1976	Shut Down
Madison, Wisconsin	400	1979	Operating (b)
Milwaukee, Wisconsin	1000	1977	Shut Down
Rochester, New York (Monroe County)	2000	1980	Shut Down
Tacoma, Washington	750	1978	Shut Down

(a) Primary Source: Reference 1, municipal solid waste facilities only, no test or demonstration facilities.

(b) Intermittent Operation

TABLE 2 DEDICATED PREPARED FUEL TYPE PREPROCESSING FACILITIES IN NORTH AMERICA PRE-1982[a]

Facility Location	Capacity (tons/day)	Year Started	1987 Status
Akron, Ohio	1000	1979	Operating
Albany, New York	750	1981	Operating
Columbus, Ohio	2000	1983 (d)	Operating
Duluth, Minnesota	400	1980	Operating
Hamilton, Ontario	500	1974	Operating (b)
Haverhill/Lawrence, Massachusetts	1300	1984 (d)	Operating (c)
Niagara Falls, New York	2000	1981	Operating
Miami, Florida	3000	1982	Operating
Hempstead, New York	2000	1980	Shut Down
Rochester, New York (Kodak)	120	1974	Operating
Toronto, Ontario	220	1978	Operating
Wilmington, Delaware	1000	1982	Operating

(a) Primary Source: Ref. 1, also Ref.4
(b) Undergoing rehabilitation work
(c) Undergoing expansion
(d) Financed prior to 1982

SWARU reveals its basic purpose. In fact, during the early years of its operation, the SWARU did not have a steam purchaser.

In eleven of the remaining fifteen operating early preprocessing facilities, a new, specifically designed combustion unit dedicated to burning the prepared fuel is included (note that two of the remaining four RDF type facilities are operating only intermittently). Further, the Ames, Iowa, RDF facility produces a fuel which is fired in a relatively new boiler installed after the RDF processing facility had been in operation for about 3 years. This new pulverized coal boiler incorporated several design features specifically for the burning of RDF at a ratio of about 10% (input Btu basis), including bottom dump grates to handle bottom ash. The new boiler is a major reason for the Ames facility's success.

The lessons from past experience, then, seem to suggest a direction for the future: *(a)* keep the waste processing system as simple and robust as possible; and *(b)* use a specifically-designed combustion unit for the particular fuel characteristics of processed solid waste.

NEW FACILITIES

Eleven new preprocessing facilities have been financed since 1982. All eleven, in fact, were financed in 1985, 1986 and 1987 after a 3 year period in which many mass burn facilities, but no preprocessing facilities were financed. Table 3 lists these facilities, four of which are in start-up or in operation at the time of this writing. All of these new facilities are of the Dedicated Prepared Fuel type except one facility in Minnesota which is of the RDF type. These eleven projects represent about $1.5 billion in financings since 1982, a significant portion of all waste-to-energy projects financed in the same period of time. Each of these eleven new facilities is different from the others in many respects. However, with only a few exceptions, a design theme seems to be common.

(a) Initial rough material sizing via "bagbreaker" or other device.

(b) Particle size classification prior to shredding for control of oversize particles only.

(c) Dedicated combustion unit specifically designed for refuse fuel.

The Rochester, Massachusetts (SEMASS) facility is the only exception to the common practice of particle size separation prior to shredding (via trommel screen or disk screen). The Minnesota facilities are exceptions to the common use of new, dedicated combustion units. However, the Newport, Minnesota, facility will utilize extensively modified boilers owned by Northern States Power in Red Wing, Minnesota. It bears noting that as of mid-1987, the Eden Prairie, Minnesota, RDF facility does not have a long-term contract for the purchase of a significant portion of the facility's RDF output.

TABLE 3 NEW PREPROCESSING FACILITIES IN THE UNITED STATES POST-1982

Facility Location	Capacity (tons/day)	Type (a)		1987 Status
Biddeford, Maine	800	DPF	(b)	Operational
Detroit, Michigan	4000	DPF		Construction
Eden Prairie, Minnesota	400	RDF	(c)	Operational
Hartford, Conn.	2000	DPF		Start-up
Honolulu, Hawaii	2160	DPF		Financing
Orrington, Maine	800	DPF	(b)	Start-up
Portsmouth, Virginia	2000	DPF	(c)	Operational
Rochester, Mass.	1500	DPF		Construction
San Marcos, California	1700	DPF		Financing
Newport, Minnesota	1000	DPF	(d)	Construction
West Palm Beach, Florida	2000	DPF		Financing

(a) DPF = Dedicated Prepared Fuel, RDF= Refuse Derived Fuel
(b) Designed for co-firing with wood chips
(c) Designed for co-firing with coal
(d) Existing coal-fired boilers extensively modified

These new facilities, in several cases, also incorporate new approaches to materials recovery. For example the Eden Prairie, Minnesota, Portsmouth, Virginia, and San Marcos, California, facilities utilize hand-picking techniques for recovery of aluminum and other recoverable items. Although decidedly "low-tech," handpicking has been selected as a flexible and economical alternative to other capital-intensive mechanical processes. Plastics are also being hand-picked at the Eden Prairie facility, and a mechanical film plastics recovery system is being proposed for installation in the San Marcos facility.

The future is likely to hold other applications of preprocessing technology. Certain full-service vendors are beginning to offer simple preprocessing systems without shredding coupled with mass burn type combustion units. This type of hybrid system would have the capability to operate either in the mass burn or preprocessing mode, blurring the distinction between the two basic types of waste-to-energy facilities. One of the early examples of this concept was installed at the Gallatin, Tennessee, mass burn facility in 1982 by National Recovery Technologies, Inc., utilizing a rotary drum, multifunction separation device which removed ferrous metals, aluminum, and fines prior to combustion [5].

REASONS FOR RETURN TO PREPROCESSING

There are several reasons why many project sponsors are selecting preprocessing:

(a) Co-firing with other fuels.
(b) Public and Political Acceptance.
(c) Reduction of ash quantity.
(d) Value of recovered materials.

Six of the new projects listed on Table 3 are designed to burn refuse fuel along with other fuels. For example, the Portsmouth, Virginia, and Eden Prairie, Minnesota, facilities produce fuel for co-firing with coal. The Biddeford and Orrington, Maine, facilities are designed to co-fire wood chips. Preprocessing is necessary to accomplish co-firing with other fuels in the types of boilers used at these facilities.

Public and political acceptance of waste-to-energy projects has always been a problem, but has become even more so in recent years. Many project sponsors have found that the materials recovery function of a preprocessing facility can be significant help in gaining public acceptance. For example, the project sponsors for the San Marcos, California, project have found through opinion surveys that the general public in the host community preferred preprocessing to mass burn because of the environmental benefits of materials recovery and because of the greater ability to inspect and remove illegally disposed hazardous wastes. This public support was confirmed with the passing of a referendum supporting the project at a special election in San Marcos on September 15, 1987.

Ash disposal has become a significant problem for the waste-to-energy industry. The USEPA is presently considering new rules for disposal of solid waste ash that are likely to increase disposal costs substantially. The preprocessing technology has the advantage of producing much less total ash than a mass burn facility (typically 8–10% by weight of the input solid waste versus 20–25% by weight for mass burn). The reduction is due to the removal of noncombustibles during processing which would become part of the ash in a mass burn facility. Although this processing residue is typically landfilled, it will not fall under the same rules as solid waste ash.

The recovery of certain materials for their market value has been another reason for selecting preprocessing systems. Aluminum and corrugated markets are well-established and market values have remained relatively high in recent years; $600–$800/ton for aluminum (used beverage containers) and $60–$90/ton for corrugated (old corrugated containers, grade 11). Although not as well-established, the recovered plastic market is developing as a viable source of revenue for a waste pre-processing facility. Reconstituted low density polyethylene pellets, for example can be sold for $200–$300/ton.

CONCLUSION

Solid waste preprocessing has experienced a resurgence in recent years, and appears to be a significant future trend in the waste-to-energy business. The success of many of the new generation of preprocessing facilities remains to be seen, however, the designers of most of the new facilities seem to have learned the lessons of the past failures in preprocessing. It is clear that preprocessing technology will be a part of a significant portion of the waste-to-energy facilities constructed in the future above a certain minimum size facility. Preprocessing is not likely to be economical below about 500 tons/day when compared with mass burn technology.

It is also likely that hybrid systems utilizing preprocessing technology coupled with mass burn combustion units will be built within the next 5 years.

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