Current Trends in MRF Design and Operation

Introduction

Material Recovery Facilities (MRFs) are an integral part of many solid waste management programs. They are typically designed to divert materials from disposal and to facilitate more efficient and economical truck routing. In some cases they serve as important front-end components of waste-to-energy facilities by removing recyclable materials such as glass and metals that are not suitable in combustion or conversion processes. This paper provides an overview of MRF design and operation, highlighting factors that are important to consider in MRF siting and operation.

Solid Waste Management Background

To understand the role of MRFs in solid waste management in North America, it is helpful to consider their historical context. In the 1880s, the City of San Diego, like many other municipalities at the time, did little to manage waste. According to historian Richard Crawford, “... San Diego had become appalling. With a rapidly growing population ... San Diego was becoming a dump. Without an organized system of trash pickup, residents disposed of their refuse any way possible. Waste was tossed in the streets, discarded in empty lots, or thrown into San Diego Bay. Professional ‘scavengers’ collected garbage for a fee and dumped it on a 2-acre plot at the foot of the Ninth Street pier, where ‘poisonous vapors ... wafted by the breeze over the city.’”\(^1\) The City tried various waste management approaches. In 1887, the City Health Officer poured crude oil onto dump sites and lit them on fire.\(^2\) The City hired a contractor to haul refuse out to sea; however, often floating waste washed onto local beaches.\(^3\)

In the late 1800s, incinerators grew in popularity. The “Brown” was used in Wilmington, Delaware, the “Anderson” was used in Chicago, Illinois, and the “Dixon” was used in Atlanta, Georgia\(^4\) and in Los Angeles California.\(^5\) San Diego City Council members travelled to Los Angeles to view the “Dixon Crematory,” and by November 1897, the City of San Diego had a Dixon incinerator at the foot of Eighth Avenue. However, the Brown, Anderson, Dixon, and other furnaces typically failed because of insufficient draft, which caused combustion temperatures of only about 1,000°F, which is insufficient to incinerate a feedstock with 70 to 80% moisture content.\(^6\)

The first “sanitary landfill” in the U. S. opened in 1937 in Fresno, California.\(^7\) Landfill operators dug trenches and filled them with trash. Bulldozers compacted waste and covered it with a layer of dirt at the end of each day. Managers believed that trash compaction would reduce vermin and would allow the site to be reclaimed for construction after a landfill closed.

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\(^1\) Richard Crawford, "San Diego Took Garbage Problem Offshore," San Diego Union Tribune (December 6, 2008).
Most early waste management efforts included materials recovery. Many of the large cities, such as New York City, employed immigrant workers to pick through the collected trash and separate out marketable materials such as bones, rags, and bottles. In San Diego, the first materials recovery facility (MRF), referred to as the “Rubbish Reduction Plant,” was financed in 1935. It was equipped with a conveyor belt, magnetic separator, and a picking line. George Morgan, the State Sanitary Inspector, provided the following analysis in 1931:

“... East of this loading station lies the can dump, and on the West is the paper-bailing shed. A short distance South, on the edge of the bay, is the trash and rubbish sorting and loading mill ... A drain from this garbage dump leads directly into a narrow channel between the dump and the can dump, which in turn runs directly into the bay, close to the refuse and trash mill. A certain amount of garbage was observed lying underneath the shoots [sic], but it was understood that all bins are emptied daily.

“The refuse and trash mill is privately owned, and consists of corrugated iron and wood buildings, employs 18 to 20 persons, and [is] operated partly by machinery.

“All trash is sorted at this point, anything of value being saved, and the refuse being loaded onto barges and towed for a distance of twenty (20) miles out to sea . . .

“Many rats were trapped in this area . . . it is considered that some other method of disposal is advisable, and it is suggested than an incinerator or garbage reduction plant be constructed. It is also suggested that men be employed for the purpose of trapping and poisoning rats . . .”

Originally economic realities drove materials recovery, but environmental goals and increased regulation provided additional incentives. The U. S. Congress enacted the Resource Recovery Act in 1970, and the Resource Conservation and Recovery Act (RCRA) in 1976. These laws provided additional focus on materials reclamation. The Environmental Protection Agency (EPA) and its predecessor, the Public Health Service, investigated equipment that could be used to recover materials from the waste stream. The study concluded that removal of metal cans by magnetic means was one of the few economically feasible technologies.

A Few of the Important Aspects of MRF Design

SCALES: Scales are critical to MRF operations for load tracking and billing purposes.

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CONVEYERS: Conveyors transport material to and from mechanical equipment within the MRF. Width of the conveyer belts is important in ensuring smooth flow and ensuring that the recyclables are properly sorted.

SORTING: Optical sorters use near-infrared, printed colors, color camera, and image-recognition technology to separate plastics, glass, and fibers by type.

SCREENING: Disc screens separate fibers into grades such as old corrugated cardboard (OCC), news print, and mixed paper. The movement of the screens is designed to minimize breakage of glass.

GRAVITY SEPARATORS: Gravity separators, also known as air tables, are used to separate light density material from heavier density material.

BALERS: Balers are used to compact separated materials for shipment.

Types of MRFs

MRFs can be divided into two general categories:

- **Clean MRF**: A clean MRF is a facility that accepts source separated recyclables. Clean MRFs can accept single- or dual/multi- stream materials. Dual-stream systems usually process fibers in one stream, and commingled plastics, metals, and glass in the other stream. Glass is one of the biggest sources of contamination for single-stream systems. However, Waste Management Incorporated’s Cascade Recycling Center in Woodinville, Washington uses a glass sorting technology to minimize glass contamination.

- **Dirty MRF**: A dirty MRF is a facility that accepts mixed municipal waste. Separating recyclable materials from the waste stream at dirty MRFs is labor- and equipment-intensive. Recovery rates are usually low. These problems can be minimized by selecting sources of waste that are high in recyclable materials. For such “dusty” MRFs, commercial waste steams high in cardboard are often selected.

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Factors Influencing Design

Many factors influence MRF design. An analysis of the waste stream can suggest whether an investment in sorting equipment to improve recovery rates will pay off in commodities sales. In California, a newly enacted law requires commercial facilities to either receive separate recyclable materials collection, or else the waste must be delivered to a dusty MRF with a specified recovery rate. This new law is likely to result in re-tooling of existing facilities and/or the development of new facilities that can achieve the necessary diversion rate.

Savings from more efficient routing that can be obtained from commingled collection may be a deciding factor in MRF design. Single-stream, clean MRFs generally have a lower per ton recovery rate than dual-stream, clean MRFs; however, high participation rates in convenient, commingled single-stream systems sometimes more than compensate for lower per ton recovery. An additional benefit of commingled collection is that it can reduce collection costs by facilitating a transition from manual rear loaders to automated side loaders. These factors have prompted several jurisdictions to transition to single-stream processing. For example the City of El Paso, Texas, after a successful pilot program in 2005, partnered with Friedman Recycling Company. Friedman Recycling provided the MRF technology to sort single-stream recyclables. The recovery rate increased from 1.6 to 16.7 percent. In contrast, the City of Auburn, Maine, found that the additional expense of dual stream collection was necessary to ensure product marketability.

Green Initiative

The newest MRFs usually incorporate sustainable elements in their design and operation. Benefits of green design include: incentives and grant money, lowering operating costs, and improved public and political perception. LEED (Leadership in Energy and Environmental Design) certification provides a way to verify sustainability efforts. The IESI McKinney MRF in McKinney, Texas is the first privately funded single-stream commingled MRF to receive LEED Gold Certification. Some of the sustainable building features that won the MRF its Gold Certification include:

- Certified wood from responsibly managed forests
- Building materials containing recycled content
- Materials with zero or low amounts of volatile organic compounds
- Energy efficient components
- Water conserving fixtures

Although many of the newer state-of-the-art facilities are opting for this certification, some incorporate green features but avoid certification costs. The Summit County MRF in Summit County, Colorado used this approach.

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Community Involvement

Successful siting and operation of a MRF often requires community involvement. Many facility proponents work with planning groups during permitting phases, making changes to accommodate community concerns.

During the planning and design stage of the Brightwater waste water treatment plant in King County, Oregon, community members set guidelines for the plant design.28 Some of these guidelines included: engineering solutions for odor, noise and safety, environmentally friendly plant and site design, and integration of art into the site.

Many facilities provide services to the local residents, such as bulky item or household hazardous waste collection. Others provide facility tours to the public. The tours also provide an opportunity to educate the public the importance of waste minimization. Waste Management Inc.’s single-stream recycling facility in Houston, Texas incorporated 20- by 40-foot education center. The room incorporates salvaged and recycled materials such as reused CDs and used pieces of tile into its design.29

In San Diego, two mid-sized solid waste facilities are located the Barrio Logan community. Barrio Logan is one of the oldest and most culturally-rich urban neighborhoods in San Diego. It is characterized by a mix of maritime industrial uses, side-by-side with residential, local retail, and community facilities. The operator of a transfer station in this community could have encountered community resistance to facility approvals. However, the company purchased the adjacent residences. Screening, litter control, and landscaping are provided, and operations are enclosed. Additionally, in an agreement with the City, the company set aside a special fund to provide amenities to the area. These measures have resulted in a favorable impression of the facility within the community. A community plan update is underway, and while the nearby materials recovery facility area may face recommended modifications, the transfer station is well accepted.

Summary

Many factors must be considered when siting, designing, and operating a MRF, foremost among them is how the facility fits within the solid waste system. For example, the MRF may need to accomplish a specific diversion rate as a result of state or local requirements. Social context is also important. For example, is the community willing to separate recyclables materials and still retain high participation rates? No one MRF design will be appropriate in all settings, but in many cases MRFs provide an economical and environmentally-sound component of an overall solid waste system.


Morgan, George S., "San Diego Garbage and Can Dump." Letter to Mr. Edward T. Ross, Division Chief of Sanitation in the State Department of Public Health. 5 May 1931.


