SINGLE STREAM PROCESSING

Discussion Paper and Questions
for Best Practices Manual Conference Calls
July 26 and August 2, 2005

Processing System Design Discussion

The processing system design can have significant impacts on the quality of materials shipped to end use markets. There are many features that need to be evaluated when designing a processing system.

First, it is important to have a clear understanding of the condition of the recovered materials as they arrive at the processing facility.

- ✓ What materials are in the load?
- ✓ What contaminants are in the load?
- ✓ What condition are they in when they come out of the truck?
- ✓ How compacted are they?
- ✓ Is the glass broken?
- ✓ How wet is the paper?

Generally, materials are not processed as they are unloaded from the truck. They are pushed up into a big pile to provide adequate space on the tipping floor for other loads to be deposited. This activity may result in reducing the recovery rate and the quality of the processed materials. As the materials are pushed into the pile, the cylindrical items roll down. These items, especially glass bottles, are frequently crushed under the wheels of the loader that is forming the pile, increasing the likelihood that they will end up in the facility residue.

It is also important to know:
- ✓ how long are the materials being stored for processing?
- ✓ How big does the pile get?
- ✓ How often is the processing floor cleared?

The pre-processing area provides the best opportunity to remove any oversized items from the collected materials before they get to the picking stations. This also provides an opportunity to remove items that may create a problem on the processing line (for example, tangles of wire and hazardous materials).

Sorting Sequence: Generally it is best to remove the biggest items first, then smaller ones, so that the large items do not trap small items when they are removed. From each fraction, the next step is to remove the ones that sort easily (like magnetic steel/tin cans) and then sort the ones that require more handling. Some of the separation equipment may increase breakage in glass, making it harder to sort the bottles.

Manual sorting: Most facilities use some equipment in association with some manual sorting. There are few fully manual hand-sorting systems left. These are facilities where the truck dumps its load on a tip-floor and sorters pull out by hand those items that are worth separating.

Mechanical sorting: the purpose of mechanical sorting is to use equipment to separate commodities by size, weight, and shape and color. Generally this task can be done more efficiently with specialized equipment than it can be done by hand-sorting.

Positive and negative sorts: a positive sort is used to remove the desired material from the pile. A negative sort is used to only remove the unwanted materials (contaminants).

Commodity Handling: Once each type of material has been sorted from the primary pile, there may be some benefit in reprocessing them to further clean them before they are shipped to market.

At the processing facility, materials are frequently sorted into debris boxes, hoppers, bunkers or bays. Bunkers can be designed with fixed floors, or with walking or live floors. Hoppers and boxes are usually mechanically dumped.

Residue Handling: Depending on the composition of the residue, it can be further processed to recover additional recyclables, or just disposed of. At a few facilities, all materials that come off the end of process lines are fed back through the system, and only contaminants that are sorted off the lines are sent off for disposal.

Rolling Stock: Vehicles used to move materials around the site and load them for market typically include bucket loaders, forklifts, haul trucks and trailers.

Processing Issues

Processing facilities are designed to handle a specific tonnage of a specific composition of material types. MRFs that are designed to handle the materials from one system may not work on another, even if the equipment is relatively new and 'high tech.'

However it is not uncommon for facilities to process materials from both residential single stream collection programs and commercial office paper collection programs with the same equipment. Additionally, in larger communities, or in facilities that service multiple communities (potentially even with different targeted recyclables), the materials recovered from one geographic area may be very different from those of a different area. It is not realistic to expect the processing equipment to do an equally good job of sorting materials from each of these material streams.

Processing facility design must take into account the site layout, equipment design, equipment layout, staffing requirements, conveyor speed and burden depth.

Processing issues also include:
- ✓ contamination of paper by glass and plastics,
- ✓ loss of recovered plastic, glass and metals (especially beverage containers) into the paper stream

In one location [San Jose] the intent of the program design was not accomplished at each stage of the process.

- Because there was not enough communication with residents at the start of the program, the new automated carts contained too many items that were not on the targeted materials list for the program.

- Because the route drivers had more interest in finishing the routes quickly than in the quality of the recovered materials, they would not identify setouts that were contaminated by residents.
- When the recyclables arrived at the processing facility and they were already contaminated, the processor discarded recyclables with the trash.
- Because the facility received more material than the equipment could handle in the time available, the processor incompletely processed the material, just to make room for the next incoming loads.
- Because the mills that were purchasing the materials did not complain or reduce the payment for the contaminated materials, the processor determined that they were doing an adequate job.

Could anything else go wrong?

Processing problems in this program also include:

- ✓ Too big a pile on the tipping floor
- ✓ Tip floor materials run over by the bucket loader, breaking glass bottles
- ✓ Infeed conveyor belt loaded with too much material
- ✓ Presort line had to deal with garbage, and could not remove intended pesort materials
- ✓ Material types accepted for collection that created a problem for the processing equipment, e.g. textiles and small appliances with cords kept the star-screen from working properly and required more maintenance down-time.
- ✓ The star-screens were too heavily loaded to allow them to separate the containers from the paper as they were designed to do – so there were many containers still in the paper stream.
- ✓ Material splitters discharged at the wrong points and loaded one side of the belt while leaving the other empty.
- ✓ Plastics picking stations were in the wrong sequence and contributed to increased contamination of the higher value plastics.
- ✓ The broken glass loads were full of small pieces of paper (and the paper was full of broken glass) and other materials, resulting in much of the recovered glass not being marketable.

As a result of these compounded problems, almost 40% of the collected materials (including a lot of recyclable materials) were landfilled. The amount of materials diverted from landfill declined during this period, as did the market revenues.

Processing System Problems

One of the biggest problems at processing facilities is broken glass. When glass bottles are shattered, the small glass fragments are scattered throughout the materials at the facility. At the new highly mechanized processing facilities, glass bottles are shattered by the disc and star screens. This problem can be eliminated if alternative, low-impact processing equipment is used until the glass bottles have been removed from the materials.

Conveyor burden depth can be reduced if the amount of equipment purchased matches the materials throughput.

Staffing must match the design capacity. However, whenever budgets are tight it seems the first action is to reduce staffing. [Once purchased, it is hard to cut back on equipment payments or the lease].

It is common for sorted materials to be contaminated by mixing with other sorted materials. The two places that this commonly happens are at adjoining storage bays or bunkers, and when the operators change from one material type to another in the baler.

The amount of glass recovered is often reduced during processing as the bottles get broken and become part of the residue instead of the recovered materials. The sooner the glass is recovered in the processing, the more likely that it will be marketed instead of landfilled.

Costs of Processing

Communities seem to worry about the cost of labor, which is perceived to be a variable cost, but not the cost of equipment (which is often depreciated as a monthly expense). So contractors can spend however much they want on expensive equipment, but sacrifice the quality of the marketed recyclables to 'keep costs down' rather than looking at the whole system cost.

Processing costs money. It takes time, labor, a facility and equipment. The processing costs must be balanced against the added value derived from the processing.

Discussion of the costs of processing for different design options

Discussion of design features that minimize processing residue

Identification of design features that work best in individual situations

Detail labor requirements for each step

Revenue Impacts

There are two primary sources of revenue from collection and processing systems.

Money is collected from the rate payers who receive the services. Generally this is in the form of a service charge per household.

Revenues are derived from the sale of the recovered materials. These revenues are highly variable, dependent on the international marketplace and the value of the processed materials to the manufacturers that make new products from these materials. The market value is [supposed to be] tied to the quality of the materials received at the mills, but other considerations also enter into the equation.

Since the large mills must continuously receive feedstock material to keep the plant running, the mill must have a steady stream of new materials. So if there is not a sufficient supply of local clean materials, then the mill must either accept materials that are not as clean or ship clean materials from more distant locations.

Both of these options have an impact on the profitability of the mill.

Materials Processing Design Recommendations

Recommendations on the design of the materials processing

Glossary of Materials Separation Techniques

Materials separation techniques include:

Air Classifier or **Air Knife** – air is blown through (at right angles to) a falling stream of materials, and the lighter (less dense) items are blown farther than the more dense items, to be sorted by type. For example, pieces of paper labels can be removed from broken glass with this technique.

Air can also be used to separate materials as they move along a conveyor when the air is blown into the material moving in the same direction as the air flow. New optical paper sorters use air to spread the paper out for the sorters to identify individual sheets.

Conveyor – a device to move materials from one place to another. Conveyors are typically horizontal (flat) or inclined. Flat conveyors are used for picking lines, and inclined conveyors are used to bring material from one level to another. Typically, material falls off the end of the conveyor, onto another conveyor, or into a large container.

When material falls off one conveyor onto a conveyor going in the opposite direction, it tends to flip the material over, so that the bottom of the pile from the first conveyor is on top on the second conveyor. Using this technique may allow sorters and screens to do a better job of separating materials by type or size.

Bounce-adherence Sorter – on a slanted vibrating table, objects with different shapes are separated by motion

Densifier [balers, compactors and crushers]: to compact load for shipment to end market, additional processor, or landfill

Disc Screen – a screen where the discs are round. The discs lift materials, and move them along in the direction of the turning disc. Smaller items fall between the discs, and larger items pass over the surface. The spacing of the discs determines which size material separations occur on the screen.

Eddy-current Separator - by combining alternating magnets, the force field repels non-ferrous metals, and will readily separate aluminum cans from other non-metallic materials (such as plastic bottles).

Finger Screen – vibrating bars that let small items fall through, between the fingers, while larger and flat items continue on. Finger spacing can vary to allow separation of different size items. Finger screens do not break glass bottles. If the burden depth is too

great, the fine materials will ride along on top of the flat materials, so the screen does not do a good job of separating materials by size.

Low-impact Sorter – these sorters are designed to separate flat items (paper) from round or cylindrical items (beverage containers). They do so by having a short conveyor belt with short cleats at a steep incline. The belt moves at a high speed and the flat items are conveyed upward, off the end of the belt, while the 3-dimensional items bounce off and are collected below the inclined belt

Magnet – uses magnetic forces to separate ferrous metals from other materials

Optical Sorter – sorts materials by their optical properties, can be used to sort fiber by color (kraft brown from other, white from colored) or glass by color (clear, green and brown; or opaque from transparent) or plastics (such as natural HDPE from other plastics)

Oscillating Screen or V**ibrating Screen** – a sorting surface where materials are separated as they move along a surface with holes

Roll Screen -- a modified disc screen, where the discs are triangular instead of round. This causes a pulsating movement, and may provide better separation of materials than a simple disc screen, depending on the nature of the materials being processed.

Star Screen – a modified disc screen, where the edge of the disc has fingers. The star discs move more material along than simple discs, and allow for better separation of materials.

Trommel Screen – a large metal cylinder with holes in it to allow some items to be separated from larger items that do not pass through the holes. Longer trommel screens can have smaller holes at the in-feed end, and larger holes further along to make more than one size separation.

Vacuum – a vacuum is used to lift lighter materials from a sort line, leaving the heavier materials on the belt. For example, plastic bags can be removed, leaving paper and beverage containers behind.

Conference Call Questions

1. What processing problems are caused by changing/increasing the mix of materials received?

2. Should communities balance the added cost of processing materials to higher quality with the value added for that cleaner material?

3. Is the existing (newest) processing equipment doing the best possible job? What changes still need to be made? Is there a role for end use markets/manufacturers in the design of processing equipment?

4. How important is it to end up with the cleanest possible material as compared with clean enough to sell? Is just 'good enough' really good enough?

5. What is the optimum sequence to de-mingle (separate) individual commodities from the co-mingled single stream mix?

6. Do we need to design new ways to process the newer mix of materials?

7. How does facility size and layout impact the ability of the MRF to process the incoming materials? How big should the facility be (square feet per ton per day processed)? Is there ever enough room?

8. What are the best mechanisms to prevent mixing of materials from bunkers (storage bays) or between baling different commodities?

9. What are the best mechanisms to reduce glass breakage before the bottles are sorted?

10. How does the staffing level impact the ability of the MRF to process the incoming materials? Is there an optimum staffing level per ton of incoming material?

11. How much contact do processors have with their markets about the quality of the materials shipped?

12. Do quality assurance incentive payments work? Does anyone have specific contract language they would like to share?

