PREPROCESSING OF MUNICIPAL SOLID WASTE FOR RESOURCE RECOVERY WITH A TROMMEL-UPDATE 1977

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ABSTRACT

The first step in processing municipal solid waste (MSW) for resource recovery has usually been shredding. However, during the past several years, a trommel (revolving cylindrical screen) has been investigated as a step to precede shredding. Some of the initial work in the United States regarding this use of a trommel was presented by Woodruff in 1975. This paper will discuss some of the additional research and developmental work conducted during the past two years and will include a brief report on the full-scale operational trommel installed in New Orleans.

INTRODUCTION

Shredding has been the first step in processing municipal solid waste (MSW) for resource recovery in essentially all of the processing facilities installed throughout the United States. In 1972, the use of a trommel screen was proposed [1] to process packer-truck refuse prior to shredding. On the basis of experimental work performed in England [2-4] as well as wide experience in the minerals industry [5], it was decided that the use of a trommel for this purpose might indeed be viable. As a result, a trommel was included by the National Center for Resource Recovery, Inc. (NCRR) in the process design for a prototype materials recovery plant for the City of New Orleans [6]. In order to develop necessary data to facilitate the design and specification for this new use of a trommel, an experimental program was initiated by NCRR. The results of that work were reported by Woodruff in 1975 [7]. Since that time, a number of other organizations have investigated the use of a trommel and the prototype facility in the City of New Orleans has come on-line.

BACKGROUND OF MSW TROMMELING

The initial basis for proposing the use of a trommel for MSW preprocessing in 1972 was two-fold. First, by removing the portion of raw MSW already within the specified shredder-output particle size range and bypassing the shredder, the throughput and hence operating costs (and possibly size) of the shredder could be reduced. Second, by removing materials, such as glass and cans prior to shredding, the recoverability of the materials would be enhanced. This reasoning is still valid. However, another, perhaps more important reason has brought added attention to the trommel in the past several years.

It has been found that shredding reduces the particle size of glass too fine [8] to enable effective separation from the MSW in downstream operations. The recoverability of glass is enhanced if removed in larger pieces prior to shredding. If not removed, the fine glass remains with the organic fraction which is that portion used as a refuse-derived fuel (RDF). The glass contained in RDF is a serious contaminant, since it not only results in
greatly increased ash content, and hence lower heat value fuel, but it also creates serious abrasion and maintenance problems in subsequent processing and handling steps. Additionally, excess glass aids in formation of slag deposits on furnace walls in boilers burning RDF. Therefore, it has become desirable to remove as much glass as possible from the RDF processing system. Various agencies and system developers have examined the removal of glass at various points in the process flowsheet in order to minimize the aforementioned problems.

Experimental work has been conducted by organizations such as the Tennessee Valley Authority (TVA), Continental Resources Recovery Corporation (CRRC) and others, for the purpose of examining the utility of a trommel for preprocessing MSW. The results of available experimental data is compared with trommel testing information reported previously.

**TVA TEST PROGRAM**

As part of its program to develop a resource recovery system, the Tennessee Valley Authority formulated an experimental program for the purpose of exploring the utility of a trommel as a preprocessing device. The basis for the tests was to explore the removal of cans and glass from raw MSW prior to shredding. The trommel selected for test purposes was the same 9 ft (2.74 m) diameter unit equipped with 4-in (10.2 cm) square clear opening screen cloth (Fig. 1), which was fabricated and tested previously by NCRR [7].

In mid-1975, the unit was shipped from Washington, D.C. to Knoxville, Tennessee where it was set up for batch operation in a solid waste transfer station. A test program was developed to examine operation at various slopes and feed rates. The experimental procedure consisted of weighing MSW samples in drums and dumping them by hand directly into the unit within a specific period of time. Thus, the feed rate was varied from 6 to 30 tons/hr (5 to 27 t/h). In addition, the slope of the unit was varied among three levels during testing; these were 3, 4 and 5 deg. The unit was operated at 7 rpm during all tests. Although previous experimental work by NCRR [7] had indicated that the optimal speed was 11 to 12 rpm, the TVA series of tests was conducted at the lower speed.

![FIG. 1 PILOT SCALE TROMMEL](image-url)
primarily to minimize excessive clean-up problems from the unenclosed unit.

Although it is felt that to truly compare data obtained by NCRR and TVA, a range of speeds should have been examined, a comparison of the separation efficiencies can be made. The separation efficiency at the slower speed would be expected to be lower than at the higher speed, if 11 to 12 rpm is optimal. As can be imagined, the depth of burden of the material within the trommel will be greater at the slower speed, thereby yielding less open space for undersized material to pass the screen openings. Also, the slower speed does not allow the material to be carried nearly to the top of the unit before allowing it to fall. This provides the tumbling action necessary to break open plastic bags to liberate cans and bottles, thereby assuring their efficient separation. By operating at the slower speed, the advantage of the large diameter of the unit is not being fully realized. Conversely, if too high a speed is utilized, the material tends to centrifuge and is not permitted to fall nearly the full diameter of the trommel. This, too, would decrease separation efficiency.

The method utilized to evaluate separation efficiency in the TVA tests was to add 100 “seed” cans to each batch of MSW fed to the unit. After each test run, the seed cans reporting with the minus 4 in. (10.2 cm) fraction were counted and the efficiency expressed as the percentage of 100. This method is considered to be an acceptable one assuming that the desired component, canstock, is liberated from the feed material. However, a sizable amount of the MSW feed to the unit is contained in plastic bags which must be broken open to liberate the contents. No actual tests were conducted to determine optimum efficiency of bag opening, so it is not known exactly how this method of efficiency measurement compares with that for the actual MSW, as received.

A summary of the TVA test data has been compiled and is presented here along with a discussion of comparisons with the NCRR experimental data.

Figure 2 graphically depicts the weight percent of the raw MSW feed reporting to the minus 4 in. (10.2 cm) fraction versus feed rate. This figure was prepared from the data of 19 trials while operating at three slopes (3, 4 and 5 deg.). On the basis of Fig. 2, it appears that to achieve maximum undersize removal, 15 tons/hr (13.6 t/h) is the optimal feed rate. This capacity is the same as reported by NCRR in 1975 [7]. It should be noted that little variation was detected for the three different slopes examined. This indicates that the retention time in the unit at each slope was similar.

![Figure 2](image2)

**FIG. 2 UNDERSIZE VERSUS FEED RATE IN TVA TESTS**

Figure 3 shows the efficiency of can separation at various feed rates based on the percentage of seed cans reporting with a minus 4 in. (10.2 cm) fraction. This figure is also a compilation of trials at all three slopes of operation. Considering that good efficiency is anything greater than 85 percent removal of the cans, the maximum feed rate for this size trommel is approximately 15 tons/hr (13.6 t/h) and the optimum feed rate is about 9 tons/hr (8 t/h).

The TVA test program reconfirmed the NCRR results which indicated the experimental unit had a capacity of 15 tons/hr (13.6 t/h). In addition, the TVA tests indicated that approximately 50 percent by weight of the feed material would report as minus 4 in. (10.2 cm) product. Although no analysis of the undersize fraction was made, from the amount of material reporting to the minus 4
in. (10.2 cm) fraction, it can be assumed that similar rates of recovery of magnetic metals, glass and aluminum were achieved. As reported by NCRR [7], these were:

<table>
<thead>
<tr>
<th>Material</th>
<th>Recovery Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Metals</td>
<td>64.0 percent</td>
</tr>
<tr>
<td>Aluminum</td>
<td>75.3 percent</td>
</tr>
<tr>
<td>Glass</td>
<td>96.6 percent</td>
</tr>
</tbody>
</table>

On the basis of the tests conducted, and data available from NCRR, TVA has included a trommel as a preprocessing device in a Regional Resource Recovery System it has developed. Figure 4 is the process flowchart for the system. As shown, a trommel screen is the first unit operation following receiving and storage. The preliminary specification prepared for this unit requires a 15 ft (4.57 m) diameter by 40 ft (12.19 m) long trommel, equipped with punched plate having 4 in. (12.1 cm) diameter openings. Its intended purpose is to produce an undersize (inorganic-rich fraction) and an oversize (organic-rich fraction) from 75 tons/hr (68 t/h) of raw MSW.

The next processing step for both trommel outputs is magnetic separation. Large massive ferrous metals are contained in the oversize, while magnetic can stock material is the principal ferrous component of the undersize. Both magnetic metal fractions can be further processed and upgraded. At this point the remaining oversize fraction proceeds to refuse-derived fuel processing which includes primary shredding, air classification and secondary shredding. The trommel undersize (inorganic-rich fraction) proceeds to a jaw crusher to reduce the particle size of the glass contained in it. Following crushing, another trommel separates a glass-rich (undersize) fraction from an organic and nonferrous metal-rich (oversize) fraction. The glass-rich material proceeds to a glass recovery system (froth flotation) and the organic and nonferrous metal-rich fraction proceeds to air classification for recovery of the organic portion as part of the RDF product.

Although the TVA Plan is not presently being implemented, it is one of the first systems designed entirely around the trommel as a preprocessing device. The New Orleans Recovery I Facility was designed with a trommel in only one of the two preprocessing lines in order to compare its performance with that of a typical shred only system. Some preliminary results of that installation are reported in the next section.

QUALITATIVE DATA FROM NEW ORLEANS — RECOVERY I

As previously discussed, the NCRR pilot plant tests were conducted in order to specify the trommel to be installed in the New Orleans Recovery I Facility. The unit is now on-line and operating successfully. The dimensions of the effective screening area, 10 ft (3.05 m) in diameter by 40 ft (12.19 m) long with 4% in. (12.1 cm) diameter openings, are essentially those specified in 1975 [7]. Having a punched plate thickness of 3/4 in. (9.1 cm), the unit is a sufficiently sturdy piece of equipment to prevent serious damage from the processing of bulky wastes. The unit rotates at 11.3 rpm and is powered with a 40 hp motor. This motor is smaller than was initially specified. Although it provides sufficient operating power, some difficulty has been experienced during start-up with the trommel full of MSW [9].

In order to process an average of 62.5 tons (56.7 t) of raw MSW per hour, the unit is fed by an 84 in. (2.13 m) wide apron conveyor, and oversize material is discharged to another 84 in. (2.13 m) wide apron conveyor. Undersize material is collected and transported by a 48 in. (1.22 m) troughed belt conveyor. The unit contains eight equally spaced lifters which are sloped approximately 6 deg. to move material through the unit. Discharge plows in the last 4 ft (1.22 m) are sloped 24 deg. to aid removal of oversize material from the unit. The entire trommel is sloped 5 deg. from the horizontal. A view of the unit (without dust cover) from the discharge end is shown in Fig. 5.

As had been predicted, no blinding problems are being encountered. Any fabric and other materials which tend to hang on the screen plate drop off after several revolutions. Woven wire cloth had been utilized in the pilot unit and minimal blinding problems were experienced; it was anticipated that blinding would be lessened with punched plate.

Although the design feed rate was 62.5 tons/hr (56.7 t/h), observation has indicated feed rates upwards of 100 tons/hr. (Information regarding the sizing and design of the Recovery I trommel is included in [7] or may be obtained from the manufacturer of the unit, Triple/S Dynamics of Dallas, Texas.) This increased capacity of the trommel, and hence the facility, has been discussed by Waste Management, Inc., owners/operators of the facility [10]. Preliminary data from the opera-
TYPICAL PROCESSING LINE FOR SCHEME I - WASTE PROCESSING PLANT
CAPACITY PER LINE - 1000 TONS PER DAY
2 SHIFT OPERATION

FIG. 4 TENNESSEE VALLEY AUTHORITY SOLID WASTE PROCESSING SYSTEM
FIG. 5 TROMMEL SCREEN AT RECOVERY I
tion indicates a 50/50 split, by weight, of the feed material to oversize and undersize products. This is similar to the pilot plant results, which had predicted 49 percent reporting to undersize with 51 percent reporting to oversize. In addition, it appears that the undersize fraction contains approximately 55 percent of the magnetic metals, nearly 80 percent of the aluminum and 90 percent of the glass. Although this data is preliminary and in-depth tests are presently underway, it compares quite closely with the predictions of the pilot tests. Bulk density measurements of the two outputs indicate densities of 7 lb/ft\(^3\) (112.14 kg/m\(^3\)) for the oversize while the undersize is approximately 21 lb/ft\(^3\) (336.42 kg/m\(^3\)).

It appears that the scale-up of the pilot unit to the production unit was accomplished successfully. In fact, it appears that the unit has a higher capacity [10]. It is believed that the trommel at Recovery I is the largest unit processing MSW [11], and therefore it will be looked to for much information regarding sizing and separation efficiencies for future installations. NCRR is presently conducting an in-depth test program to make much of this information available [12].

CONTINENTAL RESOURCES RECOVERY CORPORATION TROMMEL TEST PROGRAM

During April and May of 1975, Continental Resources Recovery Corporation (CRRC) conducted a test program at the NCRR Equipment Test and Evaluation Facility in Washington, D.C. In this program, the same trommel as shown in Fig. 1 was utilized. Again, the unit was arranged to receive feed material on a continuous basis through the use of a hopper, feeder and belt conveyor. However, the MSW feed material and screen cloth openings were different than those previously examined by NCRR [7].

MSW feedstock was not raw packer truck material, but was material which had been processed through a flail mill and from which the bulk of the magnetic metals had been removed. For experimental purposes, the material was household waste which had been processed through a flail mill installation in San Francisco, California. Screen cloth sizes which were tested included 4, 2 and 1 in. (10.2, 5.1 and 2.5 cm) square openings. The objective was to remove metals and glass, but only after flailing to assure all bags had been opened to sufficiently liberate the components to be removed.

The procedure was to weigh a sample of flailed MSW and place it in the hopper and feeder for charging to the unit. Feed rate was determined by noting sample weights and timing each trial. Each test was operated under prespecified conditions such as slope, rpm and screen cloth size. At the completion of each trial, samples of all products were taken. In most tests, two different sizes of screen cloth were installed on the unit, resulting in the production of three outputs. The use of two sizes of screen cloth provide for 5 ft (1.52 m) sections of each.

The composition and particle size distribution of the feed material are shown in Tables 1 and 2. It is quite apparent that the bulk of the magnetic metals had been removed following the flailing operation. It is also obvious from Table 2 that the flailing operation produced a coarse product. The output of a typical hammermill type shredder would have been at least 90 percent passing 4 in. (10.2 cm), while the flail mill output is only 68 percent passing 4 in. (10.2 cm). Since the MSW had been flailed, it was assumed that the bulk of the glass, being extremely friable, would be minus 2 in. (5.1 cm). Table 2 tends to substantiate this, since almost 50 percent of the MSW is minus 2 in. (5.1 cm). On this basis, the test program was conducted using wire cloth with 2 in. (0.05 m) square clear openings as one or both sections of screen on the trommel for all trials.

<table>
<thead>
<tr>
<th>TABLE 1 COMPOSITION OF FLailed MSW</th>
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<tbody>
<tr>
<td>Category</td>
</tr>
<tr>
<td>Glass</td>
</tr>
<tr>
<td>Ferrous Metals</td>
</tr>
<tr>
<td>Other Nonferrous Metals</td>
</tr>
<tr>
<td>Aluminum Containers</td>
</tr>
<tr>
<td>Aluminum Foil</td>
</tr>
<tr>
<td>Rock/Stones</td>
</tr>
<tr>
<td>Combustibles*</td>
</tr>
</tbody>
</table>
*Includes: Rubber, plastics, wood, rags, paper, food waste, yard waste, and other organic materials.

<table>
<thead>
<tr>
<th>TABLE 2 PARTICLE SIZE DISTRIBUTION OF THE FLAILED MSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (In.)</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1 1/2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>3/4</td>
</tr>
<tr>
<td>1/2</td>
</tr>
<tr>
<td>1/4</td>
</tr>
</tbody>
</table>
Test results indicate that the trommel made a reasonable separation at 2 in. (5.1 cm) when only half of the length of the trommel, 5 ft (1.52 m), was covered with 2 in. wire cloth at feed rates of 15 to 25 tons/hr (13.6 to 22.7 t/h). It was found from an average of 10 trials that 30.4 percent of the feed material reported with the minus 2 in. (5.1 cm) fraction. Table 3 indicates the average composition of this material. The two principal components of the fraction are glass and combustibles. However, when considering these components as a percentage of the amounts found in the original feed (Table 1), virtually all of the glass, but only about 20 percent of the combustibles, have reported with this undersize fraction. Additionally, 70 percent of the rocks and stones reported with this fraction. The results of this series of tests indicate that after coarse shredding or flailing, if material is processed through a trommel, nearly all the glass can be concentrated in approximately one-third of the total weight of the MSW. Additionally, the majority of the ash, rock and dirt is contained in this fraction, and although 20 percent of the combustible fraction is present, the oversize trommel output is in a form more amenable to the production of refuse-derived fuel. This series of experiments indicates another potential avenue for the utilization of a trommel in refuse preprocessing.

**TABLE 3 AVERAGE COMPOSITION OF MINUS 2-IN. TROMMEL OUTPUT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>41.0</td>
</tr>
<tr>
<td>Ferrous Metals</td>
<td>1.4</td>
</tr>
<tr>
<td>Other Nonferrous Metals</td>
<td>0.2</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.7</td>
</tr>
<tr>
<td>Rock/Stones</td>
<td>3.3</td>
</tr>
<tr>
<td>Combustibles*</td>
<td>53.4</td>
</tr>
</tbody>
</table>

*Includes: Rubber, plastics, wood, rags, paper, food waste, yard waste, and other organic materials.

**THE FUTURE OF THE TROMMEL IN MSW PREPROCESSING**

As presented, the two reasons for including a trommel as a preprocessing device in a MSW resource recovery system are: (1) to reduce the operating costs of shredding; and (2) enhancement of the removal and recovery of glass and metals from the remainder of the MSW. The data presented in this and the other reports cited strongly indicates that the trommel should meet the expectations for its use.

With regard to the reduction in operating costs for shredding of MSW, reports from Recovery I indicate this to be true [10]. Additionally, NCRR has prepared a comparison of the projected savings of a trommel and shred system versus a shred only system [13]. The cost comparison was based on the Recovery I installation which was designed to process 62.5 tons/hr (56.7 t/h) of MSW. Capital costs indicated are as follows: (1) Shredder only - $585,698; (2) Trommel and Shredder - $891,814. Projections by NCRR for the per ton cost of operation, assuming 202,800 input tons of MSW per year, are as follows: (1) Shred only - $1.41/ton; (2) Trommel and Shredder - $1.31/ton. This, of course, shows only a 10¢/ton savings. On an annual basis, this appears to be only a 6.7 percent rate of return on the incremental capital investment. Actual long-term operational data is not yet available which could substantially improve this projection. Indeed, if the trommel serves to nearly double the actual processing capacity of the line, as has been reported [10], then the true rate of return could be more than doubled. Another way to show an additional savings, which would result in an improved rate of return, would be to decrease the size of the shredder, hence decreasing the capital cost of the system. In 1975 [7], a cost analysis of a system with a trommel and smaller shredder predicted cost savings of 19.5¢/ton. Another economic benefit, not as yet determined, would credit the trommel-shred system with savings due to enhanced materials recovery and improved product quality. Two examples are increased glass recovery and higher quality RDF. At this time, no data is available from Recovery I, but because pilot plant experience indicates 90 percent glass removal prior to shredding, it is anticipated that glass recovery will be nearly twice that expected from a shred only system. At the same time, this will result in improved quality of RDF. Removal of fine glass is extremely important to improving the heat value and handling characteristics, as well as minimizing difficulties in the firing of RDF.

These benefits have been recognized by system developers such as Combustion Equipment Associates, Teledyne National and many others. As a result, it is believed that the trommel holds a significant place in the processing of MSW for resource recovery.
REFERENCES


Key Words
Classification
Equipment
Process
Rotating Drum
Separating
Separator
Discussion by

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The authors have deftly continued the earlier work begun in England and leave little doubt about the ability of a raw refuse front-end trommel to "enhance the recoverability of materials" and to "remove the portion of raw MSW already within the specified shredder output particle size . . . ." Purported operational benefits and the necessity for removing certain fractions, however, are presently subjects for debate, and this discussion will focus thereon.

A salient question is the need to remove glass with regard to:
- Boiler tube slag deposits from RDF firing.
- Ash volume.
- Shredder maintenance.
- Glass recovery.

Regarding boiler tube slagging, the case for removal of glass from RDF (nominal topsize ≤ 38 mm) for full suspension burning (with pulverized coal) appears somewhat stronger than for spreader stoker firing (partial suspension burning @ say nominal topsize ≥ 101 mm).

Particle size is not directly related other than the degree of glass pulverization inherent in producing it. Instead, furnace thermodynamics are critical, i.e., fireside tube metal temperature, atmosphere, mass gas flow, etc [1].

Likewise, for other MSW thermal reduction technologies, principally pyrolysis, the need for glass removal seems to depend upon operating temperatures and the type of furnace/reactor: molten slag tap or dry residue.

At least one proponent of the molten slag mode specifies glass in the charge, with a minimum below which additional glass (or an equivalent flux for metals) must be added.

Conversely, dry systems (catalyst reactor, multiple hearth, kiln, shaft-retort, etc.) prefer a glass free charge for minimal dry slag formation.

There seems to be a consensus, however, for removal of metals as a source of hearth, refractory, retort degradation, etc.

Pneumatic conveying of prepared MSW, regardless of recovery and/or disposal technologies, is vulnerable to significant pipe duct erosion if glass and other abrasive fines are not removed[2].

For existing pulverized coal fired boilers, the contribution of glass to bottom ash has been of concern, but for new units designed for full or partial suspension burning, such concern appears minimal.

Although significant reduction of shredder hammer wear with essentially glass-free raw infeed has been reported, it may be of diminishing and questionable benefit if the promising trend toward harder, longer life no-weld discard hammers continues[3]. The Ames experience appears corroborative[2].

Recovery of glass as a saleable by-product has evoked little enthusiasm with perhaps a few isolated exceptions.

The premise that a front-end raw refuse trommel permits use of a smaller shredder must be exercised with consummate caution.

With an oversize/undersize split by weight of approximately 50/50, and with respective bulk densities of 7 lb/ft³ (112 kg/m³) and 21 lb/ft³ (336 kg/m³), the shredder must be sized with acute awareness of the potentially small change in specific volume of the trommeled raw infeed and its lower mass flow rate.

Also, the typical discharge flow pattern of trommels (especially with lifters) should be recognized, — an elevated and concentrated stream, off to the side of a discharge hopper or on the shredder feed conveyor.

We must question the observation that "the trommel serves to nearly double the actual processing capacity as has been reported . . . ."

It does not seem at all likely that the capacity of a shredder, sized correctly for untrommeled raw refuse, can be doubled by addition of a front-end trommel. At best, the increase may be proportional to the ratio of oversize/undersize specific volumes.

DISCUSSOR'S CONCLUSION

The authors' work to date has made a significant contribution to the technology for both front-end and interstage trommel screening. We are looking forward to a continuation of the effort. (Unless a proliferation of "Bottle Bills" renders our entire dialogue academic!).

REFERENCES


Discussion by

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The paper by Woodruff and Bales gives an interesting account of work done in the U. S. on the use of trommels as a preprocessing unit for municipal solid waste (MSW). It is worth recalling that this approach was already being investigated in the United Kingdom in the twenties [1].

As pointed out by the authors, in the early stages of pilot work, at NCRR and later at TVA, the rotary screen, of common use in the ore processing industry, was viewed primarily as a glass concentrator in the undersize, and possibly a metal concentrator. Since removal of the glass fines is beneficial in decreasing abrasion and lowering fuel ash content, it follows that the device could also be seen as a fuel enricher and improver, with some loss of combustibles in the undersize. If magnetic recovery follows a loosening of the raw waste in a flail mill, as in the Continental Resource Recovery Tests, the function of the unit is glass concentration through smaller screen openings, thus with a smaller loss of combustibles to the undersize.

The main parameters of importance were investigated by the authors in a series of pilot tests. It might be of interest to discuss how the latest results from full-scale trommel tests at Recovery I, New Orleans, compare with prototype test results [2]. At throughputs of 60 ton/hr of unshredded MSW, in a 43 ft X 9.75 ft diameter trommel, with 4-in. diameter holes, Bernheisel, Bagalman, and Parker reported a 45/55 overs/unders split; 99 percent of the glass reported to the undersize; so did 82 percent of the ferrous and 91 percent of the aluminum under 4 in. in size in the feed. The bulk density of the overs and unders are 51b/ft and 21 lb/ft, respectively, a ratio of 4:1 for the densities of oversize to undersize, instead of the 3:1 ratio reported by Woodruff and Bales. As a fuel enricher, the trommel delivered a fuel containing 26 percent moisture and 10 percent ash. Thus, the results from full-scale testing at high throughputs are in remarkable agreement with those obtained in pilot studies.

As a minor aside, one might ask the authors if they would speculate on the reasons for the observed insensitivity of the transit time to a slope increase of 66 percent (from 3 degrees to 5 degrees). Could this be due to the smaller ratio of length to diameter of the trommel?

To summarize: after the publications quoted in reference by Woodruff and Bales, the present paper, Bernheisel et. al.’s results [2] and J. L. Warren’s [3] article about work carried out in the U. K. during the sixties, the trommel no longer appears as a laboratory device, but a test prototype has reached the status of a full-fledged operational unit.

REFERENCES


Discussion by

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Having personally been involved with design, start-up, and production results of the trommel at Recovery I, New Orleans, I felt quite at ease reading and commenting on this paper.

Results via test data and their compilation are still in process at Recovery I, but most of what this paper says regarding Recovery I experience is correct. The waste management trommel, which processes unshredded refuse, does, in effect, increase thru-put, by creating two separate waste streams, each fairly close in tonnage. The “unders” or heavies stream is very rich in glass and ferrous
can content. This stream does not enter the shredder. Consequently, the sum of the “overs” and “unders” streams is greater than the original design value for the total line because more tonnage is trommeled to the heavy or “unders” than originally thought possible.

We at waste management are pleased with the fact that operating costs per ton of refuse processed are lower for the line of equipment including the trommel, and for the reasons stated in the paper written by Woodruff and Bales:

1. A significant increase in TPH being processed.
2. Impressive reduction in shredder maintenance due to removal of highly abrasive glass prior to shredding.
3. Thorough (90 percent) removal of glass and a very high percentage of ferrous cans removed from the waste stream. Both can be recycled, adding income by resale. As pointed out in the update, should RDF be produced a glass free product is better and, hence, more saleable.

One principal type of data still should be developed for trommeling, that of thru-put related to diameter, barrel length and rpm. Trommels could be used as a surge handling device, with sufficient dimension to still efficiently process waste. Of course, capital costs must be considered, but a high and reliable thru-put is vital to profit and more charts or curves of data are required in this area of statistics. Undoubtedly, due to prohibitive cost for pure test arrangements of larger trommels, this data will be developed through information from actual operations.

While the general results of trommel activity at Recovery I are unusually good, all is not rosy. The “unders” stream presents problems in processing not indicated in data. One problem, in particular, is the handling of lengths of wood, conduit, and pipe which report, surprisingly, to this stream. These cords, 1½-3 ft in length, must be removed in some economic fashion or they cause plugging in the equipment downstream of the trommel.

Also, trommel design itself must be significantly improved to remove maintenance. This point, while not related to test data, impacts on the thru-put and resultant profit.

In closing, Mr. Woodruff and Mr. Bale’s paper contains data, either from testing or from preliminary production results. Results, as experienced by my firm, WMI, at Recovery I, bear out the summary by Bales and Woodruff — “It is believed that the trommel holds a significant place in the processing of MSW for resource recovery.”

Discussion by

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The sizes and cleanliness of the “seed” cans are not given. This is a rather poor method of assessing the true performance of actual wastes, since bags, bales, etc. may or may not be open in this trommel.

The use of optimum and maximum feed rate needs clarifying, as does the difference between feed rate and efficiency of can separation. It is not clear without careful reading and rereading that this is so. Did NCRR also obtain 50 percent undersize? If they did not, how can one justify the percentages of magnetics, aluminum or glass assumed in this paper.

Mention is made of a 15 ft diameter trommel that can handle 78 ton/hr. Earlier, a 9 ft diameter capacity is given as 15 ton/hr. The ratio of the squares of the diameter is 2.78; that of the capacities is 5.2. Unless something is different (rotation rates, lengths) the sizes do not seem to be commensurate with the capacities.

It is not clear that the discussion and the flow sheet showing TVA plans are needed to support the main topic of this paper.

The New Orleans trommel diameter and capacity do not agree with test data.

The paper states “nearly all the glass can be concentrated in approximately one-third of the total weight of MSW”. Would this be true if the waste is merely flailed and not magnetically separated before trommelling?

This is rather a nice companion paper to that of Nollet and Sherwin. While the latter authors appear to be aware of the trommel approach, the present authors do not have anything to say about the air classification approach.

AUTHORS’ REPLY

The trommel, as shown in Fig. 1, was utilized for all the tests reported. However, as shown, it is equipped with a section of 4 in. (10.2 cm) square opening wire cloth and a section of 2 in. (5.1 cm) square opening wire cloth. Some of the Continental Resources Recovery tests were run in this manner; however most data was derived with one size
of screen cloth mounted on the entire unit.

Regarding the seed cans used in the TVA tests, the cans were typical 12 oz (335 ml) bi-metal beverage containers. As indicated in the paper, no actual tests were conducted to determine efficiency of bag opening during the TVA tests, and hence, the seed can method can not be compared with the actual MSW results. Because of the lack of comparative data, the accuracy of the seed can method can not be assessed.

A discussion of trommel scale-up has been presented in the author’s previous paper [7]. This should adequately explain the designing of the New Orleans Recovery I trommel.

Each preprocessing line at Recovery I was specified to handle 62.5 ton/hr, one consisted of a trommel and shredder, the other a shredder only. Due to the fact that the trommel appears to be capable of handling about 100 ton/hr, with 45 percent of the MSW reporting with the undersize fraction and hence bypassing the shredder, only 55 ton/hr is fed to the 60 ton/hr capacity shredder. On this basis, it appears that the processing capacity of that line is nearly double its specified capacity. Further, it is believed that a 100 ton/hr trommel followed by a 55 to 60 ton/hr shredder might be a realistic front-end processing scheme. Forthcoming data from Recovery I should confirm this.