United States
Environmental Protection
Agency

Municipal Environmental Research
Laboratory
Cincinnati OH 45268

POSTED

Research and Development

EPA-600/S2-81-102 July 1981

EPA

Project Summary

Ferrous Metals Recovery at Recovery 1, New Orleans, Louisiana

Louis P. Soldano

This report summarizes four final technical reports that document a series of five tests (referred to as Test Nos. 4.01, 4.03, 4.05, 4.07, and 4.09) of ferrous metal recovery from municipal solid waste (MSW) at the New Orleans, Louisiana, Resource Recovery Project (Recovery 1). Test No. 4.01 documented the performance of the trommel-unders magnetic drum separator. Test No. 4.03 was conducted to evaluate the efficiency of shredded trommel-overs separator. Tests Nos. 4.05, 4.07, and 4.09 were conducted to evaluate the efficiency and energy consumption of a shredder and air classifier added to the ferrous metal recovery system. Hammer wear was also measured for the shredder.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, Ohio, to announce key findings of the research projects that are fully documented in separate reports (see Project Report ordering information at back).

Introduction

This report describes the ferrous metal recovery testing done at a full scale resource recovery operation at Recovery I, New Orleans, Louisiana. Resource recovery of MSW consists of collecting materials (ferrous metals, aluminum, glass, paper, etc) from processed or unprocessed municipal refuse. At Recovery 1, attempts to recover ferrous metal were done initially with a trommel and two drum magnets. The waste was passed through a trommel (a large horizontal metal drum perforated with holes) The waste falling through the holes (trommel unders) and waste passing through the trommel (trommel overs) was subjected to magnets that recovered any ferrous metal.

Test No. 4.01 evaluated the belt magnet performance for recovering ferrous metal from the trommel underflow. Test No 4 03 evaluated the belt magnet performance on the trommel overflow.

The contractor for the ferrous metal required that the product meet the following criteria: maximum contamination, 4 percent; bulk density, 21.5 to 26.0 lb/ft^3; and shred size, maximum, 5 percent less than 1 in. Since the trommel and belt magnets could not produce materials meeting this criteria, the system was modified. Test No. 4.07 was conducted to evaluate the efficiency of a hammermill (shredder) followed by a belt magnet in liberating and separating contaminants from the ferrous metal recovered from the trommel. The system was further upgraded to include an air knife and another belt magnet (Figure 1). Test Nos. 4.05 and 4.09 examined the modified system's ability to protect the shredder from dense objects and reduce contamination of the ferrous product. This report describes the results of the evaluations.

Test No. 4.01, Trommel-Unders Magnetic Drum Separator

At Recovery 1, there are two primary magnets The function of the magnets is to remove ferrous metal from that portion of the MSW that has either passed through the 4-3/4-in.-diameter circular openings in the trommel or flowed out the end of the trommel. The passing material is known as the trommel underflow and the magnet, the trommel underflow magnet. The drum magnets used are suspended over the head pulleys of the underflow and overflow conveyors

The trommel underflow magnet is an electromagnetic type 42 in. in diameter and 54 in long. The electromagnetic coil is powered by direct current (DC) supplied by a rectifier rated for 5,200 watts and 230 VDC.

The most significant size range for the feed of the trommel is less than 4 in and greater than 2 in In the feedstock, on a clean metal basis, this size range accounted for 72 percent of the magnetic opportunities by weight

The magnetically removed ferrous underflow product is cleaned by separating light gauge ferrous material (mainly cans) from heavier gauge (non-can) ferrous materials. Contamination carried over at the time the ferrous material was extracted from the waste stream is pneumatically removed. (The term "contamination" not only includes material caught on the ferrous product, but material actually physically joined to the product). This section of the report discusses the efficiency of the trommel underflow magnet as a light gauge ferrous separator. The underflow magnet showed an average efficiency of 87 percent measured on an "as received" basis. Magnetic efficiency on a clean (no contamination) metal basis for the light metal is 92 percent The efficiency of the underflow magnet in terms of clean metal was 85 percent for the heavy ferrous metals. Magnetic efficiency was highest for food cans (98 percent) and lowest for composite cans (11 percent)

The magnet itself acts as a cleanup device, since it differentially attracts magnetics as a function of their contamination As far as composite and contaminated food cans are concerned, an object that is less than one-third magnetic material will probably be extracted by the magnet.

According to the test results, for every 100 lb of trommel underflow magnet product, 65-1/4 lb is the desired light

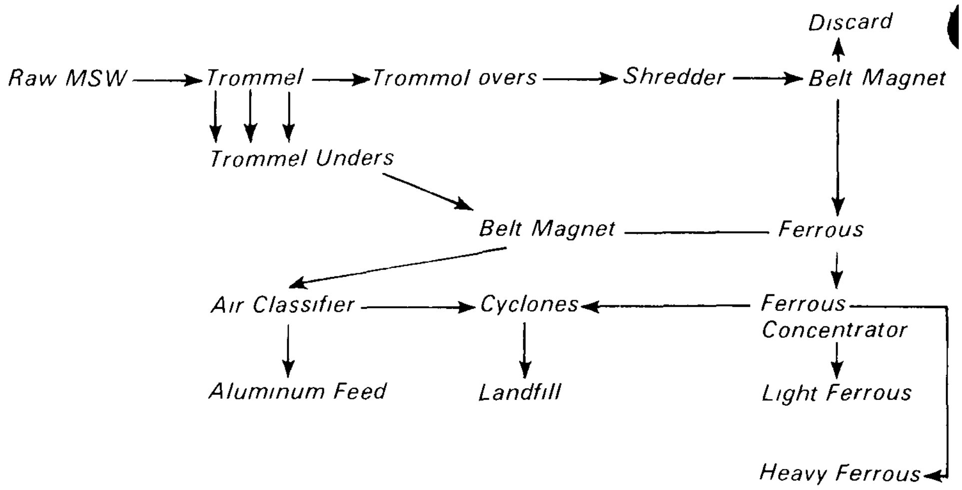

Figure 1. *Final upgraded ferrous metal recovery system at Recovery 1*

gauge ferrous, 22 to 14 lb is heavy ferrous, 2 lb is loose contamination, 9-1/4 lb is entrapped contamination (light ferrous), and 1-1/4 lb is entrapped contamination (heavy ferrous) The amount of contamination of the light gauge, almost 12-1/2 percent, is unacceptable for market use

Assuming one day's waste of 650 tons, with a bulk density of 16.6 lb/ft^2, is processed at approximately 62 5 tph, the trommel underflow magnet would produce 17-1/2 tons of magnetic metal per day. Just under 13 tons would be the desired light ferrous metal. Roughly 4-1/2 tons would be heavy ferrous The magnet would also produce 2 tons of entrapped contamination and 1/4 ton of loose contaminants

On a 650-ton MSW day, if perfect separation of heavy ferrous and loose organics was accomplished by the cleanup steps, the shipped material would average 2,820 lb/hr on an as received basis. Of this, 350 lb/hr would be entrapped contamination (at 12.4 percent shipped material) This is well above the market specification of 4 percent nonmagnetic material.

The project data resulted from the average of test runs of 15 sec each at nominal operating conditions The data developed from these tests were not extensive enough to differentiate among the causes of measured variations in runs. Some of these variables included gauss strength, level of ferrous opportunity, composition of feed, and relative weight of specific materials.

Test No. 4.03, Shredded Trommel-Overs Magnetic Drum Separator

Ferrous metal recovery is also practiced on the trommel overflow. Material that does not pass through the trommel holes is conveyed to a shredder and reduced to a nominal 90 percent by weight less than 4 in It then passes under a rotary drum electromagnet. The ferrous removed is cleaned up by blowing off loose organics and separating the light from the heavy ferrous metals. The magnetic drum separator used was a Stearns rotary drum electromagnet, 72 in. long and 48 in wide. The shredder is a Heil* shredder

The test on the trommel overflow consisted of a number of 10-sec runs at a nominal rate of 23.5 tph, of which the ferrous component accounted for about 7 percent of the total weight The total in-feed mass reporting to the trommel overs is 37.7 percent.

Ferrous metal objects in the trommel overflow feed are primarily in one of two categories: tin-plated steel cans that are too large to pass through the trommel holes and smaller cans that fail to report to the trommel overflow.

The design efficiency of the trommel overs magnet is 95 percent Test runs showed an average 27 percent efficiency. If the data were projected on a clean-metal basis, the magnetics in the trommel overs would comprise 13.5 tons of ferrous available for recovery for

*Mention of trade names or commercial products does not constitute endorsement or recommendation for use each 650 tons of MSW. At the measured efficiency, 2.7 tons per day would be recovered and 10 8 tons per day would be lost. The principle reason for the low recovery is that the air gap between the trommel overs and the magnet belt is 48 percent greater than the design air gap The efficiency of the trommel overs magnet was also different for the component categories. The magnet was more efficient on the light gauge fraction than on the heavy.

For every 100 lb of magnetic trommel overs product (on an "as received" weight basis), approximately 61.5 lb was light gauge, 4.5 lb was contaminant attached to light gauge, 33 5 lb was heavy gauge, and 0.5 lb was contaminant attached to heavy gauge.

Seventy-five percent of the recovered magnetics (clean-weight basis) were above 2 in. This size group contained 95 percent of the contaminant found in the ferrous fraction. The particles greater than 4 in were contaminated the most. In all, contaminant accounted for 11 percent of the ferrous fraction. The recovered magnetics contained 37 percent contamination, on an air dry basis.

The samples taken from the trommel overs feed and the product were tested for moisture content, bulk density, size distribution, residual magnetics, and contamination. It was found that the product is richer in bi-metal cans and tin-plated steel cans than the feedstock. Most composite can material in the feedstock did not report to the product. Noncan material is less highly concentrated in the product than in the feedstock.

Test No. 4.07, Hammermill and Belt Addition

Testing was done on the trommel overs and unders system modified by the addition of a small hammermill so that attached or entrapped contaminant could be freed. A belt magnet was used to separate metal from the liberated contaminant.

The shredder has four rows of four hammers each constructed of maganese steel with hard facing The belt magnet is a self-cleaning, permanent, magnet type.

Several test runs were done on the modified system: a standard run of 30 min, a long-duration run of 60 min, and surge runs from 10 to 60 sec with surges in feed up to 5 tph The recovery efficiencies varied from 95 to 98 percent.

Samples were taken of the waste at various points in the hammermill process. The samples were analyzed for bulk density, particle size, magnetics, and contamination. Hammer wear and current and energy consumption were also recorded.

During the standard run, the nonmagnetic portion in the discard tailings was 67 percent whereas the percent contamination in the magnetic product was 1.7 to 3.1 percent, well below the 4 percent criteria. In the long-duration test runs on the hammermill, it appeared that occasional large objects would not cause difficulty. The specific energy was 8 98 hp/hr/ton and the power consumption for the shredder was 32 hp In the feed surge runs, only the 10-sec runs were accomplished because the motor current exceeded the nameplate limit after 15 sec

At Recovery 1, a hydraulic ram crushes the recovered light ferrous product to increase bulk density before loading onto a railcar. Data from the hammermill runs indicated that the required density was met, and in several cases, compaction was unnecessary.

To meet the requirements for bulk density, there had to be a trade off in particle size Meeting the objective of having only 5 percent (by weight) be less than 1 in. proved impossible because the magnetic concentration was typically 5 to 10 percent less than 1 in.

During the tuning runs, the extent to which the hammermill product was nuggetized was evaluated. An average of 38 percent of the cans were nuggetized.

Results of the initial hammermill tuning runs and the standard run showed an observed hammer wear rate of 0.25 lb/ton of magnetic concentrate passed. The wear rate decreased significantly, however, during the long duration test when 4 additional tons of ferrous concentrate were shredded The overall wear rate for the shredder using 6 tons dropped to 0.06 lb/ton

Several possible improvements in the hammermill shredder design came to light during testing Hard facing should extend farther up the hammer to within an inch of the pivot hole Shearing action within the shredder might improve if the breaker plates were modified to contain "teeth." Additional equipment could be included in the design: principally, an armored belt magnet (to separate metal from dislodged contaminant) and an air knife, which will protect the shredder from dense objects

Results of this test of a shredder followed by magnetic separation indicate that the process effectively cleans and densifies ferrous metal without excessive size reduction or nuggetizing Product contamination is reduced to less than 4 percent, density is increased to the target figure of 21.5 to 26.0 lb/ft^3 after compaction; and particle size remains large enough to be used by the detinning industry The shredder performed satisfactorily throughout testing although the test duration was too brief to determine a long-term hammer wear rate.

Test No. 4.05 and 4.09, Air Knife and Secondary Belt Magnet Addition

For these tests, the hammermill and the ferrous concentration system were upgraded to alleviate the previous experienced difficiencies and to meet the criteria for the high ferrous product maximum contamination, 4 percent, bulk density, 21.5 to 26.0 lb/ft^3; and shred particle size, maximum, 5 percent less than 1 in The upgraded system provides a ready adjustment of the drum magnet by hydraulic activators, another ferrous air knife, a light ferrous shredder, and a secondary magnet. Since operation of the upgraded system began, the new air knife adequately protected the light ferrous shredder so that the ferrous concentrator acts now only as a vibrating conveyor The ferrous air knife was capable of handling 15,000 ft^3/min of air. The principle performance specifications were to process 5 tph of 10 to 15 lb/ft^3 bulk density magnetic product while accommodating peak loads of 6 tph of waste The air knife feed was to be separated into three output streams light metallic stream, light ferrous stream, and heavy ferrous stream.

The secondary magnet used to clean the shredded light ferrous is run on a 2 hp electric motor, and a 3K-W rectifier energizes the electromagnet. The design air gap is approximately 7 in.

Two processing lines, line #1 and line #2, feed the upgraded system. Line #1 feeds the shredded trommel unders and overs ferrous concentrate and line #2 processes scalped shredded refuse. The estimated throughput for processing line #2 and line #1 was 118 and 108 tph, respectively. The estimated overall recovery for the target can ferrous metal was 37 percent for line #1 and 48 percent for line #2. The estimated efficiency for the adjustable air gap drum magnet was 62 percent for line #2 operation For line #1 and #2, respectively, 52 percent and 64 percent of the ferrous metal, as cans in the air knife feed, was recovered as product.

In line #1 operation, 40 percent of the target can ferrous metal (clean) was lost to the air knife "heavies" stream; however, only 27 percent of the lost can ferrous metal was "aerodynamically light." This would bring this loss to 12 percent if the unseparable can metal were excluded from the feed of heavies Line #2 operation lost 31 percent of the can metal to the heavies; 34 percent of which was "aerodynamically light." This brings the loss to 12 percent.

Of the can metal in the feed, 7 percent was lost to the air knife "flies" or light metallic stream in line #1 operation and 30 percent in line #2 operation. Only 1 percent of the can metal in the upgraded system feed was lost from the second magnet for both lines #1 and #2 operation. About half of the contamination attached to the can ferrous metal in the air shredder feed was liberated by its processing. This reduced the attached contamination from 7.0 to 3.7 percent for line #1 and from 7.9 to 4.1 percent for line #2. The contamination of the can ferrous metal in the heavies was 9.0 percent for line #1 operation, whereas for line #2 operation, it was 6 2 percent. The secondary magnet of the upgraded system carried over 9 2 and 5.4 percent, respectively, of the loose contamination in line #1 and #2 feed. The product rate was 1 63 tph at 26 7 lb/ft^3 and 1.34 tph at 24 5 lb/ft^3. For both processing line operations, the minimum required bulk density for the product, 21 5 lb/ft^3, was exceeded. The product composition for the two lines was:

	line #1, %	*line #2, %*
loose contamination	*0.4*	*0.3*
attached contamination	*4.2*	*3.2*
can ferrous	*81.8*	*84.3*
noncan ferrous	*17.8*	*15.4*
ferrous less than 1 in.	*10.5*	*12.7*

The performance of the air knife met manufacturers' design specifications only in the case of the loose, nonmetallic mass split reporting to the heavy fraction. The most serious performance deficiency was the mass split of can ferrous materials reporting to the lights fraction. An increase in the blower output with appropriate modifications of the air knife interior diverters and baffles may be the logical next step in improving air knife performance.

In the ferrous stream samplings, four sample sets were obtained under line #2 operation and two under #1 operation Samples were collected from the feed, "heavies," tailings product, and light nonmetallics. Data for the upgraded process was obtained on volume, bulk density, metal weight, contamination, and voltage and amperage used.

During this test period, 58.1 tons of MSW were shredded. The shredder was run for 7 7 hr under line #1 operating conditions for ferrous recovery and 53 1 hr under line #2 conditions. For the shredder in line #1, 24 hp were required and the specific energy was 17 hp/hr/ton. For line #2, 26 hp were required and the specific energy was 15 hp/hr/ton The total weight loss from the hammers during the period was 1.20 lb, so the wear rate was then 0.021 lb/ton. It was noted that hammer wear for the four outboard hammers was substantially higher than for all hammers. During the 41.4 hr of line #2 operation, one railcar was filled with 74,900 lb of product or a production rate of 0 90 tph.

For the secondary magnet, recovery of ferrous metal was nearly 99 percent, in spite of substantially larger-than-design air gap

Conclusion

Ferrous metal recovery from municipal solid waste is feasible at a large-scale recovery plant However, at Recovery 1, the use of a trommel and magnetic belts needed to be modified by adding a shredder, air knives, and additional belt magnets.

The full report was submitted in fulfillment of Contract No. 68-01-4423 by the National Center for Research Recovery, Inc., Washington, DC, under the sponsorship of the U S. Environmental Protection Agency.

Louis P. Soldano is with the Municipal Environmental Research Laboratory, Cincinnati, OH 45268
Donald Oberacker and Carlton Wiles are the EPA Project Officers (see below).
This Project Summary covers the following reports, prepared by the National Center for Resource Recovery, Inc, Washington, DC:
"Magnetic Drum Separator Performance Scalping Trommel Underflow at Nominal Design Conditions Test No. 4 01, Recovery 1, New Orleans," (Order No PB 81-213 308, Cost· $8.00, subject to change).
"Magnetic Drum Separator Performance Scalping Shredded Trommel Overflow at Nominal Design Conditions, Test No. 4.03, Recovery 1, New Orleans, Louisiana," (Order No PB 81-213 316, Cost $8 00, subject to change)
"Ferrous Metals Recovery at Recovery 1, New Orleans; Performance of the Modified System. Test No 4.05 and Test No 4 09, Recovery 1, New Orleans," (Order No PB 81-213 324, Cost $6 50, subject to change).
"Improvement of Magnetically Separated Ferrous Concentrate by Shredding· A Performance Test· Test No 4.07, Recovery 1, New Orleans," (Order No PB 81-213 332; Cost· $8 00, subject to change)
All the above reports are available only from.
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone 703-487-4650
Donald Oberacker can be contacted at:
Industrial Environmental Research Laboratory
U S Environmental Protection Agency
Cincinnati, OH 45268
Carlton Wiles can be contacted at.
Municipal Environmental Research Laboratory
U S Environmental Protection Agency
Cincinnati, OH 45268

☆ U S GOVERNMENT PRINTING OFFICE 1981 -757-012/7264

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

ES 000329
U S ENVIR PROTECTION AGENCY
REGION 5 LIBRARY
230 S DEARBORN STREET
CHICAGO IL 60604