United States
Environmental Protection
Agency

Municipal Environmental Research
Laboratory
Cincinnati OH 45268

Research and Development

EPA-600/S2-81-121 July 1981

EPA

Project Summary

Recovery of Aluminum from Municipal Solid Waste at Recovery 1, New Orleans

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This report summarizes four technical reports that document a series of tests (referred to as Test Nos. 5.01, 5.02, 5.03, 5.07) to recover aluminum from the processing of municipal refuse at the New Orleans, Louisiana, Resource Recovery Project (Recovery 1). The objective of test No. 5.01 was to document the performance of the Eddy Current Separator that recovers principally aluminum cans, for different feed rates. Test No. 5.02 was conducted to evaluate the efficiency of the Eddy Current Separator when the feed rate was held constant and belt speed carrying the feed through the separator was varied. A "zig-zag" vertical air classifier was added as a cleanup step in Test No. 5.03. The classifier's ability to remove aerodynamically light contaminant from the Eddy Current Separator's Product was measured. Test No. 5.07 evaluated the ability of a double deck vibrating screen to separate the "heavy" product of the air classifier into an overs stream that is discarded, a middlings stream that is the feedstock for the aluminum recovery submodule, and an unders stream that is the feedstock for the glass recovery submodule.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, 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 is a summary of tests performed on a full-scale resource recovery plant operating at New Orleans, Louisiana, called Recovery 1 Resource recovery consists of reclaiming for use materials or energy (ferrous metals, aluminum, glass, paper, refuse derived fuels, etc.) from processed or unprocessed municipal solid waste (MSW). For a flow sheet representation of Recovery 1, see Figure 1.

At Recovery 1 there is an aluminum recovery submodule for the removal, cleanup, and densification of aluminum, primarily cans, found in the MSW. The operating separation equipment are in order, (1) a large revolving perforated cylinder called a trommel, through which MSW is passed The refuse is separated into greater than 4-¾-in. material that flows through the trommel, called trommel overs, and less than 4-¾-in. material that falls through the trommel holes and is called the trommel unders; (2) a scalping magnet that collects ferrous metal from the trommel unders, (3) an air classifier that blows a portion of light organics away from the less than 4-¾-in. trommel unders.

Next comes the Eddy Current Separator, called an Al Mag (Aluminum Magnet), which removes the aluminum cans from the feedstock Aluminum cans

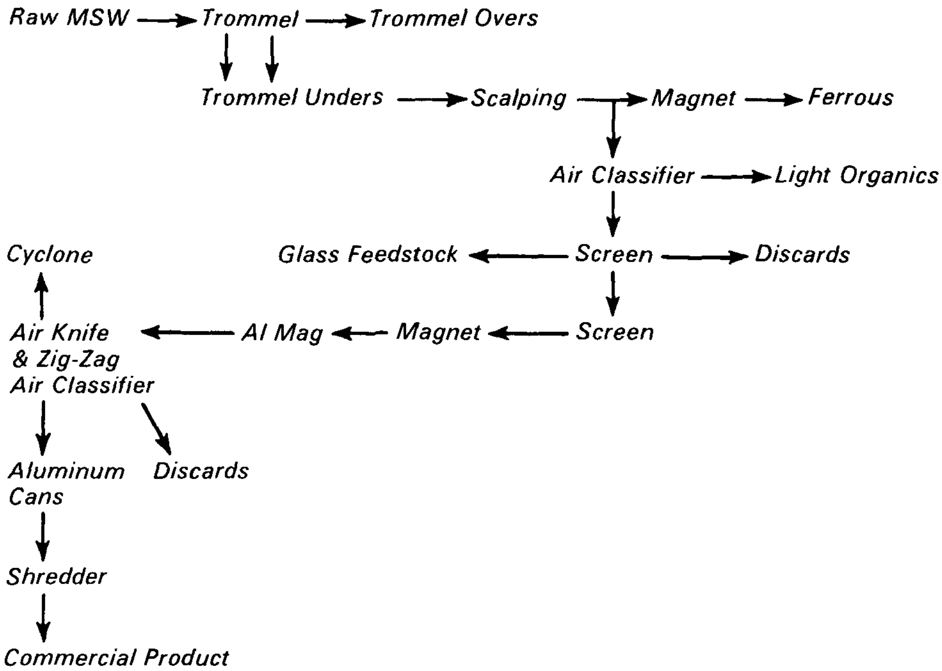

Figure 1. *Final upgraded aluminum recovery system at Recovery 1.*

usually represent about 3% to 5% by weight of the Al Mag feed.

The Al Mag operates on the principle that an electric current is generated in each conductor passing through an electromagnetic field. These "Eddy Currents" have a magnetic field that interacts with the applied field and produces a lateral force on the metal. This force expels the nonferrous metal from the conveyor.

Downstream of the Al Mag are two pneumatic separators, an air classifier, and an air knife whose purposes, sequentially, are to (1) fly the light organics from the Al Mag product and (2) blow the aluminum cans beyond the heavy organics, inorganics, and nonferrous metal that are carried over as part of the product.

Finally, a shredding process tears the cans into smaller pieces less than 1 in., mainly to increase the bulk density to 15 to 25 lb/ft^3.

The first set of tests, Test Report No. 5.01, was performed to evaluate the performance of the Eddy Current Separator for different feed rates. Al Mag feed rates of 2, 3, and 4 tons per hour (tph) were tried.

In the second set of tests, Test Report No. 5.02, the same equipment was used but instead the burden was varied. The burden is the amount of material in the magnetic field at any one period of time. This was done by varying the belt speeds of the Al Mg.

Test Report No. 5.03 was done to evaluate the performance of a "zig-zag" vertical air classifier to remove contaminant from the aluminum recovered by the Al Mag.

Finally Test Report No. 5.07 was conducted to document the efficiency of a double deck vibrating screen in separating the scalped primary trommel unders into three streams. The three streams are an overs stream that is discarded, a middlings stream that is the feedstock for the aluminum recovery submodule, and an unders stream that is the feedstock for the glass recovery submodule.

Test No. 5.01—Eddy Current Separator Performance

In the initial set of runs, three operating points are described. They differ in the amount of time an individual piece of aluminum is in the magnetic field and is subject to become Al Mag product. The objective is to find out whether this relatively expensive piece of equipment can be run at higher throughput levels without suffering major losses in efficiency. Higher throughput capacity will provide better processing economics.

The Al Mag is rated to recovery 75% of essentially whole aluminum can product. The product should contain less than 50% loose contamination from 3 tph of 8.5 to 11 lb/ft^3 feed material.

At runs of approximately 5%, by weight, aluminum can concentration the product recovery rose from approximately 175 lb/hr to 280 lb/hr when throughput was increased from 2 to 4 tph. Efficiences for the 2, 3, 4 tph runs were approximately, 81%, 77%, and 66%, respectively. Factors decreasing efficiency were inconsistent feeding and nonaluminum material that was not easily removed from the Al Mag feedstock.

For these tests, the feed to the Al Mag was intentionally seeded with aluminum cans falling into three shape categories: flattened cans, minimally deformed cans, and variously deformed cans. The percent recovery efficiencies were:

can shape	percent of seed	tph run 2	3	4
flattened	20	84	81	77
minimally deformed	20	93	89	88
deformed	60	77	73	66

Before the tests, it was expected that the efficiency of aluminum can recovery would decrease at the higher throughputs and higher belt speeds, but that the total amount of recovered aluminum cans (product mass flow rate) would increase. These expectations were true when the feed rate was increased from 2 to 4 tph. There was only an 18.5% decrease in efficiency, but the product rate rose from 175 lb/hr to 280 lb/hr—an increase of 60% of aluminum recovered in a given time interval. The average loose contamination in the Al Mag product for all runs was about 5%.

Test Report No. 5.02—Al Mag Belt Speed Varied

The next series of tests used the same equipment as in Test No. 5.01. The feedstock consisted of the screened material (the less than 2-in. light material) remaining from the feedstock used in Test No. 5.01. The burden was varied systematically, being less for faster belt speeds. The objective of this test was to measure the differences in Al Mag efficiency, product rate, and product quality that accompany changes in the composition of the feedstock, conveyor belt speed, and consequently, burden depth.

The composition of the feed cans used was 18% flattened, 71% deformed and 11% whole. In each run, the nonaluminum can portion of the feed was the same; the aluminum cans were the same; and the mass and volumetric flow rates were the same. The artificial average burden depths across the 18 in. of active belt width were calculated based on belt width, belt speed, mass flow rates, etc. These calculated depths were 3/8 in. at 300 fpm, 9/32 in. at 400 fpm, and 7/32 in. at 500 fpm.

The results indicate only a small effect on Al Mag efficiency and virtually no effect on product quality as the belt speed was varied. The belt speeds used were 300 fpm, 400 fpm, and 500 fpm. Al Mag efficiencies for the three belt speeds were 91% (300 fpm), 85% (400 fpm), and 86% (500 fpm). The product contamination was 12%, 11%, and 13%, respectively.

After adjusting the test results to account for the greater aluminum content, product rates were 396 lb/hr for the 300 fpm runs and 373 lb/hr for the 400 fpm runs. The reason for the adjustment was that the sample cans were 12% in the current test rather than the 5.5% of normal feed. It therefore appears to be a benefit to screen out as much less-than-2-in. material as possible.

From the tests it can be concluded that the effect of reducing burden depth (by running the belt faster) does not compensate for the loss of time in the magnetic field and in the time to leave the belt. At a constant feed, it is advantageous to slow down the belt.

Test Report No. 5.03—"Zig-Zag" Air Classifier

The next series of tests was done to evaluate the performance of a MAC "zig-zag" vertical air classifier to remove aerodynamically light nonmetal contaminant from aluminum cans recovered by the Al Mag.

The materials that fly in the air classifier are carried to a cyclone, where the contaminated heavy materials drop out of the air stream into an airlock feeder after which they are rejected.

Two measures of effectiveness are reported. The first, n_{al}, is based on the degree to which light gauge aluminum drops in the air classifier. The second, n_{lite} indicates the percentage of the light contaminant in the feed that flies.

At Recovery 1, there are difficulties with the unit processes that provide the feedstock for the Al Mag. These upstream processes are not as efficient in removing oversize (greater-than-4-in.) and undersize (less-than-2-in.) contaminants as was anticipated. As a result, the Al Mag operates on 2% aluminum at a throughput of 2 tph. This results in the processing rate of 80 lb/hr of aluminum cans.

The upstream processes of the air classifier are expected to improve so that Al Mag feed will have a concentration of about 4% aluminum cans at a mass flow rate of 4 tph. This would bring about 300 lb/hr aluminum into the feedstock.

To determine proportions to use in preparing the test feed for the air classifier, actual Al Mag product was collected. Three samples were taken at different times and separated into aluminum canstock (85%), less-than-4-in. and greater-than-2-in. lights (2.0%), less-than-2-in. and greater-than-1/4-in. lights (1.5%), and heavies (11.5%), both organic and metallic.

A total of 12 runs were made on the air classifier system at a nominal 250 lb/hr: three with the base line distribution above; three where the objective was to double the loading of the less-than-4-in. and greater-than-2-in. fraction; three with the loading of the less-than-2-in. and greater-than-1/2-in. fraction doubled; and lastly, three runs with both less-than-4-in. and greater-than-2-in. and less-than-2-in. and greater-than-1/4-in. fractions tripled.

The average for n_{lite} was 91% for all tests. In terms of the average of the most representative run's n_{al}, the percentage of cans dropped was 97%. Associated with this figure was a loss of 5.76 lb/hr of aluminum that flew into the air classifier. As one would expect, n_{al} fell off somewhat for the higher velocity runs, whereas n_{lite} rose.

After a number of runs, it was determined that there probably was bias in the value of n_{al}. The bias resulted from the method used to reconstitute the sample of cans after each run.

The air classifier effectively removed light contamination and appeared to work satisfactorily at the higher loadings even at decreases in air velocity on the order of 20%. Less than 3% loss in aluminum occurred. The fraction removed of the large (less-than-4-in. and greater-than-2-in.) material ranged from 73% to 100%.

The removal at the "zig-zag" classifier step of about 3 lb light organics/100 lb product produced by the Al Mag leads to approximately a 5% metal recovery improvement. The net gain from operating the air classifier is $2.50 to $3.50/100 lb product shipped.

Test Report No. 5.07—Double Deck Vibrating Screen

Test Report No. 5.07 documents a performance test of the double-deck vibrating screen. The screen separates the "heavies" from the air-classified, scalped, primary trommel unders into three fractions: an overs stream that is discarded, a middlings stream that is the feedstock for the aluminum recovery submodule, and an unders stream that is the feedstock for the glass recovery submodule.

The main objective of the test was to determine the effectiveness of the screen to concentrate recoverable aluminum and glass into their respective fractions. The screen operated at the nominal design condition of 62.5 tph. Three replicate concurrent samplings of each output stream were taken. These were analyzed for bulk density, moisture content, composition, and particle size distribution. During the tests, the actual feed flow rate was 56.2 tph and the bulk density of the MSW processed was 15.0 lb/ft^3.

The double-deck vibrating screen is a Tyler Ty-Rock Type F-800,* nominally 6 feet wide and 10 feet long. The screen was designed to process 17-1/2 tph of 15 lb/ft^3 feedstock. The screen vibration is characterized by a frequency of 846 cycles/min and an amplitude of 13/32 in. The top screen deck is a 1/2-in. thick steel plate punched with 5-in. diameter holes located on 5-3/8-in. staggered centers. There are seven rows of 21 holes and seven rows of 22 holes for a total of 41.0 ft^2 of open screen area. The bottom deck is a 2-in., square-opening wire cloth. The wire diameter is 0.135 in., which results in an 88% open area. The bottom deck is 5 ft, 8-3/8 in. wide and 10 ft long.

The double-deck screen was tested by sampling each output stream for 30 seconds. The mean feed rate for the screens was 18.60 tph. The feed to the vibrating screen separated into three

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output streams; 3.0% were overs; 27%, middlings; and 70%, unders.

As an aluminum concentrator, the top deck of the screen performed satisfactorily; 97% of the aluminum cans correctly reported to the middlings. This is the feedstock for the aluminum recovery submodule. In actual practice, the top deck accomplishes little more, in terms of preparing feedstock for the aluminum submodule, than removing relatively large and inflexible items. The top screen deck is subject to binding by flexible organics and requires frequent removal of accumulated material.

The bottom deck is also expected to perform the function of removing less-than-2-in. material from the feedstock to the aluminum recovery submodule. The test data showed that only 83% of the less-than-2-in. material reporting to the 2-in. bottom deck actually passed through the 2-in. screen openings. This compares with the 85% expected to pass.

The aluminum can concentration was 0.6% in the feed to the top deck. In the middling stream, it rose to 2.3%. If all the less-than-2-in. material had passed through the bottom screen, this could have risen to 5%. Particle size distribution for the feed to the 2-in. deck was 95% aluminum cans greater than 2 in., 94% glass less than 1 in., and 29% organics between 1 and 2 in.

The screen worked far better as a glass concentrator as practically all the glass (99.8%) was less than 2 in. The amount carried over by the 5-in. deck was insignificant, and only 3% of the total glass in the feedstream was lost to the middlings. The unders, i.e., the feedstock for the glass recovery submodule, was 49% glass.

The full reports were submitted in fulfillment of Contract No. 68-01-4423 by the National Center for Resource Recovery, Inc., Washington, D.C., under the sponsorship of the U.S. Environmental Protection Agency.

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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:
"Test of an Eddy Current Separator for the Recovery of Aluminum from Municipal Waste: Test No. 5.01, Recovery 1, New Orleans," (Order No. PB 81-217 663; Cost: $6.50, subject to change)
"Further Testing of an Eddy Current Separator for the Recovery of Aluminum from Municipal Waste: Test No. 5.02, Recovery 1, New Orleans," (Order No. PB 81-217 671; Cost: $6.50, subject to change)
"Performance of an Air Classifier to Remove Light Organic Contamination from Aluminum Recovered from Municipal Waste by Eddy Current Separation: Test No. 5.03, Recovery 1, New Orleans," (Order No. PB 81-217 689; Cost: $6.50, subject to change)
"Test of a Double-Deck Vibrating Screen Employed as an Aluminum and Glass Concentrator: Test No. 5.07, Recovery 1, New Orleans," authored by Perry M. Bagalman and Kelly Runyon (Order No. PB 81-217 697; Cost: $8.00, subject to change)
The above reports are available only from:
National Technical Information Service
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