Proceedings of the 18th Annual North American Waste-to-Energy Conference
NAWTEC18
May 11-13, 2010, Orlando, Florida, USA

NAWTEC18-3510

PLANT UPGRADE: RECOVERY OF NON-FERROUS METALS FROM A MUNICIPAL RDF FACILITY

Nathiel G. Egosi, P.E. & Mark E. Raabe, P.E.

RRT Design & Construction, Melville, NY 11747, USA

Robert Weidner & Gary A. Freel

Resource Recovery Plant, City of Ames, Iowa 50010, USA

INTRODUCTION

The City of Ames, IA (City) processes 220 tons per day of municipal solid waste (MSW) at their Arnold O. Chantland Resource Recovery System (RRS). This facility is depicted in Figure 1. The objectives of this facility have both an economic and an environmental component: to reduce the amount of MSW that is otherwise disposed in their local landfill, thereby increasing the life of the landfill; and produce refuse-derived fuel (RDF) to reduce the amount of coal consumed at the City's municipal electrical generating station. [Note: Approximately 70% of the MSW is converted into RDF, comprising 10 to 20% of the feedstock to the generating station.]

The RRS was commissioned in 1975 and is among the first municipal facilities in the country to convert MSW to RDF. The City recently achieved a new distinction as the first municipality in the country to install an ECS and ISS in a series configuration. This was achieved in August 2009 with the commissioning of a non-ferrous metal recovery system (NFMRS). RRT Design & Construction provided engineering services to the City for design and construction of the NFMRS.

The budget for this project totaled approximately $1.2 million. Financing was obtained by the City, in part, with a grant from the Iowa Department of Natural Resources, under its Solid Waste Alternative Program [1].

Figure 1. Arnold O. Chantland Resource Recovery System

NFMRS DESIGN

The NFMRS is a totally mechanized system consisting of an Eddy Current Separator (ECS) followed by an Induction Sorting System (ISS). The ECS is especially effective in recovery of aluminum and red metals, and the ISS has the capability of removing all non-ferrous metals. However, the performance of this equipment can be adjusted according to the mix of metals present.

The ECS and ISS models selected are manufactured by Steinert Gmbh. The ECS features an eccentric rotor design with extensive applications in the scrap metal industry for automobile shredding operations, and in the waste-to-energy industry for ash processing.

MSW ANALYSES

Residential and commercial MSW is collected at curbside by private haulers. Separation of recyclables is not mandatory. An additional fee is charged by haulers to collect recyclables, which includes paper, cardboard, plastics (No.1 and 2), ferrous metal and aluminum. Private haulers deliver MSW to the RRS, where any residual recyclables are recovered or used as RDF. [Note: The RRS facility also offers front-end glass recycling.]

The City observed initially through hand sorting that appreciable amounts of non-ferrous metals are present in the MSW. Two empirical studies [2,3] were conducted by the City to quantify the amount of non-ferrous metals in material rejected from the RRS, and to gain a better understanding of the relative amounts of various non-ferrous metals present. The studies consisted of collecting representative samples (one semi trailer) of rejected material from the RRS and processing at scrap metal facilities at each of the following locations:

> **Davenport, Iowa (April 5, 2006):** The sample size consisted of 40,000 pounds of RRS rejects. The material was sorted using a trommel screen. A total of 470 pounds of non-ferrous metal was recovered, equivalent to 1.17% of the sample tested. The City was advised that sorting equipment used at this facility was 12 years old and that newer models exist that operate more efficiently and with improved recovery rates.
>
> **Council Bluffs, Iowa (March 28, 2008):** The sample size consisted of 34,000 pounds of RRS rejects. The material was processed using sorting equipment by Steinert Gmbh, consisting of an ECS followed by an ISS. A total of 298 pounds stainless steel, 800 pounds ferrous metal, and 580 pounds of aluminum were recovered, equivalent to 4.9% of the sample.

The City conducted an economic analysis [4] using the study results. The purpose of this analysis was to determine the rate-of-return on investment in an ECS and ISS respectively. The analysis indicated a positive rate-of-return for each unit. The pay-back period for the ECS was less than the ISS, due to the amount and value of aluminum present. [Note: The value of commodities at the time the second semi trailer of rejects was analyzed was at an historic high; however, it was assumed that the value of these metals will maintain or increase in value steadily over the life of the NFMRS.]

HISTORY OF NON-FERROUS RECOVERY IN AMES

The design of the RRS originally included a system for the separation of non-ferrous metals that was innovative at that time. This system was operated for 3-4 years. It was then decommissioned due to mechanical problems. [Note: The system was designed in California and required used of water-cooled magnets. This design was incompatible with an unheated facility in Iowa, where winter temperatures frequently fall below freezing,] In addition, Iowa's introduction of a bottle bill in 1979 rendered this system virtually obsolete.

The old equipment was removed except for five large storage hoppers. One hopper was used for collection of MSW rejected from the RRS. The NFMRS was installed in the same location as the former non-ferrous recovery system. This allowed access to the rejected MSW material, and to the storage hoppers below. Two storage hoppers are used by the NFMRS: one for aluminum and red metals recovered by the ECS; and one for stainless steel recovered by the ISS.

DESIGN OF THE NFMRS

The RRS separates the incoming waste into two streams: the *Unders* and the *Heavies*. The *Unders* consist of fine material that passes through the disc screens of the RRS system. The *Heavies* consist of residual material from an air-knife used to air classify RDF. A visual analysis of both waste streams indicated that the majority of non-ferrous metals are located in the *Heavies*. A decision was made to process only the *Heavies* through the NFMRS. This increases efficiency of the NFMRS by reducing the throughput rate and increasing the ratio of non-ferrous metals to total material.

Design constraints included location, available floor space and headroom, and structural requirements for supporting the equipment. The location of the NFMRS is the upper level in the southeast corner of the building; thus, access for installation of structural members and sorting equipment was through exterior side panels. Interior beams were redesigned and existing columns strengthened. Figure 2 depicts portions of the structural members required for support of the ISS and the storage hoppers. Limitations in available floor space required locating the ECS and ISS on separate platforms immediately above each other, as depicted in Figure 3.

Figure 2. Structural requirement for support of ISS

SYSTEM OPERATION

The operation of the NFMRS is depicted in the process flow diagram located in Figure 4. The *Heavies* from the RRS are conveyed to a vibratory feeder and spread on to the accelerating conveyor of the ECS. Aluminum and red metal are propelled by rare earth magnets of the ECS over a splitter and discharged into a chute to a storage hopper below. The remaining material is conveyed down a separate chute on to a vibratory feeder and spread on to the accelerating conveyor of the ISS. [Note: The direction of the conveyor is 180 degrees from the conveyor of the ECS.] Induction currents detect the presence of any piece of non-ferrous metal; and, based on timed travel, its position is known. Each non-ferrous metal piece is then individually propelled by air jet over a splitter into a chute discharging to a second hopper. The remaining material from the ISS falls into a separate chute that discharges into a third hopper.

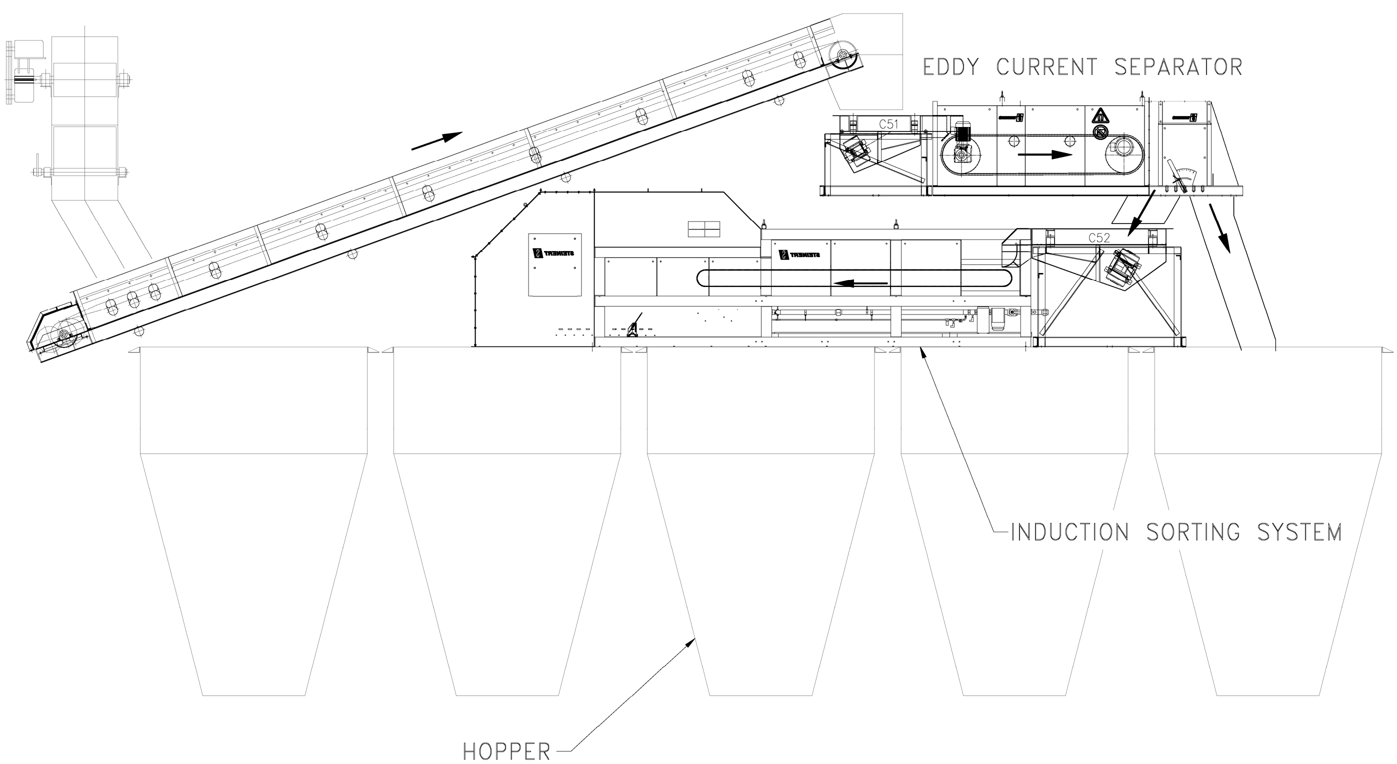

Figure 3. Profile View of the NFMRS [5]

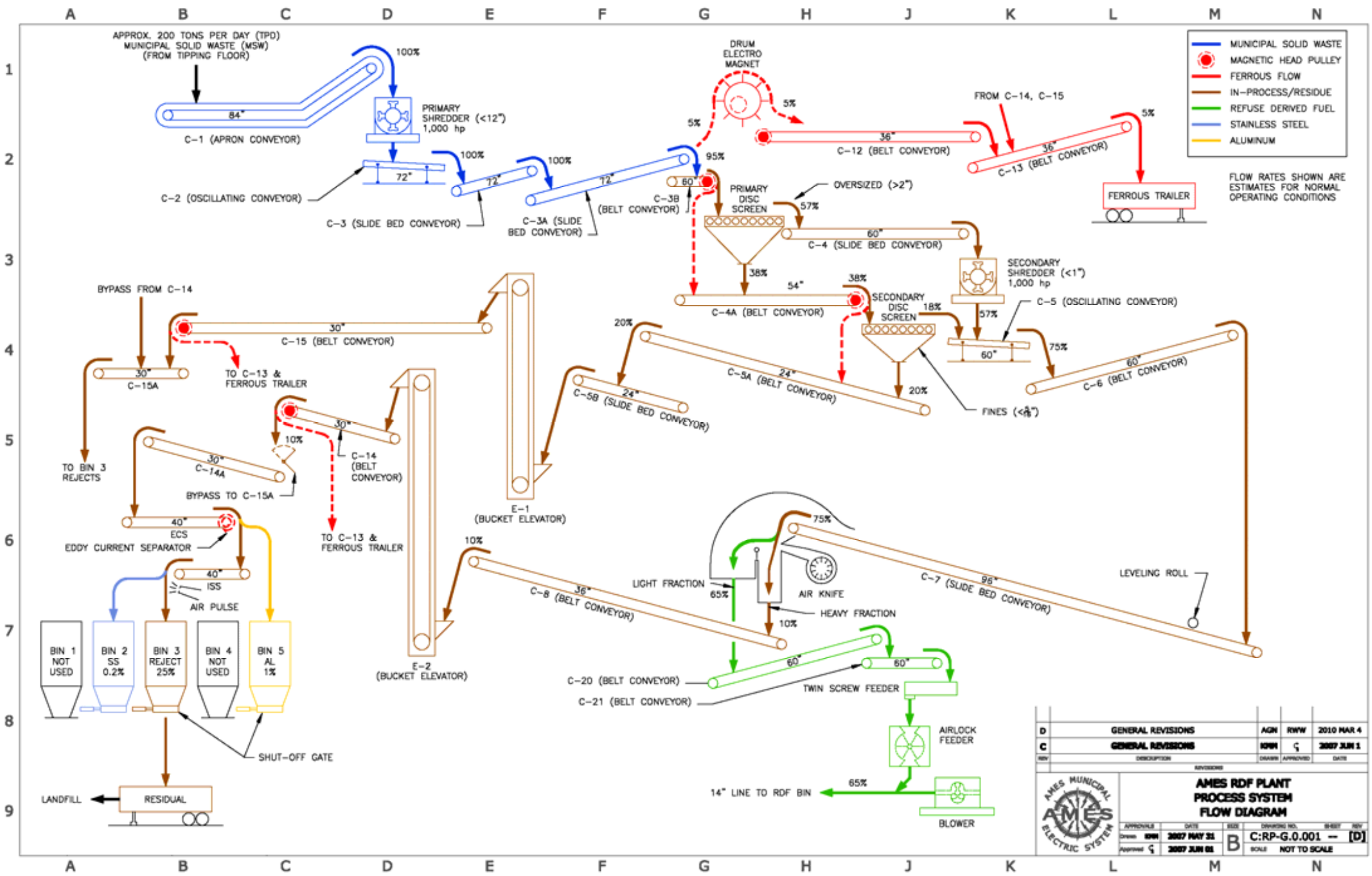

Figure 4. RRS Process Flow Diagram

The *Unders* are diverted around the NFMRS to a chute discharging to the same hopper that receives material remaining after being processed by the ISS. A diverter chute was installed in the conveyance system for the *Heavies* at a location between the RRS and ECS. This allows the NFMRS to be shut down without shutting down the RRS. When engaged, the diverter discharges the *Heavies* to the conveyor used for transport of the *Unders* around the NFMRS.

Problems encountered during the commissioning of the NFMRS concerned the burden depth of the throughput material. The ECS and ISS are unable to process material effectively with a burden depth greater than 2 inches. The depth varies according to the volume rate of throughput, speed of the conveyor, condition and type of material, and moisture content.

The City continually implements upgrades to their RRS to improve recovery of residual RDF in the throughput material, and to reduce the volume rate of throughput to the NFMRS. Since August 2009, the City reduced the quantity of the feedstock by 60% and increased conveyor speeds to achieve 'singulation' – an optimal condition where material is presented to the sorting systems in a uniform single layer, where all pieces of material are largely separated from each other. The burden depth is typically no deeper than the average particle size. This condition is depicted in Figure 5 for the ECS. Non-ferrous metal that reacts to the eddy currents is propelled over a splitter to the back of the discharge hood into a separate chute.

The ISS features various programmable options to facilitate maximum recovery of desired metals and reduce the amount of debris carried over when non-ferrous metal is propelled by the pneumatic system. The City also replaced the electromagnet in the RRS to increase recovery efficiency of ferrous metal and to limit the amount of residual ferrous metal that comes in contact with the ECS.

Figure 5. Process material on ECS conveyor

RECOVERY EFFICIENCY

The City is currently undertaking a study to determine the efficiency of the NFMRS. This study is being conducted with the assistance of students in the Industrial Engineering Department at Iowa State University. The results of this study are forthcoming.

Metals recovered by the ISS also contain light, non-metal material – typically paper and plastics – that are often removed along with the metals when the burden depth on the conveyor is above 'singulation'. One option for purifying recovered material is to pass it through a second unit. However, the City could not justify economically the installation of additional units, and lack of space made this prohibited. Instead, the City designed their own innovative system whereby the recovered metals are reprocessed through the NFMRS. Reprocessing is conducted periodically after accumulation of a specified amount of recovered metals. The metals are introduced into the RRS system (without processing MSW concurrently) at a location where the metals are minimally processed before entering the NFMRS. By reprocessing the metals, the purity of the final metals is substantially increased, enhancing its market value to scrap metal buyers.

MARKETING OF NON-FERROUS METALS

The marketing of non-ferrous metals requires a study of the local and regional market, evaluation of available local buyers, and evaluation of the various transportation options. Furthermore, the value of the non-ferrous metals is dependent on the purity of the recovered metals and the mix of metals (graded by the scrap industry as "Zorba" [6]). The City partners with a local scrap dealer to determine the composition of the Zorba. This evaluation process will be used to determine market prices for each load of mixed non-ferrous metals delivered by the City. Figure 6 depicts Zorba recovered by the ECS.

Figure 6. Zorba recovered by the ECS

The City presently uses the ECS to recover Zorba and the ISS to recover stainless steel. This operational model is largely based on the following variables: 1) the current composition of the recovered non-ferrous metals; and 2) commodity prices. The model selected maximizes the value of the recovered metals. The City reviews the model in response to changes in these variables. Data on the composition of the Zorba is obtained in conjunction with the sale of the recovered metals.

CONCLUSION

Detailed financial and economic analyses of the NFMRS will be conducted with data collected through one year of operation. The City maintains records of the amount of material processed by the RRS, amounts of non-ferrous metals collected, revenue generated from the sale of non-ferrous metals, and the revenue saved from a reduction in the cost to landfill rejected material.

After operation of the NFMRS for approximately four months, the City recovered 44 tons of non-ferrous metals, consisting mainly of aluminum, copper, brass and stainless steel, with small amounts of zinc, lead and various nickel alloys.

Assumptions and projections contained in the study during the planning phase of this project will be re-evaluated. The results will provide valuable data to other communities who may be interested in recovering non-ferrous metals from their MSW.

REFERENCES

1. State of Iowa, 2008. Solid Waste Alternatives Program (SWAP), Contract No. 08-G550-14. Iowa Department of Natural Resources, Energy and Waste Management Bureau.
2. City of Ames, IA, 2006. Non-Ferrous Testing. Study conducted under contract to Alter Metal Recycling. April 5, 2006.
3. City of Ames, IA, 2008. Non-Ferrous Testing. Study conducted under contract to Alter Metal Recycling. March 28, 2008.
4. City of Ames, IA, 2008. Internal document.
5. RRT Design & Construction, 2008. Adaptation of Process Mechanical design drawing for the City of Ames, Non-Ferrous Metal Recovery System.
6. Scrap Specifications Circular 2009. Guidelines for Nonferrous Scrap: NF-2009. Definition for “Zorba”, page. 13. Issued by the Institute for Scrap Recycling Industries, Inc. Effective Oct. 22, 2009.