

INCINERATION RESIDUE SEPARATION

RECOVERY OF FERROUS FRACTION

by

Eugene A. Glysson
Civil Engineering Department
University of Michigan

Incineration of municipal solid waste as a means of volume reduction or as a means of heat energy recovery results in a certain amount of residue. The constituents of this residue vary depending on a number of factors. It is not the objective of this paper to deal with the specific characteristics of incineration residue. It is sufficient to recognize that if the raw municipal refuse on the average contains approximately 7% ferrous metal then after incineration that same 7% will constitute on the order of 33% of the residue. The rest of the residue being made up of glass, unburned organics, inerts and a very small amount of non-ferrous metal. It is the recovery of the ferrous metal in the residue that has the greatest potential for resource recovery and is the principal topic of this paper.

The recovery of the ferrous component in municipal waste and incineration residue is not a new concept. It has been done in several cities for over twenty years. I wish to report on the recent techniques and contractual arrangements in use in southeastern Michigan, principally through the efforts of the Huron Valley Steel Corporation (HVS).

Huron Valley Steel started making pig iron in the early fifties. They used as their main source of raw material ferrous scraps that they recovered from municipal dumps and incinerators in the immediate vicinity of their plant in Belleville, Michigan. This operation continued until it was closed down due to air pollution problems in 1968. The company had then converted into the auto shredding and secondary metals reclaiming business which has resulted in a renewed interest in reclaiming ferrous scrap from incineration residues. More will be said describing this operation later in the paper.

Beginning in March of 1975 the incinerator residue produced by the Southeastern Oakland County Incinerator Authority (SOCIA) incinerator located in Madison Heights, Michigan, has been processed for ferrous iron recovery by Huron Valley Steel. This incinerator is rated at approximately 544 metric tons (600 U.S. tons) per day and about 64 metric tons (70 U.S. tons) per day of ferrous scrap is being recovered. The

incinerator consists of two furnaces which discharge their residue into a water filled quench trough which is equipped with a dragout chain conveyor. The quenched residue is pulled up an incline to allow drainage of as much water as possible prior to discharge to a wide rubber conveyor belt. This conveyor is also inclined and is equipped with a magnetic head pulley. The non-magnetic residue drops off the end of the belt into a residue truck for transport to the landfill while the magnetic fraction is held by the head pulley long enough to drop down another chute into a top loading compactor trailer for delivery to HVS. This one-step separation is not complete and is reflected by a 30% conversion loss factor in the formula for payment for the scrap. It is estimated that the magnetically separated material contains 45-50% ferrous metal.

Learning from their experience gained on this operation the design of the single stage magnetic separation might be more efficient in producing scrap with less non-metallic content if an overhead magnetic system were used. The use of the top loading compactor trailers has improved the efficiency of transfer from the incinerator to the processing plant. These trailers have a capacity of 57 cubic meters (75 cu. yds.).

The contract between the two organizations, SOCIA and Huron Valley, is a ten-year contract with a provision that after five years the authority may seek proposals from other firms, however Huron Valley has the absolute right to renew the contract for five more years by matching the highest bona fide offer received.

As established by the agreement, Huron Valley has constructed all the recovery facilities including the building in which the equipment is located and is responsible for removing all the salvable materials from the incinerator site. No stock piling of the material is allowed on the incinerator premises.

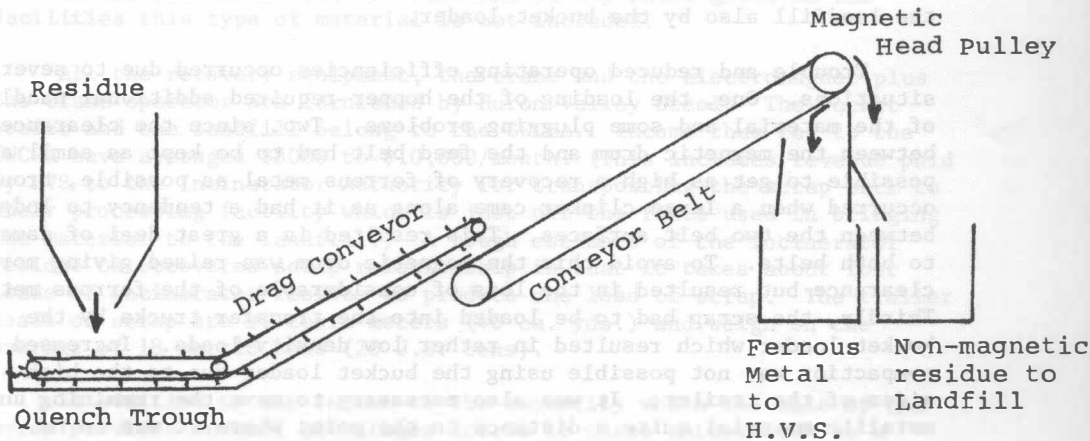
The contract provides for a minimum guaranteed consideration to the authority on a monthly basis unless the value of the scrap as established by the following formula exceeds that value. The formula agreed upon is based on 50% of the brokers buying price per gross ton [1016 kg = 1 gross ton (2,240 lbs. = 1 gross ton)] for machine shop turnings. For the city of Detroit, as reported in the first issue of each month of "Iron Age" magazine, this was \$35.50 for July 1976. This 50% is further reduced by 30% which represents the conversion loss of reclaimed scrap to clean scrap.

It is anticipated that with the incinerator handling on the average of 454 metric tons (500 U.S. tons) per day with both furnaces in operation, approximately 64 metric tons (70 U.S. tons) per day of scrap ferrous metal will be recovered. In addition another approximately 18 metric tons (20 U.S. tons) per day of white goods are anticipated. These are delivered to the incinerator site by the various collectors and are

transported to the HVS processing plant in Taylor along with the other scrap. All of the scrap material is paid for according to the formula given above.

The average value per ton to the authority during the operation to date has been about \$6.61 per metric ton (1000 kg/metric ton) [\$6.00 per U.S. ton (2000#/ton)]. This means an expected income to the authority of about \$100,000 per year.

The incinerator operates on a five-day week, 24 hours per day and the scrap recovery operation is on the same schedule. No refuse is burned or reclaiming done on Sunday. The reclamation operation is completely enclosed resulting in a minimum of noise, odors or other nuisances. A flow chart of the system is shown below.



Since last fall (Oct. 75) the ferrous scrap contained in the residue from the incinerator owned by the Central Wayne County Sanitation Authority (CWCSA) has also been recovered by Huron Valley Steel. The capacity of this incinerator is rated at 726 metric tons (800 U.S. tons) per day and handles on the average of 635 metric tons (700 U.S. tons) per day for a five-day week. Ferrous scrap is now being recovered from this residue at the rate of 27 metric tons (30 U.S. tons) per day on the average.

The recovery operation at CWC is somewhat different than the one at SEO. To begin with it was decided that no recovery operation could be conducted at the incinerator site so all the recovery operation is carried out at the landfill site. The residue is trucked by authority trailers to the disposal site located in Flat Rock [about 24 kilometers (15 miles)].

There the trailers carrying the residue are emptied out on the ground. A rubber tired bucket loader which is normally used to spread and compact the material is used for handling.

In the first system devised for this site the material was loaded onto a hopper by the bucket loader. The hopper discharged on to a conveyor belt which carried the residue under a magnetic drum and belt which picked up the magnetic material and discharged it into one pile. The non-magnetic material was dropped into another belt discharging onto another pile. The ferrous material was loaded into transfer trucks by the bucket loader and the non-magnetic material moved and deposited into the landfill also by the bucket loader.

Trouble and reduced operating efficiencies occurred due to several situations. One, the loading of the hopper required additional handling of the material and some plugging problems. Two, since the clearance between the magnetic drum and the feed belt had to be kept as small as possible to get as high a recovery of ferrous metal as possible, trouble occurred when a large clinker came along as it had a tendency to lodge between the two belt surfaces. This resulted in a great deal of damage to both belts. To avoid this the magnetic drum was raised giving more clearance but resulted in the loss of considerable of the ferrous metal. Thirdly, the scrap had to be loaded into the transfer trucks by the bucket loader which resulted in rather low density loads. Increased compaction was not possible using the bucket loader due to the high sides of the trailer. It was also necessary to move the remaining non-metallic material quite a distance to the point where it was to be placed in the landfill. In addition there was the usual problem with belts, pulleys and drive engines when handling this very heterogeneous and abrasive material.

As a result of the experience gained by this first system it was decided that the less mechanical handling done the better, and another arrangement was tried. The material is now discharged from the transfer trucks on the ground as before but at a point close to where the remains are to be put into the landfill. From this pile the bucket loader spreads a bucketfull in a thin layer on the ground nearby to be worked over by an electromagnet on a crane. The crane operator can drop the magnet directly on the material, lifting and shifting it around to get all the ferrous metal and eliminating a great deal of extraneous material. The ferrous scrap is stock piled nearby for loading by the magnet into trucks for shipment to the HVS processing plant in Taylor. In addition greater density in the transfer trailer is possible by

dropping the magnet on the material after it is loaded.

This much simpler method of separation has resulted in an increase of about 20% in the amount of scrap recovered, a much cleaner scrap, much less handling in all respects and a greater weight per trailer load of scrap. The non-magnetic residue, since it is spread near the point where it is to be incorporated into the landfill is simply scrapped into place by the bucket loader. Since all the bulky metal objects have been removed there are no oversize objects left and the material is easily moved and compacted.

It is estimated that the scrap removed by this method is 80% ferrous. The contract between HVS and CWCSA is much the same as with SOCIA. The principal difference being that due to the smaller amount of extraneous material in the scrap the conversion loss is 20% rather than the 30% stipulated in the SOCIA agreement. All the other conditions are the same. Since CWCSA does not accept any white goods at its facilities this type of material is not included.

All the recovery equipment, the crane and the electromagnet plus the crane operator are furnished by Huron Valley Steel. The bucket loader and the landfill belong to the CWCSA. Income thus far to the CWCSA have averaged \$8000 to \$10,000/month. (This includes revenue paid by HVS to the Incinerator Authority for transporting the scrap back to their processing facility which is just off the route used in bringing the material to the landfill.) A rough estimate of the incinerator residue to recovered scrap relationship is that it takes about four loads of incinerator residue to produce one load of scrap. The trailer loads of scrap are 31 cubic meters (40 cu. yds.) and weigh on the average of 18 metric tons (20 U.S. tons).

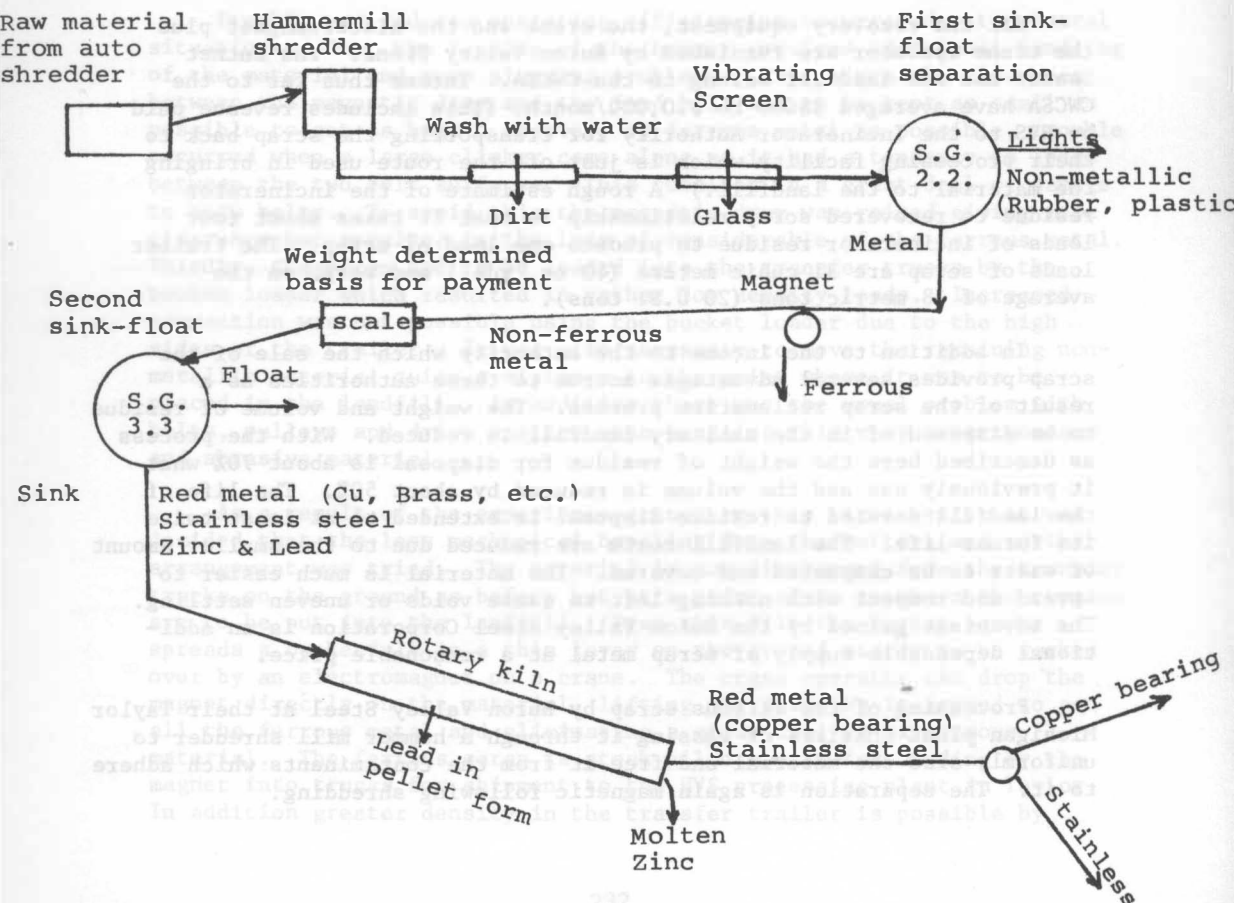
In addition to the income to the authority which the sale of the scrap provides several advantages accrue to these authorities as a result of the scrap reclamation process. The weight and volume of residue to be disposed of in the sanitary landfill is reduced. With the process as described here the weight of residue for disposal is about 70% what it previously was and the volume is reduced by about 50%. The life of the landfill devoted to residue disposal is extended to at least twice its former life. The landfill costs are reduced due to the smaller amount of waste to be compacted and covered. The material is much easier to spread and compact with nothing left to cause voids or uneven settling. The advantage gained by the Huron Valley Steel Corporation is an additional dependable supply of scrap metal at a reasonable price.

Processing of the ferrous scrap by Huron Valley Steel at their Taylor Michigan plant consists of passing it through a hammer mill shredder to uniformly size the material and free it from the contaminants which adhere to it. The separation is again magnetic following shredding.

The nonferrous content in incinerator residue is so small that it is not economical to process such residue for its non-ferrous content at this time. However, Huron Valley Steel has developed a very extensive non-ferrous metals recovery system for reclaiming such metals from shredded automobile residues. Whenever the non-ferrous metal content of incinerator residues can be considered of economic importance such a system will be essential to their recovery. A brief description of this process may be of interest.

The raw material fed into this system is the residue produced by magnetically removing the ferrous metal from the shredding of whole automobiles. This residue contains in addition to the non-ferrous metals all the rubber, plastic, glass and dirt which are present in the original automobile. Automobile shredders from all over the United States and Canada (approximately 100) send their "concentrate" to this plant. The "concentrate" contains a varying amount of metal. The preferred content is from 35% to 60% but as wide a range as from 20% to 80% has been accepted. Payment for the metal content to the producer (the auto shredder) is on the basis of clean metal units (after all the non-metallics have been removed). In July, 1976, the rate was 29¢ per each kilogram (13¢ per each pound) of clean metal units. The price fluctuates as the market fluctuates. In addition up to \$16.5 per metric ton (\$15 per U.S. ton) is allowed toward repayment of rail or truck transportation costs.

A flow diagram of the system will facilitate its explanation:



Raw material is received in gondola cars and is off-loaded into a hammermill shredder for sizing and separation. The material is next washed with water to remove as much dirt as possible, passes over a vibratory screen where the glass is removed and then passes into the first of two sink-float separations. The specific gravity of the float liquid in this phase is held at 2.2 which provides for the float-removal of the non-metallics like rubber and plastic. Following this phase the sink material is primarily metal which is passed over a magnet to remove any ferrous metal and is then weighed and forms the basis for payment to the shipper (clean metal units).

The next sink-float separation takes place in a liquid of 3.3 specific gravity which floats off the aluminum leaving the copper bearing metals, stainless steel and zinc to sink. This mixture is next put into a long rotary kiln where the temperature is controlled in such a way as to first cause the small amount of lead present to pelletize in which form it is removed. Next the zinc is melted and flows continuously from the end of the kiln being cast into pigs. The copper bearing metal plus the stainless steel leaves with the dross. This mixture is washed and then separated magnetically.

As is evident this process is capable of accomplishing the necessary separations from a mixture of non-ferrous metals but to be economical it must contain at least .20% metal in the raw material after the ferrous metal is removed. The non-ferrous content of incinerator residues is not high enough without expensive concentration to warrant its processing at this time.

The methods herein described for ferrous scrap metal extraction from incinerator residues are by no means the only methods in use today. Each situation should be analyzed and the most effective method selected. In every case, however, the success of the operation depends on the availability of a purchaser who is willing and able to upgrade the quality of the scrap and is capable of putting the final product back into the metal market.