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RESOURCE RECOVERY
TECHNOLOGY UPDATE
FROM THE U.S.E.P.A.
Office of Solid Waste Management Programs

DEMONSTRATION OF PYROLYSIS AND MATERIALS RECOVERY IN SAN DIEGO, CALIFORNIA

By Yvonne M. Garbe

Construction of a 200-ton-per-day solid waste demonstration pyrolysis facility located in El Cajon, California (San Diego County,) will be completed in December, 1977 (photo A, aerial view.) The first of its kind, the plant is designed to convert the organic fraction of municipal solid waste into an oil-like liquid fuel and to recover glass, ferrous and nonferrous metals from the remaining waste. After mechanical completion, there will be three to four months of normal shakedown before the plant begins full operation and testing in May, 1977.

The $14-million project began in 1972 with a solid waste demonstration grant—currently amounting to $4-million—to San Diego County from the U.S. Environmental Protection Agency (EPA.) The pyrolysis and materials recovery processes being demonstrated are designed by Occidental Research corporation. Occidental is contributing $8-million to the County of San Diego for the project with an additional $2-million being funded by the county.

A New Product from Solid Waste

Unlike other major pyrolysis systems, which produce low or medium BTU fuel gas, Occidental's process produces a storable pyrolytic "oil" that most resembles typical No. 6 oil. It is a chemically complex organic fluid with a heat value equivalent to roughly three-fourths that of No. 6 oil (114,900 BTU/gallon vs. 149,000 BTU/gallon for the average No. 6 fuel oil.) It is lower in sulfur than even the best of residual oils.

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The product is more viscous than typical residual oils, and its fluidity increases with temperature. Hence, it must be stored, pumped and atomized at somewhat higher temperatures. Satisfactory atomization under test conditions has been achieved with steam at 25 psi and 240°F, or about 20°F higher than the atomization temperature for typical electric utility fuel oils.

San Diego Gas and Electric Company has been contracted by the county to purchase and burn the fuel in one of their existing oil-fired steam electric power plants. After construction of additional storage and fuel handling equipment at the utility, initial test burns of the fuel are scheduled to begin in the fall of 1977.

New Processing and Handling Techniques

In addition to the pyrolysis process, there are several new processing and storage techniques incorporated in the design of the system that are worthy of attention. Successful demonstration of these items would be significant in advancing the state-of-the-art of resource recovery. These include:

- *A new storage process for housing shredded solid waste (photo B.)* Primary shredding will take place during one daily 8-hour shift. During this shift, primary shredded waste will be conveyed to an enclosed storage area where it will be automatically distributed uniformly onto a concrete pad by a 360-degree rotating conveyor. For 20 minutes of each hour during the dayshift, the conveyor will be automatically positioned over a receiving bin to allow the incoming shredded waste to go directly to subsequent processing steps. During the other 40 minutes, the waste will be piled onto the pad for use during the other two shifts. The pad will hold up to 400 tons, or roughly two days of solid waste coming to the plant. A front-end loader will be used to feed the waste to the primary shredder during the day shift. During the next two shifts, the loader will move the material from the pad into the bin feeding the rest of the plant.

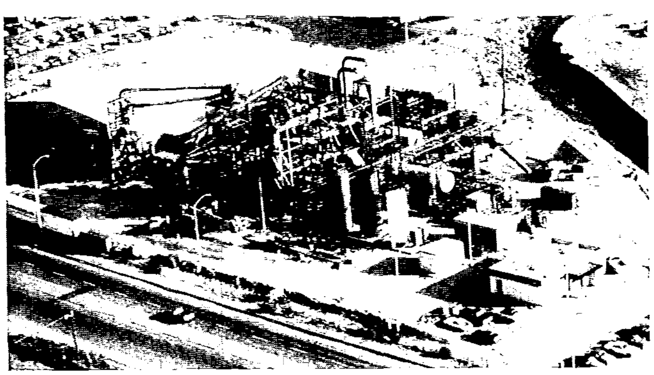
- *Doffing roll bins used to store and meter shredded material (photo C.)* These devices are commonly used in the lumber industry to facilitate handling of wood chips. They have been adopted in this process to act as a buffer storage and to uniformly meter the flow of shredded waste to both the air classifier and the pyrolysis reactor. Waste enters through the top of the bin and is moved along the floor from the back of the bin towards the front by bottom drag conveyors. At the front, it is separated and metered out of the bin by a series of rotating pick rolls.

- *Zig zag air classifier.* A new zig zag air classifier, designed and tested by Occidental, features 10 separate bends in the column. Waste is fed into the classifier at the seventh level from the bottom. A unique feature of the classifier is the recirculation of air in a closed loop.

- *A comprehensive glass and nonferrous metals recovery subsystem (photo D.)* In a trommel, glass and aluminum-rich fractions will be separated from air classifier heavies. A glass product will then be recovered through froth flotation. Aluminum will be recovered using electromagnetic separation.

Process Description

A simplified process flow diagram is shown in Figure No. 1. Municipal solid waste will be dropped onto the tipping floor during the first shift of operation. A front-end loader will push the material onto a conveyor for delivery to a horizontal shaft hammermill driven by a 1000-horsepower electric motor. The waste will be shredded to a nominal three-inch particle size (80 percent passing a three-inch screen opening.) From the shredder, the material is conveyed under an electromagnet to extract the ferrous metals. The shredded waste will then drop onto a rotating conveyor in the storage area; there, it will be either stored for later use, or dropped into a receiving bin and conveyed to the air classifier. The air classifier will separate the heavier, mostly inorganic particles, from the lighter, organic material. About 75 percent of the air classifier input is expected to be separated as



A–Aerial view of San Diego County's 200 TPD demonstration pyrolysis facility at El Cajon, California.

B–El Cajon's storage facility for shredded solid waste.

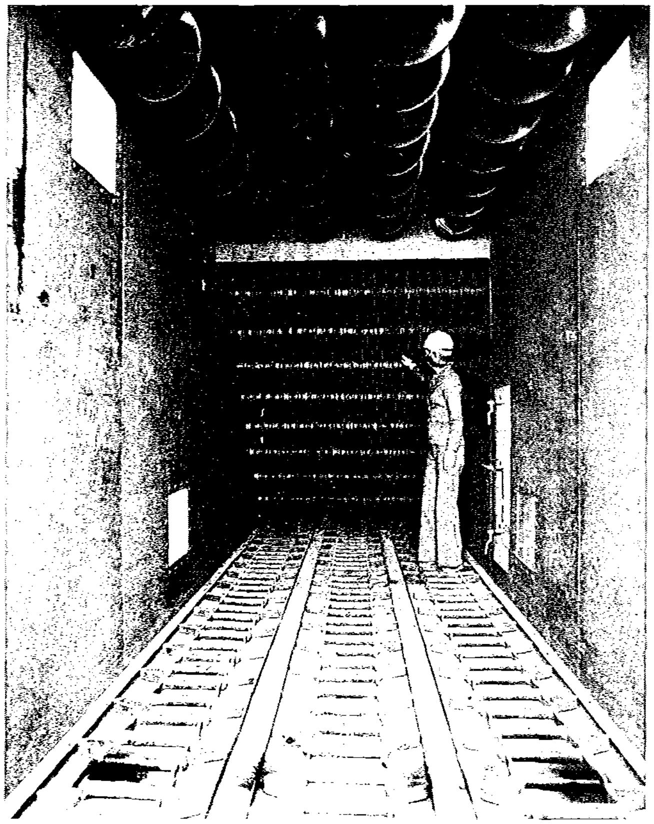
light fraction.

The light fraction will be dried to a moisture content of three percent using hot air produced from burning either combustible gas produced in the pyrolysis reactor or fuel oil. Fuel oil is used for start-up and/or emergency situations.

After drying, this fraction will be classified further, using a series of mechanical processes. A 14 mesh-screen will be used to remove larger particles for secondary shredding in an attrition mill. In this mill, waste fed between two disks is ground into extremely fine particles having a nominal size of minus 14 mesh. (That is, 80 percent of the particles could pass through a screen having 14 openings to the inch.) Meanwhile, the particles that fall through the 14 mesh-screen will be fed onto an air table where a combination of vibrating motion and air flow will separate the small, light organic particles from dense metal and glass particles. The light particles from the air table will be combined with the secondary shredder output to form the organic-feed-stock, which will be stored in a second doffing roll bin until it is fed into the pyrolysis reactor. About 60 percent of the waste input to the plant is expected to become reactor feedstock.

The pyrolysis reactor is a vertical pipe through which the organic feedstock is pneumatically transported using oxygen-free recycled gas from the pyrolysis reaction. In the reactor, hot particles of char provide the heat needed to pyrolyze the organic material. The char, which is the solid residue remaining after the pyrolysis reaction, enters the reactor after having been heated and is mixed turbulently with the organic material. The pyrolysis reaction takes place in less than a second as the char-waste mixture proceeds through the reactor.

A series of cyclones will be used to remove the char from the reactor gases. After the char is removed, it will be cooled quickly in an oil decanter to condense the pyrolytic oil. The remaining gas stream will go through a series of cleanup steps and be compressed for plant use. Part of the gas will be used as the



C–Doffing roll bins used at El Cajon to store and meter shredded waste.

oxygen-free transport medium. The rest of the gas will be burned to preheat combustion air for the char heater, to preheat the reactor transport gas, to supply heat to the dryer and to oxidize dirty gas streams that are produced in various parts of the system. The liquid fuel product will go directly to the oil storage tanks.

The remainder of the system consists of the glass and aluminum recovery processes. In the first step of this process, the heavy fraction from the air classifier will be passed through a trommel for separation into three fractions: smaller than ½-inch, which becomes the feed to the glass recovery system; ½-inch to 4 inches, which goes to aluminum recovery; and greater than 4 inches, which is returned to the primary shredder. Dense fines recovered from the air table will be combined with the glass fraction from the trommel.

After crushing to between 20 and 200 mesh, the glass will be sent to a series of froth flotation cells. In froth flotation, air is bubbled through a solution of water and special chemicals which contain the glass. The chemicals cause the glass particles to adhere to the bubbles and float off, while impurities sink. By recirculating both the float and sink fractions several times, the system is designed to recover 90 percent of the glass in the glass recovery subsystem feedstock at a concentration of better than 99.5 percent. The total recovery of glass from the incoming solid waste, however, will be no greater than 75 percent, because there are losses in various parts of the process before the feedstock is formed. Also, some of the product glass is too fine to use in a glass container furnace and must be discarded.

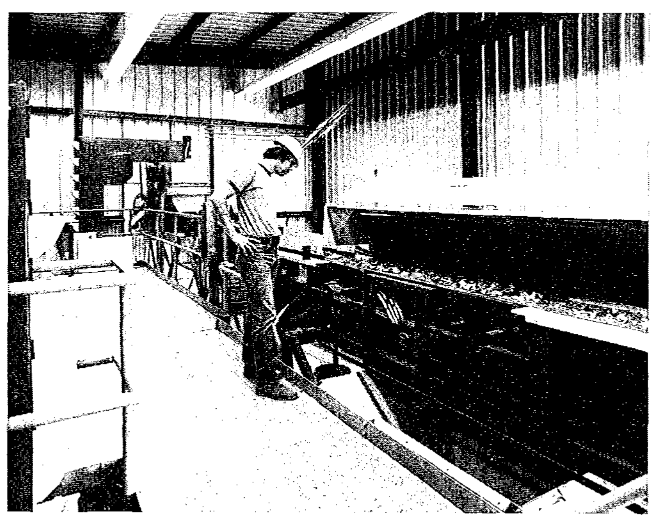
The aluminum recovery system is based on eddy current separation by linear induction motors. The ½-inch to 4-inch fraction from the trommel screen will pass on a belt over a pair of linear motors. Electrical current through the motors generates a traveling wave magnetic field above the belt. The magnetic field causes conductive materials in the refuse fraction to be deflected off the side of the belt to a collection bin. Since ferrous metals have been separated previously and nonferrous metal in municipal waste consists primarily of aluminum, the recovered product is expected to be 85 to 90 percent aluminum. It contains about 60 percent of the aluminum in the as-received waste. However, the demonstration will attempt to determine if an aluminum product with both suitable yield and purity can be simultaneously achieved.

An abbreviated materials balance for the entire process is presented in Table No. 1.

Testing and Evaluations

Following plant start-up in May, 1977, a rigorous evaluation will begin. A third-party engineering firm, working under contract to EPA, will conduct a comprehensive assessment of the environmental, technical and economic performance of the pyrolysis system. In addition, a series of test burns will be conducted at San Diego Gas and Electric's boiler using varying loads of pyrolysis oil product. The stack emissions will be monitored by the local Air Pollution Control District and EPA.

Other measures to control and test for effects on air quality include continuous monitoring of the ambient air quality in the vicinity of the plant. Due to uncontrollable meteorlogical conditions that prevail during certain seasons of the year, situations of air stagnation occur in the general area where the plant is located. This allows NO_x accumulations from all sources to build up which exceed the ambient air standards. In the event this happens, all NO_x stack emitting industries will have to shut down temporarily



D–El Cajon's comprehensive glass and nonferrous metals recovery subsystem.

until the situation clears. Three air-monitoring units have been purchased by the county, and stationed strategically near the plant-site to monitor for these conditions. It is unlikely this precaution would have been necessary had the plant been sited elsewhere in the county.

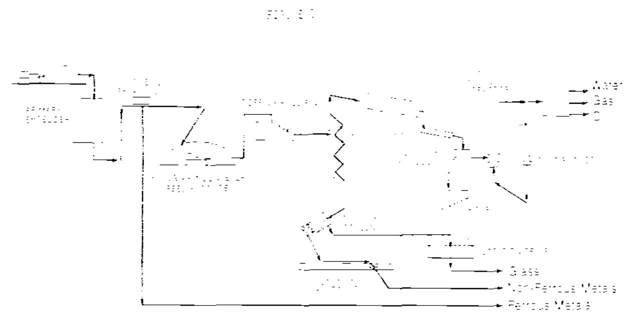
TABLE 1

MATERIALS BALANCE

Input = 200 tons per day municipal solid waste (150 tons dry weight).

Outputs	Percent of wet weight	Tons per day
Products (dry weight)		
Ferrous metals	6.7	13.3
Glass	5.3	10.6
Oil	22.0	44.1
Aluminum	0.4	0.8
Residue to landfill (dry weight)		
Solid residuals	11.6	22.2
Waste char	5.	10.
Waste gases†	24.5	49.
Moisture	24.5	50.
Total	100	200

†This includes the combustible gas which is used as a fuel in the afterburner which is formed in the pyrolysis reactor.



Economic feasibility for constructing and operating larger scales of this system is a major part of the evaluation to be conducted during the demonstration year. Like most small-scale demonstration plants, the El Cajon facility (200-tons-per-day) is not expected to be economically competitive. It will serve mainly to test the application of this pyrolysis and materials recovery process in solid waste management, and will define the expected economics of larger systems.

REFERENCES

1) Levy, S. J. *San Diego County demonstrates pyrolysis of solid waste to recover liquid fuel, metals, and glass.* Environmental Protection Publication SW-80d.2. Washington, U.S. Government Printing Office, 1975, 27 pp.

2) Preston, G. T. *Resource recovery and flash pyrolysis of municipal refuse. In* Clean Fuels from Biomass, Sewage, Urban, Refuse and agricultural Wastes Symposium, Orlando, Florida, Jan. 27-30, 1976. Chicago, Institute of Gas Technology. pp. 89-114. ■

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