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Shredded Solid Waste A New Boiler Fuel

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The author has been in the consulting engineering field for the past twenty years, and for the past 12 years has been a member of the present firm, as one of the founders; an organization of some 60 professional and technical personnel. His activities have been primarily in the steam power field, and he has been instrumental in adapting many of the advancements of the larger utilities to provide cost and operating savings to the smaller steam and power generating facilities.

Mr. Pyle is a registered professional engineer in four States; a member and Past Chairman of the Akron Section of the American Society of Mechanical Engineers, and a member of eight other technical societies; and has written several published technical articles relating to power generation. He graduated from the University of Akron with a Bachelor of Mechanical Engineering Degree cum laude. Mr. Pyle and his Company are IDHA members.

The district heating system which supplies the central business district of the City of Akron faced a questionable future because of mounting costs and air pollution problems. Raising rates to levels necessary to finance pollution-control improvements, while still maintaining a reasonable return on investment, would result in a gradual attrition of customers. On the other hand, discontinuing the service would create severe hardships for many of the business firms. The majority of the downtown buildings were constructed initially to receive district steam.

At the same time, the City of Akron foresaw increasing problems encompassing costs and land availability for disposal of solid wastes. The combination of the energy problems and the solid waste disposal problems pointed to a mutually beneficial combined solution — the Recycle Energy System — an installation to shred and burn municipal and industrial solid waste and produce steam for energy requirements.

With natural gas and fuel oil in short supply, municipal solid waste presents an attractive alternative as a boiler fuel. It is chemically clean and contains less than 0.2 per cent sulfur by weight. Electrostatic precipitators have proven effective in meeting particulate codes with this as a fuel, and steam generation has been found to provide an attractive method of cooling the gases prior to precipitation.

In Europe there are more than 100 incinerators producing steam from solid waste. There are at least four such installations in North America. Some of these installations are not marketing their steam at present, but have gone to a steam generating incinerator primarily as the most effective way to reduce the gas volumes prior to clean-up. Most of these installations are bulk burning incinerators; that is, they fire unprepared waste essentially as received.

By contrast, numerous industries burning such waste fuels as bark and bagasse, usually shred the material before firing. This industrial know-how can be utilized to provide a better way to burn municipal solid waste.

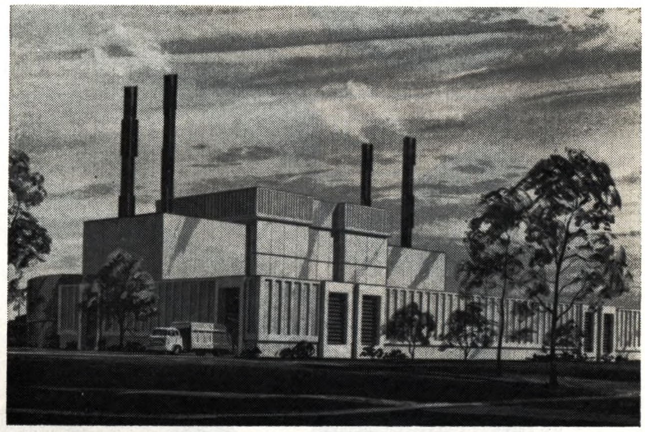

Fig. 1 — Recycle energy plant.

Advantages of Shredded Waste as a Fuel

Shredding solid waste requires additional capital outlay for shredders. Power and maintenance costs are higher for this equipment. On the other hand, there are substantial advantages to shredded waste as a fuel which were important to the Recycle Energy System Project:

- Lower boiler cost
- Higher boiler efficiency availability with shredded waste
- Higher boiler availability
- Better control of steam pressure/production
- Less restrictions on waste which can be handled
- Facilitates removal of inerts ahead of the boiler
- Facilitates recycling of metals and glass
- Less labor required

Boiler Comparison

In most cases it would be extremely improbable that both unprepared or shredded refuse could be fired in existing industrial boilers. Boiler banks and other heat transfer surfaces require wider spacing and generally avoid staggered tubes to prevent bridging and plugging. Additional sootblowers are usually required, as compared to those necessary when firing coal. Only in the paper industry, where bark-burning boilers are already designed to similar standards, would it be practical to fire shredded waste in existing boilers without severe problems.

For boilers especially designed for firing solid municipal waste, the following comparison is of interest:

333 TONS PER DAY — REFUSE FIRED BOILER

	Bulk Fuel	Shredded Fuel
Boiler and Stoker Cost	$2,100,000	$1,750,000
Grate Area - Sq Ft	480	240
Excess Air Leaving Furnace - %	80	35
Exit Temperature - Deg F	450	325
Gas Weight Leaving Precipitator - lb/hr	255,000	204,000
Boiler Efficiency - %	69.2	77.5
Steam Output - lb/hr	116,000	130,000

Thus we see that the boilers to fire a shredded fuel are 17 per cent less expensive, and produce 12 per cent more steam.

Availability

European experience suggests that 75 per cent availability is a reasonable expectation for a steam generating unit firing bulk solid waste. With domestic, open-pass, single-pass boiler design and extra attention to proper soot blower installation and placement, it is likely that the availability can be improved. However, stoker maintenance and corrosion of water wall surfaces can still be expected to lower availability over that of normal fossil fuel boilers.

By contrast, bark burners firing shredded bark generally have availabilities above 90 per cent. It is reasonable to expect similar availability from boilers firing shredded municipal waste, which is actually a better and less difficult fuel than bark. Control of air is superior to that with bulk burning, and the corrosion associated with localized reducing atmospheres in bulk burning units should not be a factor.

Controllability

A boiler firing bulk waste will have steam flow variations of $\pm$ 20 per cent if pressure is controlled, as is normal. These variations drastically reduce the useable steam output of the unit, unless substantial supplemental firing of fossil fuels is utilized whenever demand approaches boiler rating.

This swing in steam output is caused by the variability in heating value of the fuel input. Some constituents of solid waste, such as plastic, have heating values as high as 11,500 Btu per lb. Others, such as moisture, have essentially negative values because of increased losses. Even with the use of the charging crane as a "mixer," it can be expected that the Btu input to the furnace will vary substantially from moment to moment. Perhaps more importantly, the variation in Btu per cu ft of waste charge can be expected to vary even more radically. A bulk burning stoker is essentially a constant volume feeder with almost no ability to regulate Btu input. Consequently, the heat input to the boiler varies from moment to moment, and the heat output in steam must absorb this variation.

By contrast, the process of shredding and storage constitutes a blending process which evens out variations in heat value and density. Density separation of inerts after shredding can be a further factor in improving uniformity of fuel value. Metals and glass can range from 14-22 per cent of the total refuse, and even wider momentary fluctuations can be anticipated. Additionally, semi-suspension firing is inherently susceptible to automatic control. Experience with firing of shredded waste supports the inherent controllability of this method of burning.

Limitations on Waste to be Handled

A bulk burning installation must provide separate handling and size reduction of oversize objects. The alternative is to refuse to accept such items as discarded furniture and appliances. *(Continued)*

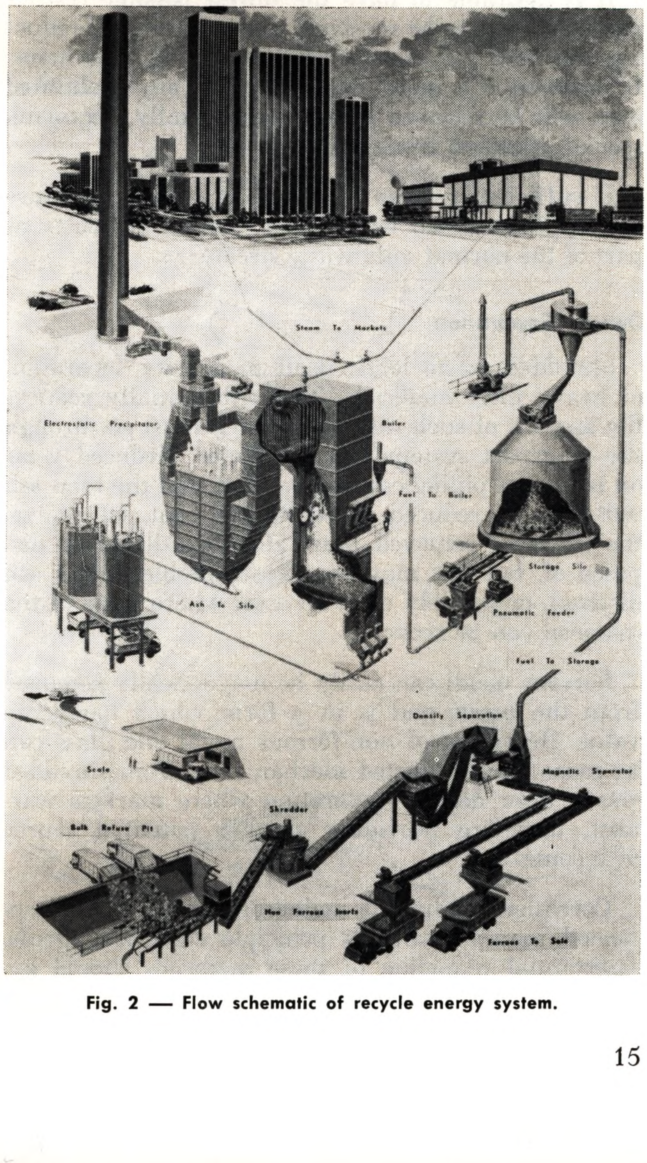

Fig. 2 — Flow schematic of recycle energy system.

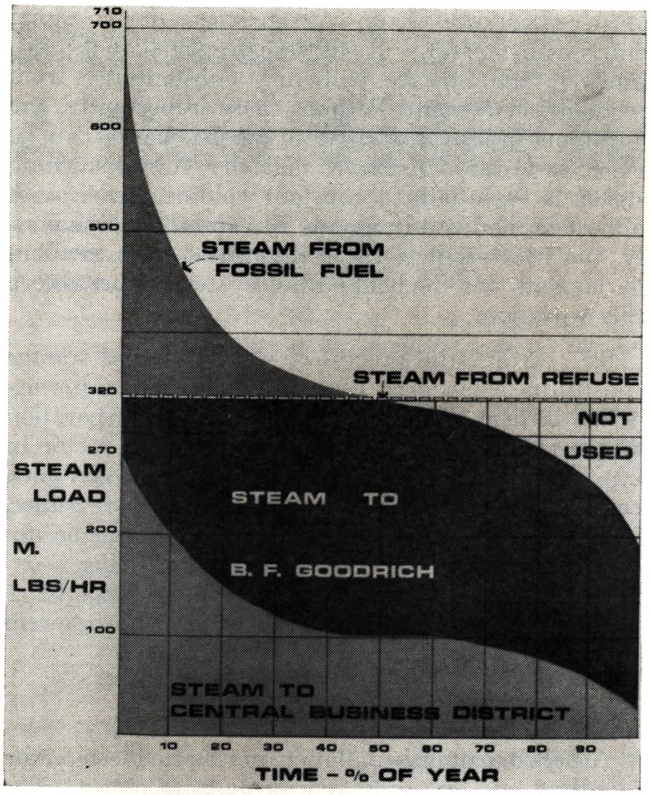

Fig. 3 — Load duration chart.

It is desirable to have the fewest possible restrictions on waste to be received, in the interest of reducing the need for separate disposal of off-spec items. In addition, it is more than likely that any prohibited item will be received at least occasionally, requiring special attention from the operators.

If sufficiently large shredders are used, furniture and appliances can be handled without difficulty as part of the normal solid waste stream.

Density Separation

Shredded waste lends itself to density separation of heavy inert materials. This substantially reduces the amount of such materials which must go through the transport system and the boiler. Reduced wear on transport piping can be expected, and the total ash will also be reduced about 80 per cent. Of course, the material removed must also be utilized or disposed of, but this may be a lesser problem than ash disposal, or possibly even an asset where some of the material can be recycled.

Ferrous metal can easily be magnetically removed from the inerts and is in a form which has scrap value. Recycling of non-ferrous metal and glass can be more easily effected mechanically from shredded waste, after density separation where markets warrant, therefore providing another potential source of income.

Corrosion studies of incinerator gases have implicated metallic salts as principle corrosion agents. Substantial reduction of these materials should appreciably reduce this potential.

Importance of Load Factor

Load factor is an important part of the economics of any steam generating installation, particularly for an installation firing municipal solid waste.

In addition to the need for disposal or volume reduction of the waste, the user should appreciate that municipal solid waste is a "free" fuel, or where dump charges can be justified, it may even be a fuel that the supplier pays the user to take off his hands.

Where steam demand is sufficiently high, a shredded solid waste fired boiler would be the preferential base load source for maximum fuel savings. In other cases, it may be advantageous for two or more users to share the output.

As with many district heating systems, Akron has relatively little air conditioning load and a load factor of only about 30 per cent. In addition, the peak demand was substantially less than the potential generation from solid waste. Consequently, substantial volumes of surplus steam could be produced.

There is another major energy user in the immediate area, the B. F. Goodrich Co., with both heating and industrial steam requirements. The sale of surplus steam to B. F. Goodrich proved to be the factor to optimize benefits to all users of the facility.

The Recycle Energy System project for Akron, now under design, will charge $2.50 per ton of waste as a dump charge. The average steam rate will be $2.40 per M lb from the distribution system, and surplus interruptible steam will be sold at $1.00 per M lb. These rates will support revenue bonds to finance the project over 20 years. Rate reductions are contemplated, when sufficient bond reserve funds have been accumulated after the first few years of operation. Δ

DISTRICT HEATING-COOLING SYSTEM AT ABBOTT PARK

Abbott Laboratories began construction of Abbott Park near North Chicago, Ill. eight years ago. The current complex, comprised of 16 buildings for offices, research and manufacturing, now occupies about one-third of the total 500 acres.

The last building in the recent expansion phase — the pharmaceutical finishing plant — was constructed last year. The piping system used for this building was Johns-Manville Super Temp-Tite. It is reported that the specifications were changed to the J-M product because of corrosion problems experienced with the system used in the previously constructed buildings. The 350 ft of eight-in. line, for delivering 150 psig steam is essentially a steel core protected with corrosion-resistant casing pipe, and a combination of lime-silica-asbestos insulation covered with high-temperature polyurethane. J-M's epoxy-lined Transite pipe was used for the chilled water line, and their Chemtite pipe for the condensate return line.