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Project Summary

Environmental Effects of Utilizing Solid Waste as a Supplementary Power Plant Fuel

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The results of three years of research on the utilization of shredded and magnetically separated municipal refuse to supplement high-sulfur coal as fuel in a stoker-fired boiler are presented. The facilities of the Columbus, Ohio, Municipal Electric Plant were used for this program. During the first half of the research, a refuse handling and furnace feed system consisting of agriculture crop handling equipment was used. With this equipment, the feasibility of blowing shredded refuse into a boiler and burning it completely on a traveling grate was demonstrated. Corrosion probe exposures were used to show the effectiveness of cofiring to reduce short-term corrosion of boiler tube metals. Reduced emissions of sulfur dioxide (SO_2) from the high-sulfur coal also resulted from dilution of the coal with refuse and by action of alkaline components of the refuse.

To study the handling and combustion of larger amounts of shredded refuse and to measure long-term corrosion effects, an improved system was developed and installed during the second half of the program. This system consisted of a hydraulic push-pit, augers, and a belt to convey the refuse to air-swept spouts that injected the refuse into the boiler. Amounts of refuse up to 6800 kg/hr (7.5 tons per hour) were burned successfully using this system.

It was demonstrated that 700-hour corrosion rates with an average of 22 weight percent refuse and high-sulfur coal were 5 to 10 times less than those with bulk refuse burning and about equal to those from coal alone. Sulfur dioxide emissions were reduced as a function of the refuse content of the mixture. The cofiring with refuse had no significant effect on particulate loading of the flue gases, fly ash resistivity, or grate ash composition, but the ash fusion temperature was lowered somewhat.

This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The objective of this research program was to develop technology for the utilization of municipal refuse as a supplementary fuel in coal-fired power or steam generating plants. Three aspects of this technology were investigated: (1) the preparation and handling of the refuse before burning, (2) the corrosivity of the mixed fuel to boiler tubes, and (3) the emissions and residues resulting from the burning of the mixed fuel. As a result of previous Battelle investigations, which demonstrated that the corrosivity of the combustion products from municipal solid waste could be reduced by the addition of sulfur, it was proposed that disposal of municipal refuse in boiler furnaces utilizing high-sulfur coal would not be detrimental to boiler tubes. In addition, the dilution of the coal with the refuse and the reaction of sulfur oxides with alkaline components of solid waste would reduce the sulfur oxide emissions to a permissible level.

To substantiate the above concept and to develop technologies associated with the utilization of solid waste as a fuel, the program investigated the effects of operational variables on emissions, corrosion, combustion, and ash properties in the Columbus, Ohio, Municipal Electric Plant's spreader-stoker-fired boiler furnace. This site was selected to represent coal-fired boiler furnaces with grates on which final burnout of the refuse could occur.

Although a program on burning of processed (shredded and classified) solid waste was conducted at the Union Electric Company in St. Louis, Missouri, and is currently operating at the Ames, Iowa, Electric Utilities, the current program was directed toward determining the limitations and the benefits of burning the shredded solid waste with high-sulfur coal with very little or no processing of the solid waste except for shredding. Deleting the classification steps in the processing made it mandatory to investigate methods for receiving, storing, retrieving, and handling the refuse within the limited space available at the plant. This work had to be accomplished before the investigation of corrosion and emissions from the cofiring process could be evaluated.

During the first year of this program, a temporary system for handling and feeding the shredded waste to the boiler was assembled using commercially available agriculture equipment for handling forage and grain crops.

During the period of development of the refuse handling system, shredded refuse from Willoughby, Ohio, and from St. Louis, Missouri, was obtained for evaluating the equipment capabilities. Preliminary corrosivity studies on the combined fuel and the baseline coal fuel were conducted during the first year. However, the Sanitation Division of Columbus, Ohio, started operation of their Jeffrey shredders in June 1975.

Hence, the second year of this research was directed towards utilizing Columbus refuse as a supplement to the coal fuel and evaluating the handling of this refuse plus analyzing the emissions and the corrosivity as the refuse was burned with high-sulfur coal. Also, the analysis of a refuse handling system for the Columbus, Ohio, Municipal Electric Plant was directed toward the design and construction of a more rugged system that would permit long-term investigations of stack emissions and fireside corrosion.

The third year of the program consisted of: (1) procuring and installing the refuse handling system, (2) optimizing the operation of the system, (3) conducting long-term corrosion runs, and (4) making additional measurements of emissions and residue characteristics.

Conclusions

The experimental program conducted at the Columbus, Ohio, Municipal Electric Plant demonstrated the technical feasibility of mechanical handling and furnace feeding of shredded municipal solid waste at an existing stoker-fired boiler with limited space and accessibility. Also, it has been shown that the refuse can be burned completely on a grate in conjunction with coal, utilizing a spreader-stoker. The corrosivity of the combustion products from refuse burned with high-sulfur coal was reduced significantly from that for refuse alone and was essentially attributable to the sulfur in the coal. The sulfur oxide emissions were reduced by dilution of high-sulfur coal with a very low-sulfur fuel and by the formation of stable sulfate particulate compounds with alkaline refuse components. The ash residues from the cofiring of refuse and coal had essentially the same composition as those from coal alone.

The following conclusions were reached:

1. The corrosivity of combusiton products from cofiring refuse and three percent sulfur coal up to a 2 to 1 weight ratio is not significantly different from that of coal alone.
2. The corrosion rates of boiler tube metals decrease rapidly with exposure time. After 700 hours, the rates for stainless steels level off.
3. Boiler tube metals can be ranked in the following order of increasing resistance to corrosion: A106 carbon steel, P9 low alloy steel, and Types 316, 347, and 310 stainless steel.
4. Reductions of SO_2 as much as 10 percent more than the dilution effect can be achieved under optimum combustion conditions.
5. Refuse can be burned with coal on a traveling grate with processing limited to shredding and magnetic separation.
6. The ash fusion temperature was reduced by burning large amounts of refuse with the high-sulfur coal.
7. The fly-ash resistivity was not changed significantly by burning the refuse with the high-sulfur coal.
8. Refuse that has undergone shredding and magnetic separation can be handled effectively with augers and belts. A live-bottom feed from storage is preferable to hydraulic ram feed.
9. The processed refuse can be fed successfully into the traveling-grate furnace with air-swept spouts.
10. The shredded refuse, nominally 10 cm (4 inches), will burn out completely on the traveling grate. The underfire air supply is a critical factor in the quality of the refuse combustion.
11. The aluminum and other low-melting metals present in unclassified waste may cause clogging of the grates if the underfire air is not properly maintained.

Recommendations

It is recommended that further development of the burning of shredded refuse with coal on a grate in existing boilers be encouraged, both to recover energy and to minimize landfill requirements.

The corrosivity of the combustion products of shredded and magnetically separated refuse should be investigated when such refuse is burned alone. Such data have not been obtained, and it is possible that the shredding process and removal of ferrous metals will influence the corrosion reactions sufficiently to reduce metal wastage to that experienced with coal alone.

The corrosive effects of burning very large amounts of refuse (90 weight percent) with high-sulfur coal should be determined. The maximum refuse input without serious corrosion is not known.

Additives other than sulfur to combat corrosion should be sought for situations such as bulk burning of refuse or where high-sulfur coal is not readily available.

The combustion conditions for shredded refuse and coal should be investigated further to optimize the reduction in sulfur dioxide emissions and to minimize the particulate loading of the flue gases.

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The complete report, entitled "Environmental Effects of Utilizing Solid Waste as a Supplementary Power Plant Fuel," (Order No. PB 85-122 422; Cost: $10.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
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