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Project Summary

A Technical Overview of the Concept of Disposing of Hazardous Wastes in Industrial Boilers

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An evaluation of the concept of disposing of hazardous wastes in industrial boilers was conducted for the EPA by the Acurex Corporation of Mountain View, California. The information presented in the full report includes a review of the rate of generation of hazardous wastes which are candidates for such use, and the present and projected extent of the use of boilers for this purpose. Also presented is an inventory of industrial boilers, standard boiler characteristics, and the temperature-time profiles of each boiler studied. Theoretical temperature-time requirements for destruction of hazardous wastes are compared to those expected in industrial boilers to assess whether the boiler is an appropriate vehicle for waste destruction. Many key variables must be considered in the use of this type of model. Examples of these are the degree of waste fuel atomization, variation of gas residence times from the mean furnace residence time, temperature variations from the bulk stream temperature across any furnace cross section, and effects of boiler load changes. The general conclusion is that expected variations in these variables are sufficient to warrant careful evaluations of waste streams and boiler combinations before firm conclusions are reached on the environmental safety of co-firing hazardous wastes as fuel. An overview of the elements for a complete evaluation of this potential disposal technology is presented.

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

Approximately 40 million metric tons of hazardous wastes are currently generated annually in the U.S. On May 18, 1980, the Environmental Protection Agency (EPA) promulgated Phase I rules and interim status standards regulating the generation, transportation, treatment, storage, and disposal of these wastes under authority of the Resource Conservation and Recovery Act (RCRA). These and subsequently announced regulations place stringent restrictions on generators of waste, including requirements for manifesting wastes and chain-of-custody liability. These restrictions may ultimately impose additional costs on the waste generator for off-site disposal. Thus, economic incentives for disposing of wastes on-site may result.

One method of disposing of wastes with high organic content is by thermal destruction. This can be done by high-temperature incineration, which is regulated by RCRA. However, another means of thermal destruction is by co-combustion of the waste or, if its heating value is sufficiently high, use of the waste as a fuel in devices whose primary purpose is energy production, such as boilers and process heaters.

Currently RCRA regulations specifically exempt facilities that burn wastes in

energy-producing operations from complying with RCRA incineration mandates. In fact, it is estimated that about 20 million metric tons of wastes that might be classified as hazardous are currently burned as fuel or co-combusted with fuel in energy-producing operations.

The purpose of this project was to provide a basis for answering the following key questions:

- What is the present and projected magnitude of hazardous waste combustion or co-combustion in boilers?
- Which waste materials and boiler types are the most compatible?
- Are there potential mechanical difficulties or environmental hazards associated with waste combustion in boilers?

The opportunity for combustion of hazardous wastes in industrial boilers is greater than currently practiced. There are over 40,000 industrial boilers in the U.S. with capacities greater than 10 million Btu/hr. These units offer great potential for hazardous waste combustion.

Regulations published on January 23, 1981 for incineration of hazardous wastes require 99.99-percent destruction and removal efficiencies (DREs) for the principal hazardous organic constituents in the waste incinerated. If the temperature-time profile of a given boiler type is similar to the time and temperature required to destroy a given waste, then the disposal of the hazardous waste in the boiler can become an option open for more extensive evaluation. This evaluation would consider the compatibility of the primary fuel to the waste, potential impacts on the design conditions of the boiler, retrofit requirements, and fugitive and secondary emissions. The full report presents information on each of these issues.

Summary of the Research Conducted

The objective of this project was to assess the problems and potential of destroying hazardous wastes in industrial boilers. The major elements of this overview include:

- Surveying hazardous waste generation and disposal practice
  - —Document present generation and disposal inventories
  - —Establish the present extent of waste combustion as fuel
  - —Project the future extent of waste combustion as fuel
- Assembling an inventory of industrial boiler capacity capable of hazardous waste combustion
  - —Inventory by size, design type, and fuel fired
  - —Provide regional inventories
  - —Select a set of model boilers typifying the installed population
- Characterizing the combustion characteristics of typical boilers
  - —Establish boiler operating and design characteristics
  - —Establish boiler temperature-time profiles as a function of boiler characteristics
- Characterizing hazardous wastes suitable for combustion
  - —Specify the requirements (temperature and time) for waste constituent destruction
  - —Define the composition of candidate wastes and rank the listed waste streams for potential use as fuel
- Identifying the matrix of wastes/boiler types suitable for hazardous waste combustion
  - —Combine boiler combustion characteristics with waste constituent destruction requirements
  - —Specify boilers/wastes achieving 99.99-percent destruction
- Provide an overview of considerations for further evaluating the waste/boiler destruction option.

Conclusions and Recommendations

As discussed in the introduction, the primary purpose of this study was to determine whether hazardous wastes could potentially be safely destroyed under the conditions found in a number of industrial boilers. The study determined that the thermal destruction requirements of most wastes evaluated are satisfied by the conditions found in a large percentage of industrial boilers currently in use. However, because of the nature of such a theoretical evaluation, it can only be concluded that boilers appear to have the potential for safe waste destruction. Further experimental work is necessary to confirm this conclusion. In this respect, this study represents only a starting point for more detailed technical evaluation of industrial boilers as vehicles for the safe disposal of hazardous wastes. This project did establish that further work is warranted and could result in significa benefits in both the expansion of sa hazardous waste disposal capacity a the utilization of the energy content th wastes represent.

Conclusions

The following conclusions were deve oped from this theoretical analysis:

- Co-firing of hazardous wastes at small percentage of the base fu (about 5 to 10 percent) appears to be viable method of disposing of mo hazardous organic material.
- Co-firing many wastes or firing som high Btu content wastes entirely ma produce lower levels of criteria pollu tant and trace element emissions tha either traditional coal or oil combus tion.
- The conditions found in many types c watertube boilers appear to be suffi cient to achieve at least 99.99-percen destruction of most hazardous organi compounds.
- The conditions found in firetube boiler do not appear to be sufficient to destro all hazardous organic materials. Ther is too great a likelihood that cold tube wall quenching of the waste degrada tion reactions is possible befor complete destruction can occur.
- Watertube boilers whose furnace ex temperatures are greater than 1,100 (1,500°F) and whose furnace mear residence times are greater than on second appear to be best candidate for the destruction of simple hazardou organic waste streams.
- Complex organic waste streams ar likely to require approximately 200 (360°F) higher temperatures.
- Insufficient data are available to predic whether hazardous products of com bustion could be released from a boiler Laboratory data should, however, be able to provide some conservative estimates of the likelihood of the release of such materials. The forma tion of hazardous products of combus tion must be addressed by further research.
- In the absence of other data, the autoignition temperature appears to be a possible predictor of the relative ease of thermal destruction of a compound. This needs further confirmation.

Recommendations

This study showed that, theoretically, certain boilers can destroy hazardous organic materials. This work suggests that the following areas of further research need to be addressed:

- The available waste destruction kinetic data are based on results obtained from thermal destruction analytical system (TDAS) experiments. While such work is very useful, it does not model the destruction phenomena that occur in a flame. This type of information must now be obtained through a flame-mode destruction apparatus.
- The current TDAS work (as well as future flame-mode work) needs to be broadened to include destruction characteristics of the wastes under the pyrolytic (no oxygen) as well as under high oxygen concentration conditions. Further information on the formation and destruction of hazardous products of combustion is also needed.
- The information that will be obtained by EPA under the hazardous waste manifest system needs to be evaluated to determine other wastes which are potential candidates for destruction in boilers.
- A field program needs to be initiated to verify the preliminary results of this study. The program should include testing of the full boiler system, not just the boiler emissions. The test should include:
  - —Full input/output analysis of all streams
  - —Boiler temperatures at a number of points in the combustion chamber
  - —Boiler residence time variations
  - —Testing for the principal organic hazardous components in the waste and for hazardous products of combustion. TDAS data can be used to determine which products of combustion could occur and hence should be tested for.

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***Robert A. Olexsey** and **George C. Huffman** are the EPA Project Officers (see below).*

The complete report, entitled "A Technical Overview of the Concept of Disposing of Hazardous Wastes in Industrial Boilers," (Order No. PB 85-138 576; Cost: $17.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officers can be contacted at:

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