United States Environmental Protection Agency
Research and Development

Air and Energy Engineering Research Laboratory
Research Triangle Park, NC 27711

EPA/600/SR-94/060 May 1994

EPA

Project Summary

Application of Pulse Combustion to Incineration of Liquid Hazardous Waste

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The report gives results of a study to determine the effect of acoustic pulsations on the steady-state operation of a pulse combustor burning liquid hazardous waste. A horizontal tunnel furnace was retrofitted with a liquid injection pulse combustor. The pulse combustor burned No. 2 fuel oil that was doped with principal organic hazardous constituents (POHCs). The POHCs that were used were carbon tetrachloride and chlorobenzene.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, 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 purpose of this study was to determine the effect of acoustic pulsations on the steady-state operation of a pulse combustor burning liquid hazardous waste. A pilot scale horizontal tunnel furnace was retrofitted with a liquid injection pulse combustor supplied by Sonotech, Inc. (Atlanta, GA). The pulse combustor burned No. 2 fuel oil that was doped with principal organic hazardous constituents (POHCs). The POHCs that were used were carbon tetrachloride and chlorobenzene

Pulse combustion refers to a combustion process that varies periodically. Pulse combustion is a relatively old technology. It was first discovered in 1777 when it was noted that a flame placed in a long vertical tube produced the "singing flame" phenomenon. One of the first applications of a pulse combustor was for the engine that propelled the World War II "buzz bomb." Pulsating combustion occurs when the heat released by a combustion process spontaneously excites a pressure wave within the combustion chamber. When this pressure wave is in phase with periodic heat release, pressure and gas velocity oscillations occur. In order to excite large amplitude pulsations from a pulse combustor, the frequency at which it operates must equal one of the natural acoustic modes of the combustion chamber. When these frequencies are matched, resonant pulsations are excited in both the combustion section and the tailpipe portion of the pulse burner. An important benefit of a pulse combustor for hazardous waste incineration is the improved mixing of combustion gases. The resonant pulsations cause significant gas turbulence within the combustion zone.

Baseline conditions were tested as well as hazardous waste operations. For each test condition, the burner was operated in both a pulsing and nonpulsing mode. Large amplitude acoustic pulsations were generated by adjusting the burner frequency to match the natural frequency of the combustion chamber. Detailed chemical analyses of the stack gases were performed, including destruction and removal efficiency (DRE) computations, volatile and semivolatile screening analyses, particulate loading determinations, and a particle size distribution analysis. The results show that steady-state operation of the pulse combustor was not successful in isolating the effect of acoustic pulsations on combustion emissions. DRE values were found to be greater than six nines (99.9999%) for both pulsing and nonpulsing operations. The pulse combustor for this study was equipped with a fuel vaporization unit that may have enhanced the destruction capabilities of the burner. It is not known if operating without a vaporizer under nonideal combustion conditions would degrade burner performance.

The EPA author, ***Carin DeBenedictis*** *(also the EPA Project Officer, see below), is with the Air and Energy Engineering Research Laboratory, Research Triangle Park, NC 27711.*

The complete report, entitled "Application of Pulse Combustion to Incineration of Liquid Hazardous Waste," (Order No. PB94-161262; Cost: $27.00, 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 Officer can be contacted at:

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*U.S. Government Printing Office: 1994 — 550-067/80253

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Environmental Protection Agency
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EPA/600/SR-94/060

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