United States
Environmental Protection
Agency

EPA/540/MR-95/502
March 1995

EPA

SITE
SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION

Demonstration Bulletin

Cello® Pulse Combustion Burner System

Sonotech, Inc.

Technology Description: Sonotech, Inc. (Sonotech), of Atlanta, GA, the developer of the Cello® pulse combustion burner, claims that its burner system can be beneficial to a variety of combustion processes. The system incorporates a combustor that can be tuned to induce large amplitude sonic pulsations inside combustion process units such as boilers or incinerators. According to Sonotech, these pulsations increase heat release, mixing, and mass transfer rates in the combustion process, resulting in faster and more complete combustion. Sonotech has targeted waste incineration as a potential application for the system. To test its potential applicability and effectiveness, the Sonotech system was demonstrated on the pilot-scale rotary kiln incineration system (RKS) at the EPA Incineration Research Facility (IRF) in Jefferson, AR. In the demonstration, a Sonotech Cello® system was retrofit to the primary combustion chamber of the RKS.

A pulse combustor typically consists of an air inlet, a combustor section, and a tailpipe (see Figure 1). In the Cello® pulse combustor, fuel oxidation and heat release rates vary periodically with time, producing periodic variations or pulsations in pressure, temperature, and gas velocity. Sonotech claims that large amplitude resonant pulsations excited by its frequency-tunable pulse combustor can significantly improve an incinerator's performance, thereby reducing capital investment and operating costs for a wide variety of incineration systems.

Waste Applicability: The Sonotech Cello® combustor can be incorporated into the construction of most new combustion devices or can be retrofit to many existing systems. The Cello® burner system can be used to treat any material typically treated in a conventional incinerator, and Sonotech believes the technology is ready to be used for the full-scale incineration of contaminated solids, liquids, sludges, and medical wastes. Contaminated soil, sludge, and tar samples collected from two manufactured gas plant Superfund sites were blended for use in this SITE demonstration.

Demonstration Results: The primary objective of the demonstration was to develop test data to evaluate the treatment efficiency of the Sonotech Cello® combustor system compared to conventional combustion. Test data were evaluated to determine if the Sonotech system (1) increased incinerator capacity, (2) increased destruction and removal efficiency (DRE) of principal organic hazardous constituents (POHC), (3) decreased flue gas carbon monoxide emissions, (4) decreased flue gas nitrogen oxides emissions, (5) decreased flue gas soot emissions, (6) decreased combustion air requirements, and (7) decreased auxil-

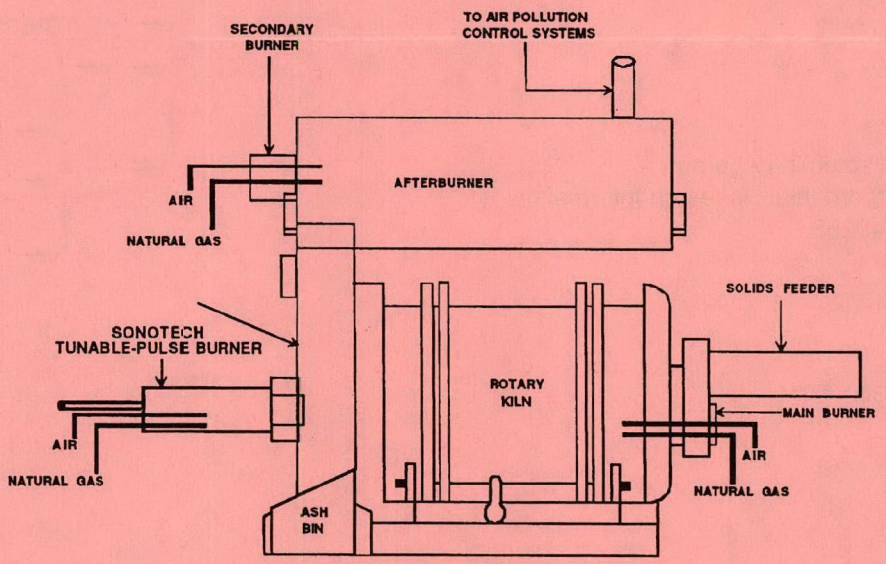

Figure 1. The Sonotech Frequency-Tunable Pulse Combustion Burner System fitted to the IRF RKS.

iary fuel requirements. The demonstration's secondary objective was to develop additional data to evaluate whether the Sonotech system, compared to conventional combustion, (1) reduced the magnitude of transient puffs of carbon monoxide and total unburned hydrocarbons (TUHC) (2) significantly changed the distribution of hazardous constituent trace metals among the incineration system discharge streams (including kiln bottom ash, scrubber liquor, and baghouse exit flue gas); and (3) increased the leachability of the toxicity characteristic leaching procedure (TCLP) trace metals from kiln ash.

To achieve the demonstration objectives, tests were performed in triplicate at four different incineration system operating conditions, for a total of 12 individual tests. The four test conditions included (1) conventional combustion at typical operating conditions (2) conventional combustion at its maximum feedrate; (3) Sonotech pulse combustion at the conventional combustion maximum feedrate (the same nominal feedrate as condition 2) and (4) Sonotech pulse combustion at its maximum feedrate. A summary of preliminary demonstration results is presented below.

- The Sonotech system increased the incinerator waste feedrate capacity by 13% to 20% compared to conventional combustion. The capacity increase was equivalent to reducing the auxiliary fuel needed to treat a unit mass of waste from 27.4 thousand British thermal units per pound of waste (kBtu/lb) for conventional combustion to 21.5 kBtu/lb for the Sonotech system, however; the demonstration waste had significant heat content. Visual observations indicated improved mixing in the incinerator cavity with the Sonotech system operating.

Other demonstration results, for test conditions at the same nominal feedrate, are summarized as follows:

- Benzene DREs for all 12 test runs were greater than 99.994%, with a slight improvement in the third decimal place for the Sonotech combustor results. With the Sonotech system operating, the average benzene emission rate was reduced from 7.7 to 5.7 milligrams per hour (mg/hr) at the afterburner exit. This represents a 25% reduction, although changes of this magnitude are within the precision of this type of measurement.

- Naphthalene DREs were greater than or equal to 99.998% for all test runs. With the Sonotech system operating, the average naphthalene emission rate was reduced from 1.2 to 1.1 mg/hr at the afterburner exit. This represents an 8% reduction, although again, this magnitude of change is also within the precision of this type of measurement.

- The average afterburner carbon monoxide emissions, corrected to 7% oxygen, decreased from 20 parts per million (ppm) with conventional combustion to 14 ppm with the Sonotech system. This represents a 29% reduction.

- The average afterburner nitrogen oxides emissions, corrected to 7% oxygen, decreased from 82 ppm with conventional combustion to 77 ppm with the Sonotech system. This represents a 6% reduction.

- Average afterburner soot emissions, corrected to 7% oxygen, were reduced from 1.9 milligrams per dry standard cubic meter (mg/dscm) for conventional combustion to less than 1.0 mg/dscm with the Sonotech system. This represents a 53% or greater decrease in soot. However, all soot measurements were within a factor of 3 of the method detection limit, so the significance of this reduction is uncertain.

- Total system combustion air requirements, determined from stoichiometric calculations, were 5% lower with the Sonotech system in operation.

Demonstration findings addressing the frequency of transient carbon monoxide and TUHC puffs, trace metals distribution, and the results of TCLP testing are under evaluation.

A Technology Capsule and an Innovative Technology Evaluation Report will be available in mid-1995.

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