EMISSIONS TESTING OF INDUSTRIAL PROCESSES
BURNING HAZARDOUS WASTE MATERIALS

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Discussion by

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The authors are to be congratulated in reporting on the results of some initial emissions testing of industrial processes while burning hazardous waste material. The need for this type of emissions data is obvious in light of the mounting national awareness and concern relative to the disposal of hazardous wastes. A recently released EPA report, "National Survey of Hazardous Waste Generators & Treatment, Storage, and Disposal Facilities Regulated under RCRA in 1981" (EPA 530/SW-84-005), indicated that EPA now estimates that 246 million metric tons of hazardous wastes, regulated under the Resource Conservation & Recovery Act (RCRA), was generated by U.S. industry in 1981. This amount is more than six times greater than previous estimates and more than 60% greater than EPA's preliminary estimate released just last August. The same report indicates that nearly 60% of all regulated hazardous waste was disposed of by underground injection, with 21% going to landfill disposal and less than 1% was incinerated. With Congress's and many states mounting concern about possible groundwater contamination attendant to injection-well disposal methods, incineration of regulated combustible hazardous wastes is likely to be greatly increased in the future as a possible disposal alternative.

The paper clearly points out that the emission results reported therein were only of two boiler tests of a 12-test series of full scale boiler tests as part of EPA's Regulatory Impact Analysis effort to determine if, and to what extent, processes that produce energy and only incidentally burn hazardous wastes should be regulated in the future. The authors correctly point out that the emissions tests were run under a highly restrictive set of circumstances as to boiler and kiln operating conditions, the type and concentrations of hazardous compounds destructed and therefore the reported results of high percentages of Destruction and Removal Efficiency (DRE) of the POHCs must be viewed in that light. The results, however, are encouraging in that 99.9% destruction of most of the Principal Organic Hazardous Constituents (POHCs) under the described test conditions was achieved.

In the combustion of hazardous wastes, a number of states and local air pollution control agencies have proposed or adopted combustion design and operating requirements that impose minimum combustion temperatures and minimum high temperature retention times to effect the EPA-DRE requirements for the destruction of hazardous wastes. In many instances, the furnace time/temperature relationships embodied in these regulations appear to be unusually restrictive. What is clearly needed is more of the type emissions data and testing that is reported in this paper to more adequately define the acceptable operating envelope for the combustion of hazardous waste materials. A specified minimum time/temperature approach to regulation would reduce the amount of field emission testing that would have to be performed (and therefore the costs) in securing approval of a regulatory agency for operation of such a facility. It is hoped that EPA in carrying this testing program forward will in the future testing work measure and ascertain the combustion chambers or furnaces minimum and maximum tempera-
tures and the related furnace high temperature gas retention times in the various industrial combustion process (boilers, kilns, metallurgical furnaces, ovens, etc.) as a parameter of interest in better defining the operating conditions under which the emissions testing was conducted. Such data was not presented by the authors for the tests reported in their paper.

Future emissions tests, in addition to being conducted under more normal modes of system operation — particularly with regard to boiler tests — should not only be conducted under normal variable and fluctuating steam load conditions (as suggested by the authors) but also should be conducted with boilers operating over a much wider range of rated boiler capacity operation. In both of the boiler tests reported, the steady state boiler operating loads were approximately 50% of boiler rated capacity. A more severe emission test condition might well be where the boiler is operated at, or near, rated capacity when boiler furnace temperatures may be somewhat higher but gas retention times in the high temperature zones of the furnace may be considerably reduced at the higher gas flow rates and higher gas temperatures.

It would also be helpful in the ongoing test program that some modeling work be done on emissions that are emitted in relatively high concentrations (such as the 4000 μg/s MMA emissions in the Boiler No. 1 tests) to ascertain the maximum ambient ground level concentrations of such pollutants in and near the combustion facility. It may well be that this type effort is already being done as part of the total RIA process. Similarly, comparisons of HCl emission rate data when burning various POHCs at different and higher than 3% chloride concentration input levels, with some of the more restrictive HCl emission standards that have been adopted at State or local levels, would also be helpful to owners and engineers that are considering codisposal of hazardous waste in an industrial combustion process. The ongoing emission testing program should also consider the use of some of the combustible compounds under consideration at potential NESHAP's as the spiking agents in the future testing program in lieu of the EPA Administrators, recent commitment to decide early whether a number of these chemicals are to be regulated under NEHSAF's.

I believe this paper makes a valuable contribution to the evolving knowledge in this relatively new field of environmental concern.

Discussion by

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(1) My first comment is that of a better method of telling what the various abbreviations mean. It would be convenient to have a page that listed the abbreviations used and their meaning. It becomes very inconvenient to have to look up the abbreviations each time you use them and would make the paper better if a better method such as a page devoted to that at the beginning of the paper.

(2) On page 424 the idea of subtle variations needs some more clarification as it leaves me a bit uneasy about the tests and how much I can rely on them due to their extreme accuracy requirements of, e.g., 99.99%.

(3) On page 425 the use of an onsite gas chromatograph disturbs me as I feel the opportunity for error is increased when you open up analytical instruments to field conditions and the many unknown and outside influences that can affect the instrument. In addition, since the accuracy is so critical, I feel suspicious of the test results.

(4) On page 427 a three-way valve exists and I wonder if it was greased, and is so, then was the type of lubricant used inert to the test, or is it possible that some interferences may happen into the tests, results due to an unknown of irregular grease used here?

(5) In boiler 1, I assume that the boiler has no grate system. I wonder what effect a hot mass of grate might do to the fuel consumption when these wastes are introduced. It might be worth considering what effect the introduction of preheated combustion air might do to the DRE in this case.

(6) On page 430, the artificial spiking of the waste material with other compounds to determine the effective destruction of the POHC may have caused a problem in that there may be a catalytic effort or some similar reaction that may skew the tests results or even distort them.

(7) In Table 5, it appears that boiler 1 only passed 10 tests in meeting the 99.99% DRE and thus we have to give it a grade of 83% which is only a B in most schools.

(8) It appears that boiler 2 came equipped with a stoker and thus cooled off a portion of the fire box due to the mass of cooler metal in the stoker. This may be a partial cause of the less favorable showing of the test results that are listed in Table 9 on page 436. When we apply the same type test to these DRE results, it yields a grade of only passing four tests out of 12. We thus have to give it a grade of 33% which in most schools is a failing mark.

(9) The lime kiln is an excellent waste compound destruction device and the authors are to be commended for their foresight and/or luck in selecting a rotary kiln to test. I have discussed this rotary kiln as an excellent device for destroying hazardous wastes in my article on "Hazardous Waste: A Special Roundup Feature Report on Incineration," that appeared in the April Issue of Pollution Engineering magazine on pages 36-42.

It passes 100% of the time and thus we give it an A+ as a device for destroying the wastes in this test series.
In the list of references there are too many "Draft Reports" and that makes me uneasy as to the possibility that this paper might become the basis for the U.S. Congress to establish a law that would permit any boiler to try and destroy hazardous wastes, which could open up a great deal of problems.

I feel that the test results expressed in this paper should point to the use of specialized devices to destroy hazardous wastes. The only successful tests were those done on the lime kiln and when they were done they caused operational problems.

AUTHORS' REPLY

To Fred R. Rehm

In its earliest proposals to regulate hazardous waste incinerators, EPA suggested a time at temperature approach to regulation that was parallel to the Agency's existing PCB incineration regulations. Comment from the technical community was overwhelmingly negative in that there was concern that EPA should not promulgate a design regulation since such an approach would preempt the regulated community's options and stifle development of more effective and efficient technologies. EPA considered these objectives to be legitimate, withdrew the design standard, and proposed in its place a performance standard (the DRE approach). Industry is free to use whatever means it feels appropriate to burn the wastes as long as the performance requirement is achieved. Individual incinerator permits may have time and temperature requirements built into them that have been specifically derived for those incinerators based on trial burn or other data. Regarding measurement of gas temperatures and retention times inside an operating boiler or kiln, the authors solicit input as to how to best obtain this data. Boiler operators routinely record steam temperature and pressure but do not record gas temperature or residence time. Boiler furnace exit temperatures can be used to estimate maximum firebox gas temperatures for given fuels but such estimates are very rough and yield no information on temperature distribution. Measurements after the superheater section tell us only the minimum temperature experienced and are not an accurate gauge of the thermal environment the gas experiences. One can measure temperature profiles through insertion of commercially shielded thermocouples into the hot zone of the furnace but the authors remain in doubt as to the effects of the shielding itself on the accuracy of the temperature measurement. Finally, the host sites for all the boiler and kiln tests were voluntary participants in the test program. We felt that making holes in the boiler to obtain questionable measurements for only one week's testing would be wearing out a very gracious welcome. In the case of boilers, EPA had conducted pilot-scale tests that do record temperature profiles within the firebox. This data will be coming out soon.

The non-steady state testing for boilers will be conducted at both high and low load levels and at transitions between load levels. Low loads should yield lower temperatures and longer residence times.

Modeling work will be conducted on all major pollutant emissions as part of the Regulatory Impact Analysis. In the case of HCl emissions from boilers, there is, of course, a very strict policing mechanism in that anyone burning over 3% chloride input concentrations in a boiler will not be doing it for long. From the municipal solid waste area we have a wealth of data on the effects of chloride contents in this range on boiler tube wastage.

"Spiking" compounds were selected based on their presumed resistance to thermal destruction. It is possible that future tests could take the NESHAP situation into account. However, one compound that will never be used as a POHC "spike" is benzene since it shows up everywhere in laboratory analysis and strong evidence exists that it is a resin breakdown product and a product of incomplete combustion (PIC) of many other POHCs.

Many thanks to Mr. Rehm for his knowledgeable discussion points and his compliments on the paper.

To Jon Peacy

We will address Mr. Peacy's comments in the order that he presented them:

1) Sorry about the abbreviation. We work with the jargon every day and perhaps, too often, take for granted a universal understanding of the terms. The table is a good idea and we will remember it for future papers.

2) The "subtle" variations in the sampling and analytical protocols refer, primarily, to differing GCMS interpretive techniques to accommodate the different POHCs burned in the various boiler tests. In addition, two separate TENAX cartridge designs were used during the program. However, resin mass (1.5 g) and gas throughput (20 l) were identical for each configuration.

3) The onsite gas chromatograph was used only to quantify gross hydrocarbon emissions which are reported as "C1 to C6 HC" in the tables on criteria emissions. Determination of POHC concentrations for DRE computation was conducted by GCMS analysis of the XAD-2 and TENAX resins.

4) No stopcock lubricant of any kind was used in the VOST or MM-5 trains. Train assemblies were fit and refit until leaks test were passed.

5) No comment.
(6) Good point. We may have seen some of this "catalytic" effect at Boiler No. 1 where the MMA DRE's decreased with the addition of the chlorinated "spike" (Table 5).

(7) It is true that in the four tests described in Table 5, 99.99% DRE was not achieved for methyl methacrylate (MMA) when the chlorinated spike was also burned. However, in the one test wherein MMA was burned as the only POHC (no chlorinated spike), 99.99% DRE was achieved. This was the test of most importance to the host facility since this was the waste normally burned at the facility.

(8) No comment.

(9) The goal of this testing program was not to select devices that would give high destruction efficiencies but to evaluate the ability of industrial process to destroy hazardous waste materials. Many such processes do, currently, or have proposed to, dispose of hazardous waste materials. In addition to industrial boilers and lime kilns, processes that have been tested or will be tested include cement kilns, aggregate kilns, steel making furnaces, batch asphalt plants, glass making plants, and brick making furnaces. Rotary kiln incinerators have been tested under a separate program to evaluate the ability of hazardous waste incinerators to comply with EPA's hazardous waste incinerator regulations. Rotary kiln incinerators for hazardous waste always have an afterburner after the kiln to destroy liberated organic materials. Rotary kiln incinerators are used to burn solid or semi-solid hazardous wastes. The liquid wastes that were burned in the boiler and kiln tests would most likely be burned in a liquid injection incinerator, not a rotary kiln.

(10) The authors are flattered that there is concern that Congress might use this paper as a basis to draft legislation. In fact, Congress drafts broad legislation which requires the Agency to study and regulate practices. The entire series of boiler and kiln tests will be used as one tool by the EPA in establishing a regulation for industrial processes burning hazardous wastes. Economic and risk assessment are components of the process. In addition, the Agency must consider (and, in fact, solicit) any other data that has a bearing on the issue. Any proposed regulations must be advertised in the Federal Register and public comment must be considered before a regulation is promulgated. The authors wish to point out that currently, anyone may burn hazardous waste in any boiler without a Federal permit since this process is not subject to any RCRA regulations. Of course, individual states and localities may regulate boiler disposal of hazardous wastes. In fact, many states have chosen to do just that. In addition, Federal, state, and local air pollution regulations may cover some aspects of boiler disposal of wastes.

The issue of "draft" reports is a difficult one to address. There is considerable tension between the needs to transfer current information to the technical community and to report and reference only approved and cleared source materials. The presented paper is one vehicle for achieving both goals in that current material can be presented through papers that have been subjected to the Agency's clearance procedure even though all reference material has not yet been cleared.

The authors wish to thank Mr. Peacy for taking the time to provide such a thorough and relevant discussion.