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RCRA TRIAL BURNS: ADVENTURES AT ROLLINS*

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Summary

The article discusses the origin of the Trial Burn concept and experiences with it. Details are presented on the development of a Trial Burn for a major hazardous-waste commercial incinerator, the analysis of feeds, the operating conditions and results. Problems encountered derived from analytical shortcomings are discussed. Repeat trials and continuing analytical problems are shown. Recommendations for research needs and continuity in the emissions permitted are discussed.

Introduction

The U.S. EPA has determined that *all* devices used to destroy hazardous waste by thermal destruction must undergo a rigorous testing process called "the trial burn". In this trial the incinerator must achieve the performance standards specified in 40 CFR 264.343, specifically these are that they:

1) must achieve a destruction and removal efficiency (DRE) of 99.99% for each principal organic hazardous constituent (POHC) designated. The exception being 99.9999% for PCBs and dioxin-contaminated material.
2) must demonstrate control of HCl emissions such that the larger part of either 1.8 kg/h or 1% of the HCl in the stack gas prior to entering any pollution control equipment is removed. This latter requirement could use further elaboration by the EPA.
3) must meet the particulate standard of 180 mg/dscm after certain corrections for oxygen are made.
4) then there is a statement that the operating requirements specified in the permit will be regarded as in compliance with this section. This again could use a little more discussion.

Trial burn development

This author's first experience with trial burns was when managing the U.S. EPA Combustion Research Facility (CRF) where a trial burn was required by

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the EPA Regional Office in Dallas, TX, as part of the official Resource Conservation and Recovery Act (RCRA) Part B permit process. The most intense, complicated, and sometimes very frustrating trial-burn experience was obtained while employed by Rollins Environmental Services (RES) at their Baton Rouge, LA, facility.

After some eight months of planning, reviewing, and negotiating, the RCRA Part B trial burn was first conducted at the facility on April 30 and May 1, 1987. The plan was designed to establish permit conditions for the incinerator as part of the U.S. EPA hazardous waste management regulations. The Louisiana Department of Environmental Quality (LDEQ) approved of the plan and was very active at the facility during the trial burn in a observation role. The 1987 test was designed to demonstrate over the course of 4 hours sampling done in triplicate the temperature, POHC feed rate, chlorine feed rate, metals feed rates, heat release rate and scrubber efficiency. Guidance provided by the Regional Office said that all conditions must be demonstrated simultaneously. This became very difficult to do when one is faced with the requirement to maximize feed rates, chlorine content, and at the same time demonstrate the lower acceptable operating temperature necessary for the required DRE. Something about the laws of nature came into play. The incinerator and all waste feed ports were sampled on a set schedule by an independent outside contractor, hired by RES but with the unofficial approval of the LDEQ. This was done to provide third-party unbiased results for this very important job of sampling and analyzing the system performance.

The incinerator tested is designed to receive waste from 8 different sources.

TABLE 1

Incinerables analysis

Parameter	Waste stream[a]							
	1	2	3	4	5	6	7	8
Btu/lb[b]	18,570	11,131	12,602	12,956	5,777	12,240	1,851	989
Wt.% chlorine	6.04	31.23	25.7	25.5	16.3	0.74	0.8	1.6
Density, g/ml	<1	<1	1.08	1.09	1.3	1.2	1.0	1.0
Viscosity, mPa·s	N/A	N/A	34.1	31.9	N/A	N/A	47.3	30
Ash @ 800°C	12.75	14.68	0.1	0.1	<0.1	2.1	2.2	2.2
Moisture	N/A	N/A	1.2	1.7	N/A	N/A	83.9	95
Flash point	N/A	<70	–[c]	–	–	–	–	–
Volatiles	N/A	N/A	98.7	98.7	31.1	7.1	89.6	96

[a]Waste description: 1 aluminium alkyls, 2 titanium tetrachloride, 3 liquid waste blend, 4 liquid waste eductor, 5 kiln solids, 6 kiln solids, 7 pumpable sludge, and 8 contaminated water.
[b]1 Btu/lb ≙ 2.3 kJ/kg.
[c]– None exhibited by sample.

TABLE 2

Metal analysis ($\mu g/g$)[a]

Element	Waste stream						
	3	4	5	6	7	8	9
Al	3.0	2.1	19.4	30.2	129	ND	–
Fe	196	218	176	14.5	1440	10	–
Mn	2.5	2.7	1.2	0.9	58	0.8	–
Mg	17.4	20.2	ND	5.0	175	45.1	–
As	ND	ND	ND	ND	ND	ND	0.9
Sb	ND	ND	ND	ND	ND	ND	ND
B	0.2	0.3	ND	ND	ND	0.9	–
Pb	ND	ND	ND	ND	2.8	ND	3.0
Se	ND	ND	ND	ND	ND	ND	ND
Tl	ND	ND	ND	ND	ND	ND	1.6
Ba	1.9	2.2	ND	ND	6.2	3.0	8.2
Be	ND	ND	ND	ND	ND	ND	ND
Cd	4.9	ND	ND	ND	ND	ND	ND
Cr	3.5	3.9	3.5	0.5	12.4	0.2	19.8
Co	ND	ND	ND	ND	19.6	0.7	–
Cu	6.7	7.6	2.7	0.4	32.4	0.5	1.5
Mo	5.2	3.8	ND	ND	ND	26	–
Ni	6.1	7.1	56.4	ND	8.3	8.7	4.2
V	ND	ND	ND	ND	600	ND	–
Sr	0.4	0.3	ND	0.3	ND	61.2	–
Sn	ND	ND	ND	ND	7.1	ND	–
Ti	ND	ND	ND	ND	17.8	0.3	–
Ag	ND	ND	ND	ND	21.6	ND	ND
Zn	4.7	4.9	ND	ND	215	2.2	13.8
Hg	ND	ND	ND	ND	0.4	ND	ND

[a]Due to high reactivity of streams 1&2, no analysis was possible.

For the 1987 trial burn 8 waste streams were used. Table 1 presents an analysis of the incineration parameters for each waste used. In Table 2 there is a detailed presentation of the metal analysis for each waste stream plus the soil used to supplement the kiln solids during the trial burn.

In addition to the known metals content for each waste, except for the 2 highly reactive streams, the kiln solids (soil) was spiked with known amounts of 3 heavy metal species. The concentrations were preweighed so as to yield the following final concentrations for each fiber pack fed:
Test 1: 1000 ppm Cd, 500 ppm Pb, and 25 ppm Hg;
Test 2: 500 ppm Cd, 250 ppm Pb, and 15 ppm Hg;
Test 3: 2000 ppm Cd, 1000 ppm Pb, and 50 ppm Hg.

An attempt was made to track the metals throughout the incineration process. A metals balance was calculated but was inconclusive.

TABLE 3

Waste feed rates during trial burn

Waste feed (lb/h)	Test		
	1	2	3
Stream 1	556	516	444
Stream 2	1,653	1,062	984
Stream 3	2,831	3,240	3,294
Stream 4	129	262	83
Stream 5	717	714	778
Stream 6	638	629	664
Stream 7	963	1,554	1,462
Stream 8	1,456	1,824	1,860
Stream 9	3,186	3,207	3,269
Total feed	12,129	12,972	12,838
Chlorine, lb/h	1,994	1,959	1,948
Chlorine as % of feed	16.4	15.1	15.2

[a]Stream 9 is given as pounds of dirt/h.

TABLE 4

Operating conditions

Monitored parameter	Test		
	1	2	3
Kiln temperature, °F	1,788	1,830	1,864
Afterburner temp., °F	2,217	2,116	2,106
Afterburner draft, "H_2O	0.84	0.91	0.80
Stack CO, ppm	2.4	2.4	3.5
Afterburner oxygen, %	9.9	9.5	10.0
Condenser CO_2 %	8.2	7.7	6.8
Quench chamber temp., °F	171	171	170
Scrubber H_2O flow, gpm	494	498	496

In Table 3 we see the waste feed rates observed during the trial burn. Table 4 presents the operating conditions based on averages of readings taken over the course of the trial burn duration for each test which was four hours. Table

TABLE 5

Stack gas analysis

Parameter	Test		
	1	2	3
POHC, %DRE			
Carbon tetrachloride	99.9997	99.99992	99.99991
1,2-Dichlorobenzene	>99.9997	>99.99997	>99.99997
Trichloroethylene	99.995	99.997	99.998
Hydrogen chloride			
Emission rate, lb/h	<0.22	<0.193	<0.235
Removal efficiency, %	99.985	99.9909	99.9889
Particulate emission			
Grains/dscf @ 7% O_2	0.0241	0.0188	0.0086
Gaseous emissions, lb/h			
Carbon monoxide	0.657	0.44	1.112
Total hydrocarbons	0.20	0.142	0.099
Nitrogen oxides	28.0	22.5	26.7
Sulfur oxides	>16.8	26.9	30.9
Carbon dioxide, vol.%	7.4	7.9	7.8
Oxygen, vol.%	11.0	10.6	11.0

TABLE 6

Percent ash collected for kiln

Test	Ash loading to kiln (lb)	Ash collected (lb)	% Ash collected
1	7204.9	4860	67.45
2	7255.3	4336	59.76
3	7250.4	3964	54.67

5 presents the stack gas analysis observed during the trial burn and Table 6 presents the percent ash collected based upon ash loading rate to the kiln.

Due to the public concern over dioxins and furans, the trial burn incorporated the analysis of these compounds, limited to the 2,3,7,8-isomers of each.

TABLE 7

Chlorinated dioxin/furan analysis of stack gas (ppbv, dry)

Compound	Test[a]		
	1	2	3
2,3,7,8-TCDD	0.0000018	<0.000000136	<0.00000114
Total TCDD	0.0000025	0.0000678	<0.00000578
1,2,3,7,8-PCDD	<0.00000292	<0.000000429	<0.000000699
Total PCDD	0.00000149	<0.000000429	0.00000123
2,3,7,8-TCDF	0.00000198	<0.00000167	0.00000288
Total TCDF	0.0000434	0.00000714	0.00000527
1,2,3,7,8-PCDF	0.00000223	<0.000000192	0.000000646
Total PCDF	0.0000234	0.00000192	0.00000302

[a]For purposes of comparison, the U.S. EPA and several foreign governments, namely, Sweden, have established an emission level for TCDD as TCDD equivalents using a procedure established by Eadon. A 0.5 ng/m^3 lower limit compares to the RES (LA) result from test burn #1 of 0.03 ng/m^3, test burn #2 of 0.003 ng/m^3 and test burn #3 of 0.005 ng/m^3. This translates to at least 10 times less TCDD equivalents observed in the RES (LA) test burn than is accepted by EPA as a safe level.

These results are presented in Table 7 with a brief discussion of the meaning of the results.

Trial burn problems

As with all highly visible important projects it seems Murphy enters the scene at the most critical points to interject his laws of frustration. (If anything can go wrong, it will.) The 1987 trial burn received a visit from Murphy at several critical points in the process. After all the samples were collected, chain-of-custody established, data charts reviewed, analysis performed, and the report submitted the following items appeared that represented problems:

(1) The contract lab conducting the Volatile Organics Sampling Train (VOST) analysis had tubes break on samples from 2 different tests. To compound this unfortunate event, the contractor hired to collect the VOST samples, ENTROPY, collected only 3 tubes for each test, the bare minimum required by EPA to present a statistically sound result. Subsequent discussions with several EPA officials resulted in frustration.

(2) During preparations for the trial burn the incinerator underwent extensive maintenance. It so happens that during this time new thermocouples were installed in the afterburner area that is used to present the operating temperature used for permit compliance. However, the thermocouple was inadvert-

ently not connected to the hard copy recorder in the control room and the problem went unnoticed until the charts were reviewed by the LDEQ.

(3) Even though the state made an official pre-trial burn inspection of the incinerator and the control room, they did not realize the facility utilized an eight-pen multi-color recorder for the liquid feed rates. During the review of the test results the LDEQ made the comment that is was very hard to integrate each pen so as to obtain the required time-average feed rate over the course of each test.

(4) After reviewing the calculated results for heat release and overall feed rate, the management of Rollins felt the incinerator could have obtained higher rates and thus agreed to conduct a second trial burn in the spring of 1988.

1988 Trial burn

The repeat trial burn included many of the priority pollutant metals again spiked in with the kiln solids, basically added to soil. It also included a different approach to obtaining maximum heat release and maximum feed rates for waste streams. Another change from the 1987 trial burn was the conduct of different feed rates and different heat releases over test period 2 h in duration each, 3 per test set. During the 1987 trial burn comments received from the regulators required everything to be demonstrated in 1 set of tests. This turned out to be bad advice.

The 1988 trial burn was contracted to ALLIANCE TECHNOLOGIES after their very acceptable performance at the RES facility in Texas. Again the trial burn was physically observed by several representatives from LDEQ and EPA. After a brief delay initially due to a leak in one of the stack samplers the trial burn went very smooth until, as we will see, the results were reviewed.

At the request of the LDEQ, or better yet the insistence of, other halogens along with chlorine were introduced during the trial burn. All of the halogens were spiked in various waste feeds to demonstrate the effectiveness of the existing scrubber to remove them prior to discharge of stack gases to the environment. The additional metal species were also strongly recommended by LDEQ representatives because they understood EPA was getting ready to issue new incinerator regulations that would place limits on these metals in the feed or as a percent of the feed. At this writing these regulations have not even been proposed in the Federal Register yet!

Results

As fate would have it, the repeat trial burn had a VOST result that was clearly a test outlier based on the results of all other samples taken and analyzed for this particular test run. However, after repeated appeals and presentations to the LDEQ officials, the VOST results were deemed unacceptable

TABLE 8

DRE results for 1988 test[a]

Run	Sample no.	Carbon tetrachloride		Trichloroethylene		*O*-Dichlorobenzene	
		ng detected	DRE (%)	ng detected	DRE (%)	ng detected	DRE (%)
1	1A	19100	99.96946	2037	99.99638	<10000	>99.99997
	1C	102	99.99984	<25	99.99996		
	1	151	99.99984	137	99.99983		
2	2A	68	99.99989	<25	99.99995	<10000	>99.99998
	2B	47	99.99992	<25	99.99995		
	2C	43	99.99993	<25	99.99995		
3	3A	74	99.99990	<25	99.99997	<10000	>99.99996
	3B	65	99.99992	<25	99.99997		
	3C	29	99.99996	<25	99.99997		

[a]Afterburner temperature is 1832-1840 °F (1000-1005°C).

and the company advised that yet another trial burn would have to be conducted to demonstrate 99.99% DRE for the volatile organic compounds selected. Here Murphy entered the picture in that Alliance collected 4 tubes for each test run, but for run 1 they had a tube broken in shipment and the first tube analyzed from this run was the one that was either contaminated or defective in some way as the remaining results were all very good as can be seen in Table 8.

A lot of second guessing was done but final "guidance" coming from EPA was that if one fails, all fail and the test has to be redone. This was not in any official EPA guidance or Federal Register publication, but review of an advanced copy of the "new" incinerator regulations makes specific reference to this situation. Seems there might be some hindsight in the new regs!

The third trial burn was conducted in the fall of 1988 for VOST only. The results were very acceptable and within all trial burn requirements, both official and unofficial! The Part B permit process has begun and some public meetings have been held in the Baton Rouge area. As expected outside petitioners have made disruptive attempts to delay or terminate these hearings, but to the LDEQ's credit the process has moved forward.

Recommendations

In spite of its stated position of not interfering with state control of hazardous waste management programs the EPA still controls the money and has the final say on all test results and permits. EPA should have established a national program of standardized RCRA trial-burn testing, or at least some form of it,

by using a predetermined mixture of specific organic compounds. In this way EPA would have a much more useful data base to use for future regulatory development, since all tests were based on similar materials. EPA could have been a lot more helpful, if they had published guidance for conducting trial burns developed by a contractor familiar with the pitfalls of the trial burn. This guidance could have stipulated what was required to be demonstrated, what was acceptable and what was not, how the test should be conducted and what the results will be used for in developing the final permit. Instead, the EPA has tended to further polarize the relationships with state programs. EPA has played the role of second guesser to such an extent many states try to outguess them or try for the "one up men's ship" award. Caught in the middle of this are the companies that must comply with the regulations and are being asked to do things in "anticipation" to new regulations.

If an incinerator is being tested for destruction of hazardous waste, it must meet all the same test conditions in South Carolina that it has to meet in South Dakota. If not then one or both are surly not protective of human health and the environment. *No* incinerator should be permitted to operate with regulated hazardous waste without a scrubber system capable of meeting all stationary source standards and RCRA emission standards. Even if the management of the facility say they will not take wastes requiring a scrubber, the system should not be permitted until such time a scrubber is added.

What the hazardous waste management industry needs is new, state-of-the-art incinerators with the best demonstrated available technology (BDAT) for scrubbers that incorporates available process controllers and some form of oversight by the responsible agencies, even if it involves remote monitoring of operations by CRT.

In general there is not nearly enough information available, or what is is not clear, to help a company and the state agency to adequately prepare to conduct a trial burn, and the results can be very expensive and time consuming when events transpire such as the VOST situation. Some upfront dialogue on sample requirements might have prevented the problem in the very first trial burn.

Some way, some how, the federal EPA and the state agencies must learn to work better and closer for everyone's benefit.