2,3,7,8 TCDD Equivalent Emissions from Long Wet or Long Dry Cement Kilns Burning Hazardous Waste in the United States During Trial Burns

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Effective August 21, 1991 the United States Environmental Protection Agency (USEPA) adopted the Boiler and Industrial Furnace (BIF) rules which govern cement kiln operations burning hazardous waste as fuel. BIF set limits on cement kiln emissions of metals, chloride and organics. Testing was required by August 21, 1992, and if, during the course of testing, the air pollution control device (APCD) in use at the cement kiln recorded temperatures between 450°F and 750°F, then 2,3,7,8 TCDD testing was necessary. The 2,3,7,8 TCDD testing was mandated due to a lack of data available from cement kilns for these emissions and USEPA concerns arising in the review of stack test data from municipal waste combustion units.

Approximately 15 dioxin emissions tests were performed at cement plants. The emissions tests were developed to meet EPA criteria and were designed to be under worst case conditions. A worst case scenario would be defined as maximum waste fuel being burned with the highest allowable chlorine content in addition to the maximum temperature that would be encountered in the APCD. Table 1 lists the results of the emissions tests.

Upon compilation of this data, an evaluation was performed for a correlation between HCl and Cl_2 emissions and 2,3,7,8 TCDD emissions. Wide variation in the HCl and Cl_2 emissions exhibited. No correlation could be obtained between chlorine and 2,3,7,8 TCDD emissions. However, a trend was observed between the kiln exit temperature and dioxin emissions. Higher temperatures were associated with the higher 2,3,7,8 TCDD emissions.

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The database was sorted by descending temperatures. Subsequent to the sort, the data was plotted (Plot 1) for all long wet or long dry kiln plants in the U.S. The dioxin emissions appear as a function of stack exit temperature. The dioxin emissions show a corresponding decrease in concentration as a function of temperature when it drops below approximately 585°F with significant dioxin emissions occurring at temperatures in the 600°F to 750°F range. This corresponds with EPA's concerns about dioxin emissions increasing as a function of stack or APCD temperature increase. Subsequent to this finding, we chose one plant in the U.S. that had eleven tests performed under varying conditions yielding results exhibiting a range of temperatures vs. dioxin emissions. Table 2 outlines the results for that particular test facility. The corresponding dioxin emissions are presented for those emissions tests, during which a similar type of curve is observed. Higher dioxin emissions occur during the higher temperatures (greater than 450°F and increasing to 495°F) with a significant decrease in dioxin emissions occurring below 420°F.

In conclusion, temperature seems to be a contributing factor to dioxin formation. The lower temperature in the APCD may result in lower dioxin emissions being formed with subsequent lower emissions exiting the stack. If temperatures can be controlled below 450°F, there may be a reduction in dioxin emissions from cement kilns burning or not burning hazardous waste fuels.

1USEPA. 40 CFR 266: Burning of hazardous waste in boilers and industrial furnaces. *Federal Register* 1991;56:35
2Gossman Consulting. Commercial BIF compliance test results. Hampshire, Illinois. 1993.
3Gossman Consulting. Trial burn and certification of compliance test report. Holly Hill, South Carolina. August 1992.
4Gossman Consulting. Trial burn and certification of compliance test report. Clarksville, Missouri. July 1992.
5USEPA. Boiler and industrial furnace regulations: certification of compliance for Southdown, Inc. Knoxville, Tennessee. June 25, 1992.
6Mittelhauser Corporation. Boiler and industrial furnace regulations: certification of compliance for National Cement Company. Lebec, California. August 1992.
7Radian Corporation. Boiler and industrial furnace regulations: certification of compliance for Lafarge Corporation. Alpena, Michigan. August 1992.
8Radian Corporation. Boiler and industrial furnace regulations: certification of compliance for Lafarge Corporation. Fredonia, Kansas. August 1992.

Table 1. 2,3,7,8-TCDD Equivalent Dioxin Variation with Temperature for One Facility

KILN EXIT TEMP (°F)	GAS FLOW RATE DSCFM	DUST LBS/HR	HCl LBS/HR	Cl_2 LBS/HR	DIOXIN 2,3,7,8 EQ GRAM/SEC	DIOXN CONC 2,3,7,8 EQ NG/DSCM
759	97300	45.7	12.1	0.1	2.11E-06	3.685E+01
724	40900	12.8	40.1	0.3	1.12E-06	4.653E+01
640	298000	70.5	62.3	0.6	6.14E-06	3.501E+01
616	96200	47.0	13.0	0.4	3.25E-07	5.741E+00
604	133000	53.8	48.8	3.0	1.95E-06	2.491E+01
583	113000	0.7	0.9	0.1	1.41E-09	2.120E-02
583	112000	0.9	1.5	0.1	1.01E-09	1.532E-02
563	150000	36.4	119.0	0.4	1.59E-07	1.801E+00
541	43000	12.1	7.2	0.2	1.28E-07	5.058E+00
516	124000	76.4	0.5	0.0	2.83E-07	3.878E+00
516	135000	8.9	17.6	1.2	2.45E-08	3.084E-01
503	258000	17.7	12.2	1.6	1.69E-09	1.113E-02
503	335000	17.2	4.8	7.0	1.39E-08	7.051E-02
500	243000	69.3	0.1	0.0	8.29E-08	5.797E-01
499	9260	4.4	55.7	2.0	2.01E-11	3.688E-03
497	55000	15.7	33.8	0.1	2.39E-07	7.384E+00
494	63400	15.0	0.7	0.0	1.07E-10	2.868E-03
491	56800	18.0	72.7	1.2	1.93E-08	5.774E-01
451	103000	43.3	11.1	0.2	2.26E-09	3.728E-02

DIOXIN VS TEMPERATURE

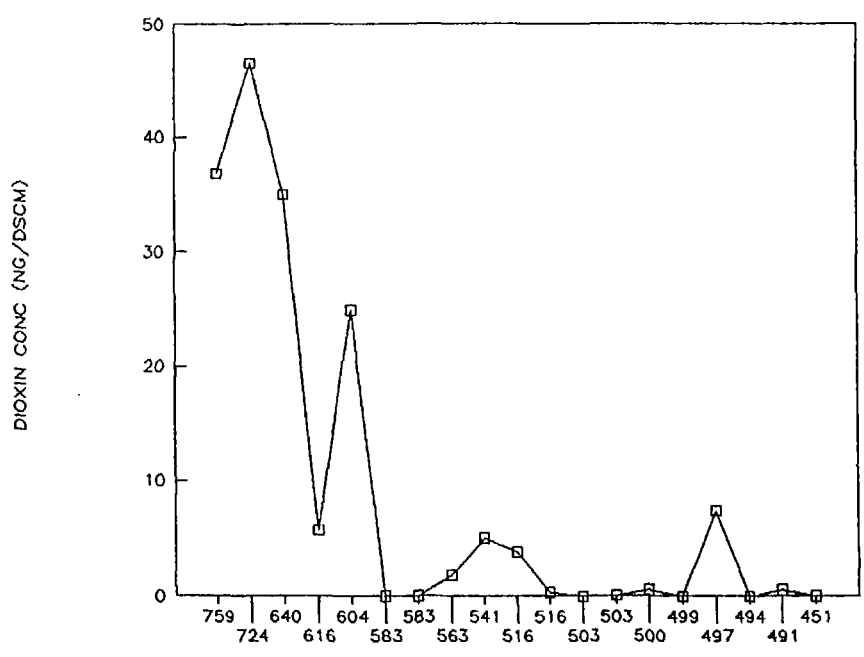

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Table 2. 2,3,7,8-TCDD Equivalent Dioxin Variation with Temperature for Multiple Facilities

TEST	DIOXIN GRAMS/HR	TEMP	OXYGEN	THC	WASTE FUEL	DIOXIN NG/DSCM
HHH713B	4.77OE-04	495	7.0	16.0	11.5	2.00795
HHH713C	5.270E-04	495	7.2	16.0	11.5	2.47413
HHH713A	3.380E-04	488	7.0	16.0	11.5	1.42989
HHH613A	1.308E-5	420	7.0	4.0	0.0	0.05511
HHH613B	5.865E-06	415	7.0	4.0	0.0	0.02527
HHH711C	5.763E-05	373	10.1	15.0	6.0	0.28824
HHH711B	2.625E-05	371	10.1	15.0	6.0	0.13505
HHH712B	2.436E-06	370	10.3	14.5	0.0	0.0116
HHH712C	4.871E-06	366	10.3	14.5	0.0	0.02436
HHH712A	3.765E-06	363	10.3	14.5	0.0	0.01796
HHH711A	8.132E-06	362	10.1	15.0	6.0	0.03835