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SUMMARY

ROTARY KILN INCINERATOR ENGINEERING TESTS ON SIMULATED TRANSURANIC WASTES FROM THE IDAHO NATIONAL ENGINEERING LABORATORY

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Thousands of metric tons of waste, contaminated with Transuranic (TRU) radionuclides, predominantly plutonium, have been stored or buried at the Idaho National Engineering Laboratory (INEL). The stored waste, composed of both combustible and noncombustible materials, will be retrieved and shipped to the Waste Isolation Pilot Plant (WIPP) for permanent disposal. That portion of the waste which does not meet the WIPP waste acceptance criteria will be processed. The selected processing option for the Process Experimental Pilot Plant (PREPP) currently under design includes incineration for removal of combustibles and liquid, thereby reducing the volume, and then cementing for immobilization of the incinerator fines. Waste, packaged in drums and wooden boxes, will be shredded prior to incineration. The shredded waste, containing a large percentage of noncombustibles and metal, will be charged to the incinerator. The combustibles will be burned, and the remaining ash and noncombustible material from the incinerator will be immobilized by cementing and then packaged for disposal at WIPP.

During 1981, a detailed systems' evaluation, using the Kepner-Tregoe (K-T) decision analysis method, was performed on incineration alternatives. Rotary kiln incineration was selected as being most applicable for INEL TRU waste processing. However, further evaluation and testing were necessary to design and construct a radioactive waste incineration system for PREPP.

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A series of tests, initiated by EG&G Idaho, Inc., for the Department of Energy, were conducted on an existing rotary kiln incinerator located at the Colorado School of Mines Research Institute (CSMRI) in Golden, Colorado. During June 1982, nine incineration tests were performed on simulated TRU waste mixtures from the INEL. Approximately 10,100 kg of simulated (non-TRU) waste from the INEL were processed during the nine tests (see Table 1).

The tests were conducted on a 0.9 m (ID) by 9.1 m long rotary kiln, equipped with a secondary afterburner. The kiln contained a high alumina cast refractory liner and was fired with natural gas to temperatures approaching 1100°C. The secondary afterburner was operated at 900° to 1100°C. The kiln normally rotated at 1 RPM at a longitudinal slope of 1.2°. A baghouse was utilized downstream of the incineration system for collection of particulate prior to release to the atmosphere.

The purpose of the engineering tests was to obtain design information with respect to waste feeding characteristics, off-gas and end-product compositions, fuel and air requirements, kiln rotation rates, incinerator temperatures, and mass energy balances. Various off-gas measurements and chemical analyses on the incinerator end-product were a part of the test scope. Off-gas measurements included: flow rates; temperatures; particulate loading; particle size distribution; elemental analyses; and gaseous sampling for NO_x, HC, SO_2, H_2O, CO, HCl, O_2, and CO_2. Incinerator end-product samples were analyzed for particle size distribution, unburned combustibles, and up to 45 specific elements. Incinerator operating parameters (temperature, fuel usage, feed rate, etc.) were also documented.

The results of the testing indicated that complete combustion was achieved for the combustible material in the waste, even in the presence of large percentages (>80%) of noncombustibles and metal; volume reduction percentages ranged from 71 to 96%. The incinerated ash product was also found to be suitable for immobilization by cementing. Off-gas emissions varied considerably, depending on the waste mixtures; however, all gaseous emissions and particulate loading appear tolerable and can be controlled with state-of-the-art off-gas treatment technology (see Table 2).

TABLE 1. INCINERATOR TEST RUN SUMMARY

RUN NO.	KILN FEED WASTE DESCRIPTION[1]	FEED RATE (Kg/h)	RESIDENCE TIME (Min)	PRODUCT RATE (Kg/h)	VOLUME REDUCTION (%)	AVERAGE KILN TEMPERATURE (°C)	METAL CONTENT OF PRODUCT (Wt %)
1	Metal-Filled Box	152	86	122	71	948	[2]
2	Combustible-Filled Drum	89	70	46	96	1072	66
3	Average Waste	154	75	86	85	987	84
4	Inorganic Sludge	147	∿60	43	94	876	45
5	Inorganic Sludge/ Average Waste	163	60	64	89	924	63
6	Average Waste/ High Lead	147	∿75	73	90	889	84
7	Metal-Filled Box	155	∿85	115	71	1047	92
8	Combustible-Filled Drum/High Kiln RPM	97	60	37	93	882	84
9	Organic Sludge	48	72	10	77	832	79

[1] Tests 1 through 7 and 9 ran at 1 rpm; Test 8 ran at 2 rpm.

[2] No data obtained.

TABLE 2. OFF-GAS MONITORING RESULTS

WASTE DESCRIPTION	OFF-GAS CONCENTRATION RANGES [1]										
	H_2O (%)	O_2 (%)	CO_2 (%)	CO (%)	N_2 (%)	HCl (PPM)	HC (PPM)	SO_2 (PPM)	NO (PPM)	H_2SO_4 (PPM)	Particulate loading (g/dscm)[2]
Metal-Filled Box	4.6-8.5	13.0-14.6	3.4-4.8	0.0	81.6-82.6	20.7	3-730	1.1-1.8	5-899	0.5	0.5-1.8
Combustible-Filled Drum	11.5-13.5	4.0-10.8	7.8-10.8	0.0	83.4-84.6	131.9	22-280	175-178.3	4-177	1.6-2.0	1.4-1.8
Average Waste	2.8-8.8	9.8-15.0	3.4-8.0	0.0-0.2	81.0-83.0	88.9-123.0	3-430	3.6-18.8	3-470	0.2-3.6	0.7-1.8
Inorganic Sludge	11.8-12.8	12.0-12.8	4.6-5.0	0.0	82.4-83.2	64.6	4	1.0	25-782	0.1	0.9-1.2
Inorganic Sludge/ Average Waste	11.8-13.5	9.6-12.6	4.8-6.6	0.0	82.4-83.8	25.7-187.4	4-57	21.7	4-410	3.0	1.4-3.2
Average Waste/ High Lead	7.6-11.0	7.8-11.8	4.4-8.6	0.0	83.6-83.8	111.5	5	9.3	25-390	0.5	3.7-4.1
Combustible Filled Drum/ High Kiln RPM	7.3-8.1	10.2-15.4	2.8-6.8	0.0	81.8-83.0	26.9	3	6.3	0-232	0.3	0.9-2.0
Organic Sludge	9.0-15.3	12.0-14.8	3.0-5.0	0.0-0.2	82.2-83.0	68.9-337.2	50	34.5	0-60	0.7-1.2	3.0-3.7

[1] Single values indicate limited sampling results or no apparent range of concentration during sampling.

[2] Grams per dry standard cubic meter of off-gas.

REFERENCES

(1) M. G. Pattengill, F. A. Brunner, J. L. Fasso, S. R. Mitchel, and R. T. Praskac, Rotary Kiln Incinerator Engineering Tests on Simulated Transuranic Wastes from the Idaho National Engineering Laboratory, Final Report, EGG-2223, September, 1982.