COMBUSTION OF HAZARDOUS WASTES

Sampling and Analysis Methods

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Foreword

Sampling and analysis methods for the measurement of hazardous constituents found in the influent and effluent streams at hazardous waste incineration facilities are described in this book. The need for such methods is based on promulgated EPA regulations which would ensure the combustion of hazardous wastes in an environmentally responsible manner.

The primary criterion upon which the operational specifications are based is the destruction and removal efficiency (DRE) of the incinerator. The DRE value, defined in terms of waste input and stack output levels of designated principal organic hazardous constituents (POHCs), must be equal to or greater than 99.99%. The book addresses the sampling and analysis methods to be used when measuring the levels of the POHC(s) in the various streams of an incinerator facility (inlet waste, stack gas, process water, fly ash, and bottom ash) for the purpose of calculating a DRE value for the incinerator.

Included in the book are concise summaries stating recommended methods, types of samples and specific analytes to which a method applies, a brief description of the method and instrumentation and operating conditions.

The information in the book is from *Sampling and Analysis Methods for Hazardous Waste Combustion (First Edition)*, prepared by Judith C. Harris, Deborah J. Larsen, Carl E. Rechsteiner, and Kathleen E. Thrun of Arthur D. Little, Inc. for the U.S. Environmental Protection Agency, December 1983.

The table of contents is organized in such a way as to serve as a subject index and provides easy access to the information contained in the book.

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NOTICE

Abbreviations and Glossary of Terms

AAS	Atomic Absorption Spectroscopy
Accuracy	The difference between a single value or the mean of a set of results and the value which is accepted as the correct (true) value for the quantity measured.
AFID	Alkali Flame Ionization Detector
amu	Atomic Mass Unit (1 amu = 9.314×10^8 eV)
APCD	Air Pollution Control Device
Appendix VIII	Hazardous Constituent List (40 C.F.R. Part 261)
ASTM	American Society for Testing and Materials
atm	Atmosphere (1 atm = 1.013×10^5 Pa = 760 Torr)
Btu/lb	British Thermal Unit per Pound (1 Btu/lb = 2.3244×10^3 J/Kg = 0.556×10^{-3} kcal/g)
Btu/h	British Thermal Unit per Hour (1 Btu/h = 2.931×10^{-1} W)
C	Corrosivity Test--RCRA Characteristic
C.F.R.	Code of Federal Regulations
CI	Chemical Ionization Mode (Mass Spectrometry)
cm	Centimeter (10^{-2}m)
CO	Carbon Monoxide
Coliwasa	Composite Liquid Waste Sampler
CV	Coefficient of Variation
2,4-D	2,4-Dichlorophenoxyacetic acid
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene

DDT	Dichlorodiphenyltrichloroethane
D.E.S.	Diethylstilbestrol
DFTPP	Decafluorotriphenylphosphine
Directed Analysis	Qualitative confirmation of compound presence and identity. Also, quantitative data of known quality for a set of constituents that might reasonably be expected to be present in the waste based on professional judgment and/or the results of proximate and survey analyses.
DNPH	Dinitrophenylhydrazine
DRE	Destruction and Removal Efficiency--the measure of the mass emission rate of a principal organic hazardous constituent (POHC) in the output stack gas versus the mass feed rate of the same POHC in the influent waste.
dscf	Dry Standard Cubic Foot (1 dscf = 2.8317×10^{-2} dscm)
dscm	Dry Standard Cubic Meter
E	Extraction Procedure Toxicity Test--RCRA Characteristic
ECD	Electron Capture Detector
EI	Electron Impact Ionization Mode (Mass Spectrometry)
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
ESP	Electrostatic Precipitator
eV	Electron Volt (1 eV = 1.602×10^{-19} J)
Excess Air	Air flow rate above that required to achieve theoretically complete combustion.
FPD	Flame Photometric Detector
ft	Foot (1 ft = 3.0480×10^{-1} m)
FT-IR	Fourier Transform-Infrared Spectroscopy
g	Gram (10^{-3} kg)

gal	Gallon (1 gal = 3.785×10^{-3} m^3)
GC	Gas Chromatography
GC/AFID	Gas Chromatography/Alkali Flame Ionization Detector
GC/ECD	Gas Chromatography/Electron Capture Detector
GC/MS	Gas Chromatography/Mass Spectrometry
GC/MS/DS	Gas Chromatography/Mass Spectrometry/Data System
GC/NPD	Gas Chromatography/Nitrogen-Phosphorus Detector (Alkali Flame Ionization Detector)
GC/TD	Gas Chromatography/Thermionic Detector
gr	Grain (1 gr = 6.48×10^{-5} kg)
GRAV	Gravimetric Analysis
h	Hour
HCl	Hydrochloric Acid
HPLC	High Performance Liquid Chromatography
HPLC/UV	High Performance Liquid Chromatography/ Ultraviolet Spectroscopy
I	Ignitability Test--RCRA Characteristic
ICAP	Inductively Coupled Argon Plasma Atomic Emission Spectroscopy
I.D.	Internal Diameter
in	Inch (1 in = 2.54×10^{-2}m)
IR	Infrared Spectroscopy
Isokinetic Sampling	Collection of stack gas samples under conditions such that the linear velocity of gas through the sampling nozzle is equal to that of the undisturbed gas stream at the sample point.
Isothermal	With or at equal temperatures.
J	Joule

kcal	Kilocalorie (1 kcal = 4.184×10^3 J)
K-D	Kuderna-Danish Evaporative Concentrator
kg	Kilogram (10^3 g)
L	Liter (1L = 1.00×10^{-3} m^3)
LC	Liquid Chromatography
LC/EC	Liquid Chromatography/Electrochemical Detector
LOD	Loss on Drying
LOI	Loss on Ignition
LRMS	Low Resolution Mass Spectrometry
µg	Microgram (10^{-6} g)
µL	Microliter (10^{-6} L)
µM	Micrometer (10^{-6} m)
m	Meter
m^3	Cubic Meter
M5	Method 5 Sampling Train
mg	Milligram (10^{-3} g)
min	Minute (1 min = 60 sec)
mL	Milliliter (10^{-3} L)
mm	Millimeter (10^{-3} m)
MM5	Modified Method 5 Sampling Train
MS	Mass Spectrometry
mV	Millivolt (10^{-3} V)
MW	Molecular Weight
NDIR	Non-Dispersive Infrared Analyzer
NFPA	National Fire Protection Association

ng	Nanogram (10^{-9}g)
nm	Nanometer (10^{-9}m)
NO_x	Nitrogen Oxides (NO, NO_2, etc.)
N.O.S.	Not Otherwise Specified
O.D.	Outer Diameter
Opacity	Measurement of the optical density of stack gas emissions of an incinerator.
Pa	Pascal
PCB(s)	Polychlorinated Biphenyl(s)
POHC(s)	Principal Organic Hazardous Constituent(s)
P_2O_5	Phosphorus Pentoxide
ppb	Part Per Billion One part in 10^9. For gaseous mixtures, a volume:volume basis is typically used and 1 ppb is on the order of 1 $\mu g/m^3$: $\mu g/m^3 = ppb \times \frac{RT}{MW}$ where RT = 22.4 L/mole at 0° and 1 atm = 24.5 L/mole at 25° and 1 atm For liquid materials, a weight:volume basis is most commonly used and 1 ppb = 1 µg/L ($\approx$ 1 µg/kg for liquids with density $\approx$ 1). For solid materials, a weight:weight basis is most commonly used and 1 ppb = 1 µg/kg.
ppm	Part Per Million One part in 10^6 (see ppb). 1 ppm $\approx$ 1 mg/m^3 gaseous streams 1 ppm = 1 mg/L liquid streams 1 ppm = 1 mg/kg solid streams
Precision	The reproducibility of measurements within a set of independent replicate determinations. The relative standard deviation expressed as a percentage of the mean is a common measure of precision.

Proximate Analysis	Provides data relating to the physical form of the waste and provides an approximate mass balance as to the composition of the waste.
psi	Pounds Per Square Inch (1 psi = 6.8948×10^3 Pa)
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
R	Reactivity Test--RCRA Characteristic
RCRA	Resource Conservation and Recovery Act of 1976
RI	Refractive Index Detector
rpm	Revolutions Per Minute
RSD	Relative Standard Deviation
SASS	Source Assessment Sampling System
s	Second
SCFM	Standard Cubic Feet per Minute
SD	Standard Deviation
Segregation	Heterogeneity in a sample
Semivolatiles	Organic species with moderate vapor pressure sufficient to allow analysis by gas chromatography, generally have boiling points of 100°C or higher, molecular weights of 100-400, seven to twenty carbon atoms per molecule.
SO_x	Sulfur Oxides (SO_2, SO_3)
Sparging	Removal of the volatile constituents of a sample by bubbling an inert gas stream through the sample.
Surrogate	A known compound added to a sample which is chemically similar to a POHC of interest so that an estimate of the accuracy of the analytical measurement and an assessment of the overall efficiency of the analytical procedures can be made.

Survey Analysis	Provides an overall description of the sample in terms of the major organic compounds and major inorganic compounds that are present in the sample. The analysis provides a qualitative description of the overall chemistry of the sample.
T	Transmittance
2,4,5-T	2,4,5-Trichlorophenoxyacetic acid
TCD	Thermal Conductivity Detector
TCDD(s)	Tetrachlorodibenzo-p-dioxin(s)
TCO	Total Chromatographicable Organics
TGA	Thermogravimetric Analysis
THEED	Tetrahydroxyethylenediamine
TLC	Thin Layer Chromatography
TOC	Total Organic Carbon Content
TOX	Total Organic Halogen Content
2,4,5-TP	2,4,5-Trichlorophenoxypropionic acid
TSDF	Hazardous Waste Treatment, Storage, and Disposal Facility
UV	Ultraviolet Spectroscopy
V	Volt
VOA	Volatile Organics Analysis
Volatiles	Organic species with appreciable vapor pressure at room temperature, generally have boiling points of 100°C or lower, molecular weights less than 200, one to seven carbon atoms per molecule.
W	Watt
W_{in}	Mass feed rate of one POHC in the waste stream feeding the incinerator.
W_{out}	Mass emission rate of the same POHC (see W_{in}) present in exhaust emissions prior to release to the atmosphere.

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