

Investigating the Fate of Dioxin in Ash in Landfills

Presented at the

Great Lakes Binational Toxics
Strategy 2002 Stakeholder Forum

May 30, 2002

Windsor, Ontario Canada

Prepared by

Richard F. Anderson, Ph.D., Consultant

Patrick Dyke, PD-Consulting, UK

Investigating the Fate of Dioxin in Ash in Landfills

This research is sponsored by the
Integrated Waste Services
Association (IWSA)

This presentation is intended to
provide an overview of work that
is still in process

Investigating the Fate of Dioxin in Ash in Landfills

Research Context and Question

Municipal Waste Combustors (MWCs) have achieved a dramatic reduction (over 99.99%) in dioxin air emissions through a combination of good combustion practices, application of effective flue gas cleaning equipment and temperature controls.

- It has been suggested that the decrease in air emissions has resulted in an increase in dioxins in the ash residue.
- It has further been suggested that dioxin in ash in a co-fill environment is susceptible to leaching as there may be organic liquids present in the co-fill that will act as "solvents".

Investigating the Fate of Dioxin in Ash in Landfills

Research Context and Question

Statement of Concern:

MWC ash is disposed of in combined form in US landfills. The air emissions of dioxin from MWCs has declined and there has been some increase in the dioxin concentrations in ash. If air emissions are reduced and ash concentrations might be rising but the ash is well managed, then one remaining potential exposure route to humans and the environment could be from unmanaged or mismanaged landfill leachate.

Research Question:

Is there evidence in the literature and/or unpublished data that indicate dioxin leaches from combined ash disposed in a cofill?

Dioxins

- PCDD/PCDF (dioxins and furans)
 - 210 congeners
 - 17 identified as potentially toxic
- Toxic Equivalency Factors (TEFs) used to multiply Congener concentrations
- Toxic Equivalency (TEQ) sum of 17 congeners

Dioxin Characteristics

- Dioxins and furans are “hydrophobic”
 - They are insoluble in water
- Dioxins and furans are “lipophilic”
 - They have an affinity to sequester in fat
 - They will readily adhere to carbonaceous materials

Units of Measurement

- MWC ash dioxin concentrations
 - Nanograms per kilograms ng/kg (ng, billionth of a gram)
 - ng/kg equivalent to parts per trillion (ppt)
 - ng I-TEQ/kg means nanograms of Toxic Equivalency
 - Nanograms per gram (ng/g) parts per billion (ppb)
- Aqueous solutions, (approximations)
 - Picograms per Liter, (pg/L) – ppq (pg I-TEQ/L: ppq I-TEQ)
 - Nanograms per liter, (ng/L) – ppt
 - Micrograms per liter, (ug/L) – ppb

Units of Measurement

- Soil standard 1 ppb
- Drinking water standard
 - 3×10^{-8} mg/l for 2,3,7,8-TCDD
 - 30 ppt
- Other drinking water standards
 - 1 ppq Great Lakes Region
- ***Leachate ≠ Finished Drinking Water***

Ash Disposal in Landfills

2 Types of Landfill Designs

Monofills: ash disposed in segregated cells

Cofills: ash commingled with municipal solid waste or non-hazardous industrial waste

Research Approach

- Review data on leachate from monofills and co-fills accepting MWC ash.
- Review literature for any other supporting data

Landfill Leachate Studies Reviewed

U.S. Studies

NITEP 1984

CORRE 1990

Woodburn 1988-2002

International Studies

IAWG 1994

Yoshikawa 1999

Noma 1999

Landfill Leachate Investigations - U.S.

National Incinerator Testing & Evaluation Program (NITEP)

- 1984 Environment Canada
- A variety of lab leaching test procedures applied that do not represent real landfill environment
- Results showed that dioxins were insoluble in water
- Dioxins were detected in only five samples
- Authors stated detection likely due to fine particle matter

Laboratory and Field Investigations

Coalition on Resource Recovery and the Environment (CORRE)

- Four landfill (3 monofills and 1 cofill) leachate samples yielded nondetects for dioxins
- One monofill yielded detectable dioxins in 5 of 7 tests, ranging from 0.048-0.405 ppb total
- Additional EPA analyses of 3 monofill leachates yielded dioxin concentrations ranging from 0.0-0.062 ppb TEQ

Laboratory and Field Investigations

The Woodburn, Oregon Monofill

- Leachate samples were analyzed for dioxins and furans over a number of years, 1988-2002
- Samples were collected from a monofill taking combined MWC ash
- The samples generally indicate non-detect for dioxins and furans
- The high range of samples was relatively low at 0.0111 ppt TEQ (If WHO TEF, then 0.00111 ppt)

Landfill Leachate Investigations - International

International Ash Working Group (IAWG)

- 1994 IAWG paper study reviewed ash characteristics and leaching potential from landfills
- Primarily reviewed data on disposal of separate ash streams: low leaching was indicated for fly ash and bottom ash
- Leaching behavior of combined ash was not studied

Landfill Leachate Investigations - International

Yoshikawa et.al., 1999

- Survey of dioxin and furan leaching from 13 landfills
- No clear patterns were reported

Noma et.al., 1999

- Reported findings of a mass balance study of a landfill taking ash from 3 Japanese MWCs.
- Essentially no release into raw leachate.
- Samples suggest raw leachate dioxin concentrations are on the same order as rain water and river water in this area of Japan.

Laboratory Investigations

- The following investigations were also reviewed to determine if they might support the Hypothesis.

Carsch et. al., (1986)

Karasek et.al., (1987)

Takehita and Akimoto, (1991)

Schramm 1995a, 1995b, 1997

- These studies did not directly address the fate of combined ash in cofills:

- used fly ash, not combined ash in experiments

- solvents applied didn't reflect real landfill conditions

- dioxin leaching was low, in the ppq and low ppt range, and the drinking water standard is 30 ppt for 2,3,7,8-TCDD

In Summary

- MWC ash in the USA is disposed as combined ash in monofills or commingled with solid waste in co-fills or used as cover material.
- Early studies (NITEP, CORRE and some Woodburn reports) indicate that dioxin concentrations leached from ash in laboratory analyses are below the 30 ppt drinking water std
- The early studies, and the Woodburn long-term study indicate that landfill leachate data shows non-detect to low levels of dioxins (0.011 ppt, based solely on the OCDD congener)
- International studies not directly comparable to combined ash in co-fills indicate results similar to U.S. studies

In Summary

- The literature does not provide evidence that disposal of MWC ash in monofills or co-fills with municipal solid waste leads to appreciable dioxin leaching
- The theory that organics in a co-disposal site act as solvents is not supported in the literature other than as a theoretical proposition