

UNINTENTIONAL RELEASES OF POPS AND THE IMPLEMENTATION OF BAT/BEP (KENYA)

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Introduction

- Polychlorinated dibenzo-p-dioxins (PCDD) and Polychlorinated dibenzofurans (PCDF), Hexachlorobenzene (HCB) and Polychlorinated Biphenyls (PCBs) are unintentional persistent organic pollutants (U-POPs).
- They are formed and released from thermal processes involving organic matter and chlorine as a result of incomplete combustion or chemical reactions.
- U-POPs are commonly known as dioxins because of their similar structure and health effects (Tangri 2003).

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Introduction

- They are both of natural and anthropogenic origin.
- They resist photolytic, biological and chemical degradation. They are bio-accumulative, widespread geographically and are toxic to life.
- The concentration of U-POPs of anthropogenic origin has greatly increased over the years.
- Toxics Link Report (2000) identifies several potential sources of U-POPs, among them being medical waste incineration and open burning of domestic waste.

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Introduction

- According to USEPA estimates, municipal solid waste incineration and medical waste incineration are among the top sources of dioxins released into the air.
- Of all source categories, combustion sources account for nearly 80% of air emissions.

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Introduction

- Article 5 of the Stockholm Convention requires that parties address measures to reduce releases of derived from anthropogenic sources of each of the chemicals listed in Annex C.

Chemical
Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF)
Hexachlorobenzene (HCB) (CAS No: 118-74-1)
Polychlorinated biphenyls (PCB)

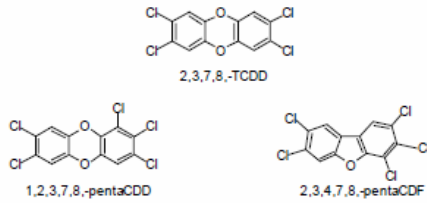
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Dioxins

- Dioxins are two series of organohalogenated substances which form a group of 210 different substances divided in 135 PCDFs and 75 PCDDs.
- Isomers presenting chlorine in the 2,3,7,8 positions have been reported to be toxic to exposed organisms. This reduces the number of compounds of interest to 17, 7 PCDDs and 10 PCDFs.
- Not all 2,3,7,8 chlorinated PCDDs/PCDFs present the same toxicity. The most toxic is 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD) which was catalogued by the World Health Organization (WHO) as carcinogenic for humans.

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Most toxic isomers of dioxins and furans



(Source: Environment Australia, 1999)

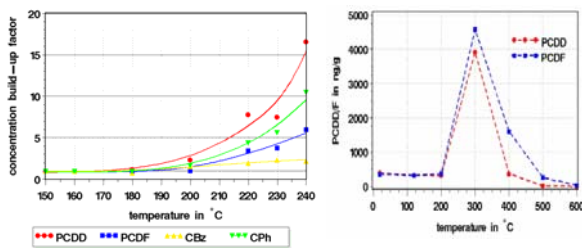
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Dioxin formation

- Formation of dioxins from high temperature processes has been thought to occur because of one or more of the following theories:
 - Formation from related chlorinated precursors such as PCPhs, PCBzs and PCBs.
 - De novo synthesis from the elements C, H, Cl and O.

(Source : Wikström, E., 1999)

Formation of PCDD/F in incinerators



(source: Hunsinger, 1994)

Source : Vogg, 1986]

- Build-up factor of the formation of PCDD/F, chlorinated benzenes (CBz) and phenols (CPh) in the raw gas of a waste incineration plant as a function of the temperature

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Important ingredients and conditions necessary to form PCDD and PCDF

- Products of incomplete combustion (PIC), e.g. soot,
- Halogenides, mainly Cl-, but also Br-,
- An oxidising atmosphere, and
- A catalyst, Cu salts being the most effective ones.

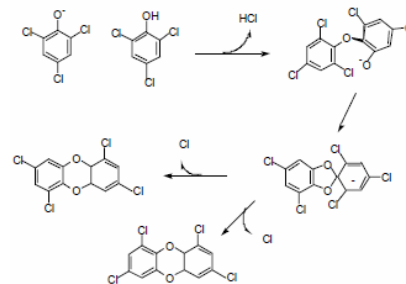
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Effect of various elements in waste stream and in fly ash on PCDD/F formation in de novo reactions.

Element	Effect	Reference
Aluminium	Negative	Hinton & Lane, 1991a
Carbon ¹	No effect	Hinton & Lane (1991b)
Chlorine ¹	Positive	Hinton & Lane, 1991a
Copper	Strongly positive	Hinton & Lane, 1991a
Potassium	Positive	Hinton & Lane, 1991a
Silicon	Negative	Hinton & Lane, 1991a
Sodium	Positive	Hinton & Lane, 1991a
Sulfur (low Cl/S)	Strongly negative	Luthe et al, 1997
Sulfur (as SO ₂)	Insignificant	Ruuskanen et al, 1994
Sulfur ¹	Positive	Hinton & Lane, 1991a
Tin	Positive	Ruuskanen et al, 1994
Zinc	Positive	Hinton & Lane, 1991a
Surface area	No effect	Hinton & Lane, 1991a

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Formation of PCDD in the fly-ash catalysed precursor pathway.

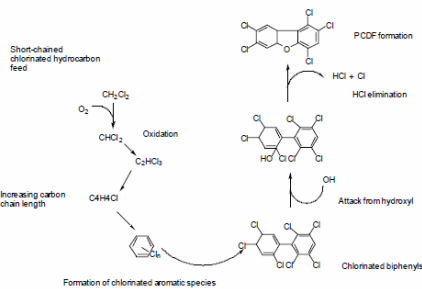


2,4,6-trichlorophenol reacts to form 1,3,7-TCDD or 1,3,6,8-TCDD.

(Source: Ruuskanen et al 1994)

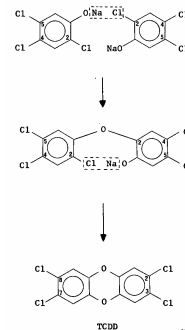
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Pathways for PCDD/F formation



Formation of polychlorinated benzene from relatively simple **short-chained chlorinated hydrocarbons**, subsequently leading to formation of PCDD/F (Source: Bozzelli & Chiang 1996)

Formation of dioxins from chlorinated phenols and derivatives



Degradation of dioxins

- Dioxins decompose at high temperatures while degradation starts at 400 °C and after one second in 1000 °C the dioxins are totally destroyed [Wikström, E., 1999].
- Controlled combustion and complete burnout of especially soot keeps the amount of dioxins low in the flue gas (Hunsinger et al., 2002).
- Temperatures below 200 °C are too low to achieve degradation of the total amount of dioxins during thermal treatment of the ash, regardless the composition of the fly ash (Lundin and Marklund., 2005).

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MEDICAL WASTE INCINERATION

- Medical wastes are considered as a hazardous waste because they contain toxic materials, infectious, or non-infectious wastes and they are considered as a hazard to millions of patients, health care workers, and visitors.
- Treatment processes for medical wastes comprise autoclaving, microwaving, chemical disinfection, irradiation, plasma system, and incineration.
- Incineration is a thermal process, which destroys most of the waste including microorganisms. Combustion process must be under controlled conditions to convert wastes containing hazardous materials into mineral residues and gases.

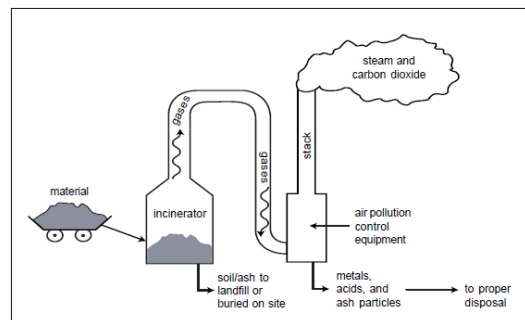
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MEDICAL WASTE INCINERATION...

- Hospital waste incinerators may emit a number of pollutants depending on the waste being incinerated.
- These pollutants include particulate matter, acid gases, toxic metals, and toxic organic compounds products of incomplete combustion, e.g., dioxins (UPOPs), and carbon monoxide, as well as sulfur oxides and nitrogen oxides.
- So, there should be a reduction of emissions of most of these pollutants by air pollution control devices.

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Recommended incineration steps



(Source: USEPA, 542-F-01-018 February, 2002)

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Medical Waste Incineration in Kenya

- Incineration facility at Kenyatta National hospital



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Medical wastes generation

Hospital	Waste generated per day (kg)
Mater Hospital	155.30
Nairobi Hospital	93.00
MP Shah Hospital	92.00
Mbagathi District Hospital	110
Guru Nanak Hospital	8.5
Aga Khan	250
Masaba Hospital	133
Kenyatta Hospital	250
Pumwani Maternity	64.5
Jamaa Hospital	48

(Source: Kenya Pops Inventory, 2006)

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Medical Waste Disposals Methods

Incineration (burners)	58.9%
Open burning	12.8%
Macerator	2.5%
None	25.6%

(Source: Kenya Pops Inventory, 2006)

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Main Legal Instruments Addressing the Management of Chemicals

Legal instruments and references	Responsible ministries or agencies	Chemical use/waste disposal categories covered	Objectives of legislation
EMCA Act	MENR Resources / NEMA	All categories	Coordinate environmental management as a whole
Factories and Other Places of Work Act (Cap 514)	Ministry of Labour	All categories	Protection of workers
Food/Chemical Substances Act (Cap 254)	Ministry of Health	Preservatives, additives	Food safety
Pest Control Products Act (Cap 346)	Ministry of Agriculture Pest Control Board.	Pesticides and growth regulators	Regulate sale, use, export and import
Fertilizer Act (245)	Ministry of Agriculture	All fertilizers	To increase agricultural output
Petroleum Act	Ministry of Energy	Petroleum products	Regulate import, refining and distribution
Standards Act Public Health Act Local Government Act	MI&T	Industrial chemicals	Quality Control

Conclusions and recommendations

- The total Dioxins (PCDD) and Furans (PCDF) release in Kenya is estimated to be 4,000 g TEQ per annum.
 1. Uncontrolled Combustion Processes category generates
 2. Waste Incineration
 3. Disposal/Landfilling
 4. Ferrous and non ferrous metal production
- There is need for reduction of the national releases of the UPOPs levels by applying Best Available Technologies (BAT) and Best Environmental Practices (BEP).

(Source: Kenya Pops Inventory, 2006)

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Management interventions related to medical waste handling

- i) Enforce the existing rules for handling waste;
- ii) Provide proper documentation and control of waste disposal procedures;
- iii) Ensure that personnel handling the waste wear protective clothing (gloves and boots) during collection, transportation and storage to reduce direct exposures and the transmission of contaminants;
- iv) Enforce standards/guidelines for incinerators gazzeted by NEMA,

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Management interventions related to medical waste handling

- v) Train all personnel who handle medical wastes on the management of risks associated with medical waste;
- vi) Classification and codes of the different waste fractions;
- vii) Streamline for waste management procedures from generation to disposal; and
- viii) Awareness creation on potential health risks associated with mistakes and mismanagement

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Medical incinerators

<http://www.youtube.com/watch?v=Z9oWguV9Ivc>

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Thank you for your attention

End

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