United Nations Industrial Development Organization

Persistent Organic Pollutants (POPs) Disposal Technology Options

by

Dr.Azza Morssy

Energy &Cleaner Production branch

Programme Development & Technical Cooperation

•Tel : 43 1 26026 3841

•Fax: 43 1 26026 6819 – Email:amorssy@unido.org

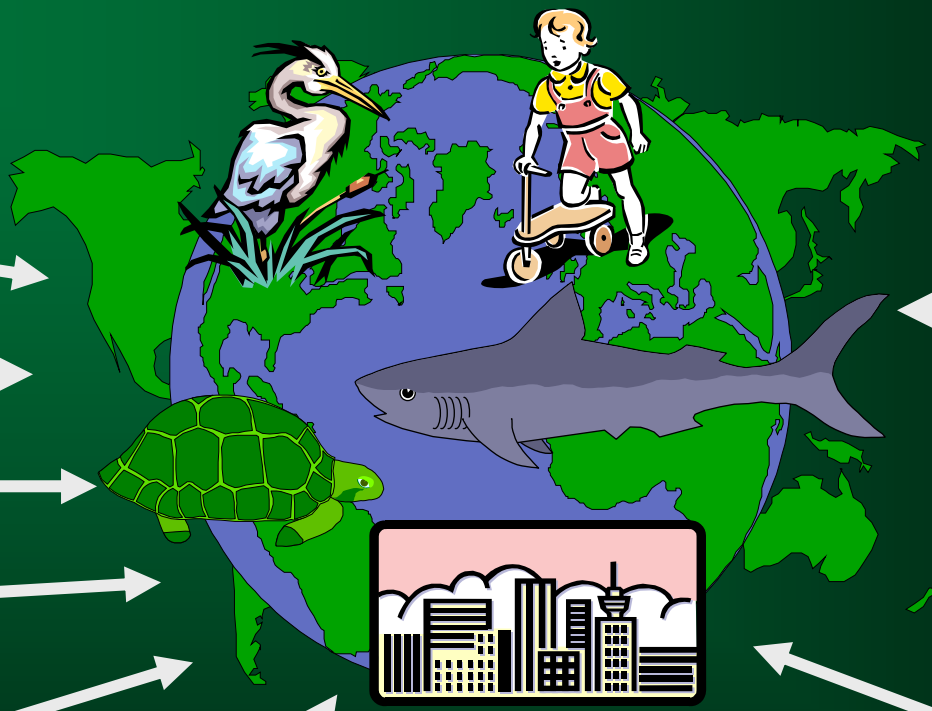
VIENNA INTERNATIONAL CENTRE

P.O. BOX 300, A-1400 VIENNA, AUSTRIA

THE DIRTY DOZEN

PESTICIDES

- ALDRIN
- CHLORDANE
- DDT
- DIELDRIN
- ENDRIN
- HEPTACHLOR
- HEXACHLOROBENZENE*
- TOXAPHENE
- MIREX



INDUSTRIAL CHEMICALS

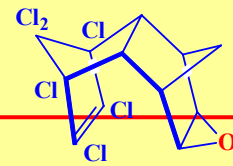
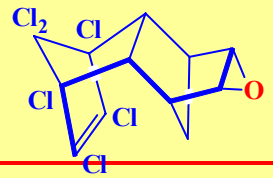
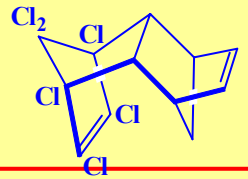
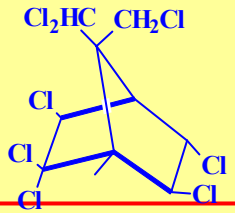
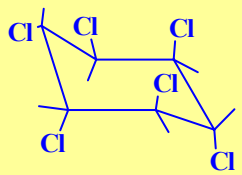
- PCBs

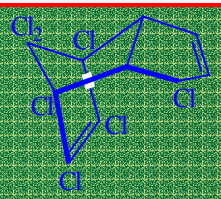
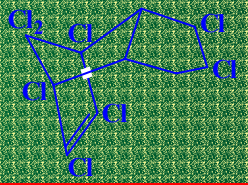
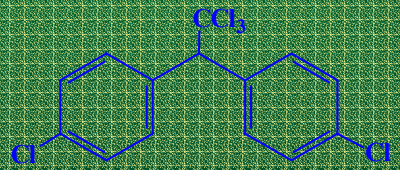
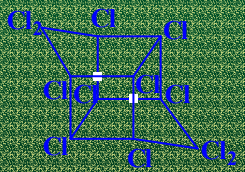
BY PRODUCTS

- DIOXINS
- FURANS

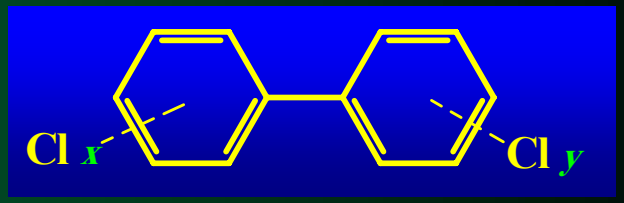
* used in the manufacture of pesticides and also as a pesticide

PESTICIDAL POPs

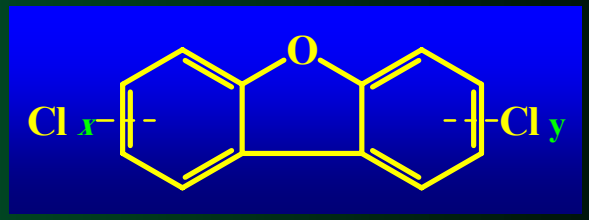
NAME	STRUCTURE	HISTORY	LD_{50} (mg/kg) Male Rat (oral)
ENDRIN		First described in (1951)	28.8
DIELDRIN		(1949) Kearnes	47
ALDRIN		(1949) Kearnes (1950) Lidov	54
TOXAPHENE		First described in (1947)	90
HEXACHLOR O- BENZENE		(1825) Faraday (1912) Linden (1942) Dupire & Raucourt	190

NAME	STRUCTURE	HISTORY	LD_{50} (mg/kg) Male Rat (oral)
HEPTACHLOR		Was first isolated from technical Chlordane	100
CHLORDANE		First introduced (1945)	400 - 500
DDT		(1874) Zeidler (1939) Muller	500 - 2500
MIREX		(1959) Allied Chemical Corporation	600 - 3000
PCBs	209 Congeners		µg Range
FURANS	135 Congeners		µg Range
DIOXINS	75 Congeners		µg Range

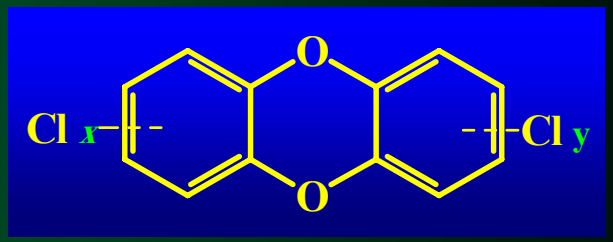
Polychlorinated Biphenyls
(PCBs)
About 209 Congeners



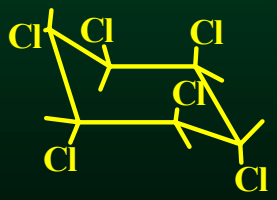
Polychlorinated Dibenzofurans
(PCDFs)
About 135 Congeners

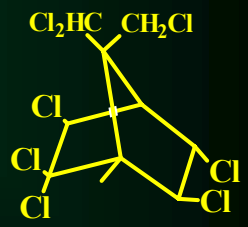


Polychlorinated dibenzo-*p*-dioxins
(PCDDs)
About 75 Congeners



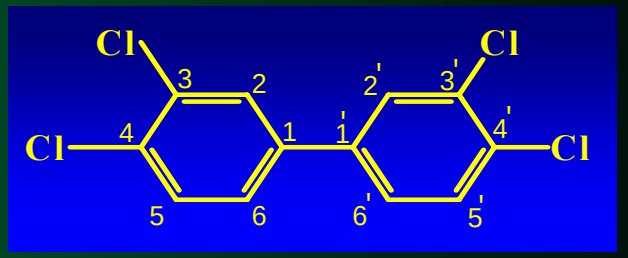
Chlorinated Hydrocarbons
(e.g. HCB & Toxaphene)
About 180 components



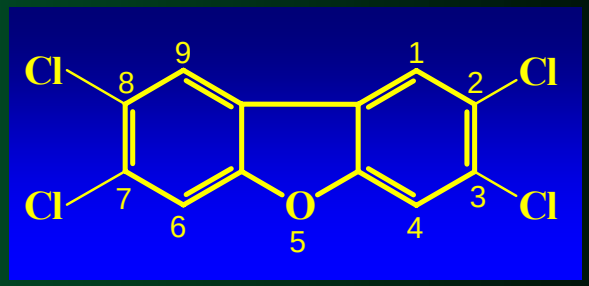


POPs BY-PRODUCTS

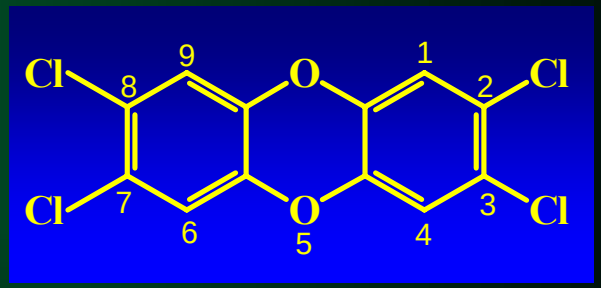
3,3’,4,4’-Tetrachlorobiphenyl



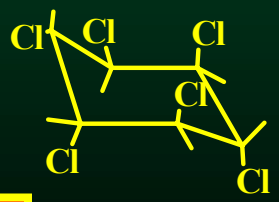
2,3,7,8-Tetrachlorodibenzofuran

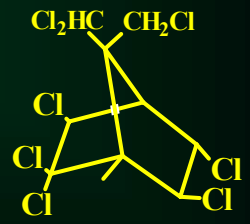


2,3,7,8-Tetrachlorodibenzo-*p*-dioxin
(TCDD)



Hexachlorobenzene and
Chlorinated Camphenes (67-69% Cl)





POPs BY-PRODUCTS

Why disposal?

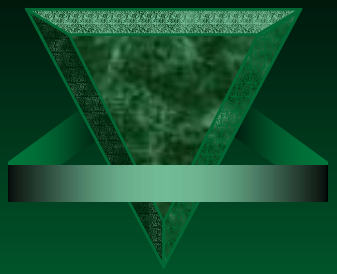
- Long-term threat to local health and environment
- Global environmental and health threat (e.g. POPs)
- Ongoing leakage and continued deterioration of containers and products
- Changes in government/management can undermine current arrangements (e.g. long-term storage)

Key considerations

- Obsolete pesticides tend to be mixtures of chemicals, often contaminated, plus contaminated soil and other materials, as well as containers, all of which need to be disposed of safely
- No disposal or management method that would not be permitted in industrialized nations should be applied in a developing country

Key considerations

- Locally implemented initiatives must be part of a national strategy for the management of hazardous waste, with full approval of all stakeholders, and not isolated solutions for specific problems



Developing world issues

- Lack of resources
- Lack of expertise
- Inadequate infrastructure
- Underdeveloped management capacity

Waste management options

- **High-temperature incineration**
- **Chemical treatment**
- **Engineered landfill**
- **Long-term controlled storage**
- **Reuse/reformulation**
- **New technology**

High temperature incineration

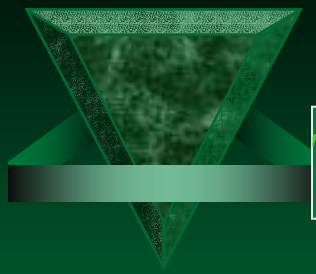
- Operating temperature > 1 100°C; residence time > 2 seconds; turbulence& DRE > 99.99%
- Emission controls needed to prevent dioxin and furan formation and other pollutants such as NOx, SOx and particulates
- Complex supporting infrastructure needed, including stable electricity and water supplies, continuous fuel, waste and other material supplies, analytical laboratories, emission monitoring

High-temperature incineration

- Cost of construction
  - US$1 million for small fixed incinerator (1 to 2 tonnes/day)
  - US$1.5-15 million + set-up costs for mobile incinerator (2 to 20 tonnes/day)
  - US$10-200 million for large fixed incinerator (12 to 170 tonnes/day)
- Public aversion
- Overcapacity in industrialized nations

High-temperature incineration: cement kiln

- Input, emission and monitoring systems must be installed
- Waste input must be carefully regulated
- New skills must be developed and maintained
- This method does not deal with contaminated soil and containers
- Waste destruction should not compromise plant product quality
- Does it fit into national hazardous waste management strategy?
- Full approval of all stakeholders is needed



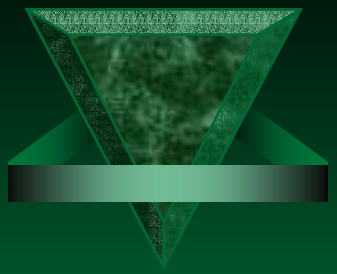
Technology	Avoid
• High Temp.incineration	Inorg. and organo. Met. Pesticides
•Incineration without Scrubber	Pesticides containing Cl, P, S,N
•Small scale incinerator/mobile with scrubber	Pesticides containing Cl, Br
•Cement Kiln	Pesticides containing Cl, Br, phenoxys

Chemical treatment

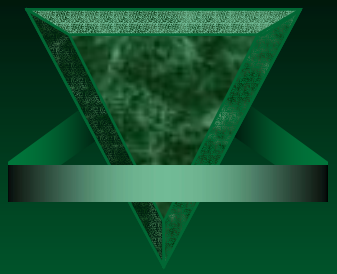
- Is highly specific
- Provides limited or no solution for contaminated materials and containers
- Creates significant potential hazards
- Requires high levels of expertise and supporting infrastructure
- Requires processing facilities to be constructed
- Generally produces larger volume of less hazardous waste needing disposal

Engineered landfill

- Landfill of hazardous waste is not generally permitted in EU and the United States
- Significant investment in infrastructure is needed
- Long-term management and maintenance is required
- It is not a permanent solution (it is only containment& not disposal)
- Leachate and gas must be treated as hazardous waste &monitored .



- Solution must present no additional unacceptable hazards
- Facilities must exist for safe and appropriate reuse/reformulation
- Who benefits from such a solution: people and environment, or pesticide manufacturers and owners?



New developments

- Gas phase hydrogenation
- Electrochemical oxidation
- Molten metal
- Molten salt
- Solvated electron process
- Supercritical water oxidation
- Plasma arc

New developments

Gas phase hydrogenation (Eco Logic)	Reaction with hydrogen at high temperatures decomposes chemicals primarily to methane and hydrogen chloride. The system is closed and therefore produces no emissions.	Only one commercial plant (in Australia) and one experimental plant (in Canada) are operating. The Australian plant is destroying DDT and PCB successfully. Technology being developed to deal with soil treatment.

Electrochemical Oxidation	An electrochemical cell generates oxidizing agents in an acid solution to attack organic compounds, which are decomposed into carbon dioxide, water and inorganic ions.	The system is not yet in commercial operation and would apparently not be capable of dealing with contaminated materials such as mixed pesticides.

Molten Metal	Organic materials are decomposed in a vat of molten metal at high temperature generating gases and metals which can be recycled and inert waste materials which can be landfilled.	The technology appears to be on the verge of operating commercially in the US. This may be an appropriate technology for the destruction of organo-metallic pesticides should any be found, since these cannot be incinerated.

New developments

Solvated Electron Process	Strips halogens from organic compounds using an alkaline solution containing free electrons and metal cations.	Primarily designed to decontaminate soils holding halogenated pollutants. Not appropriate for large quantities of mixed pesticides.

New developments

Supercritical Water Oxidation	Organic compounds dissolve in supercritical water at high temperature and pressure to form benign compounds	This process is under trial and not yet commercialized

New developments

Plasma Arc

Waste is injected into a plasma arc field at extremely high temperatures of 5000 – 15 000ºC at which compounds are broken down into their constituent atoms.

Only one such plant is known to be operating in Australia. Destruction costs are higher than incineration and destruction efficiencies vary. Dioxins can be produced at unacceptable levels.

UNIDO Recommendations

1. High temperature incinerations still the best options, but one should have level of national or international standards of management of operations and monitoring.
2. Capacity should be developed for viable alternate technologies , which are proven & economically feasible .
3. Up gradation of existing analytical laboratory facilities should be taken up.
4. Appropriate legislatives measures should be introduced or modified to meet SC requirements & properly implemented.