The Stockholm Convention and POPs Destruction Technologies

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Stockholm Convention

- The first legally binding global treaty on toxic chemicals
- Signed on 23 May 2001
- Entered into force on 17 May 2004
- All nations has agreed to begin to act immediately
- Initially targets 12 chemicals – the dirty dozen **pesticides**: DDT, endrin, dieldrin, aldrine, heptachlor, mirex, chlordane, toxaphene; **industrial compounds**: HCB, PCBs; **by-products**: dioxins (PCDD), furans (PCDF), (by-products are also PCBs and HCB)

Stockholm Convention

Requires:

„….*each country to reduce the total releases derived from anthropogenic sources of [POPs], with the goal of their continuing minimization and, where feasible ultimate elimination.“*

Elimination

- Identify processes and materials in which by-product POPs are formed
- Avoid introduction of industries which cause formation of POPs
- Phase-out of processes and materials in which POPs are formed
- Remediation of contaminated soils, sediments, groundwater

Cleaning up the mess – secondary sources

- Stockpiles of PCBs, pesticides, wastes
- Lands, sediments, groundwater, materials contaminated with PCDD/Fs and other POPs
- Essential that this is done in a way that doesn´t result in formation or release of POPs
- Use of non-combustion destruction technologies

Stockholm Convention

Parties are to take measures so that POPs wastes are:

- *Disposed of in such a way that the persistent organic pollutant content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of POPs……*
- *……not permitted to be subject to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses for POPs.*

Stockholm Convention

Parties must:

….*promote the development and, where it deems appropriate, require the use of substitute or modified materials, products and processes to prevent the formation and release of PCDD/Fs and other by-product POPs.*

Criteria from Stockholm Convention

A suitable destruction process/technology therefore should:

- Prevent the formation of dioxins, PCDD/Fs and other by-product
- Prevent the release of PCDD/Fs and other by-product
- Not generate any wastes with POPs characteristics
- Not utilise any POPs disposal methods which are non-destruction, such as landfilling or recycling in any form

IPEN Criteria

for the destruction of POPs wastes

Destruction … must be accomplished in a manner that does not further degrade the environment.

- **An effective destruction efficiency of 100% - taking into account all inputs and releases;**
- Complete containment of all process streams to enable testing and reprocessing if necessary to ensure (1);
- No uncontrolled releases from the process.

Further Consideration when Evaluating Technologies

- Eliminate inappropriate technologies (based on guidance / criteria) – e.g. Formation of POPs / POPs waste / landfill, etc.
- Destruction Efficiency (based on inputs vs. all outputs)
- Ability to contain all process streams
- Ability to reprocess materials, residues, gases, liquids if required
- Availability of complete process information (analytical data)
- Track records / commercial availability
- Safety and protection of the workers
- Hazardous material use
- Community acceptability

Available Technologies

GPCR - Ecologic	Incineration
Base Catalysed Dechlorination	Vitrification
Sodium reduction	Deep-well injection
Solvated electron	Plasma
Electrochemical	Solvent washing
Super Critical Water Oxidation	Landfill/burial
Ball milling	Solidification/stabilization
Molten salt	Land spreading
Catalytic hydrogenation	Molten metal*

Incineration

- The most common way of POPs disposal
- All incinerator releases have the potential for public health impact:
  stack gas, fly ash, bottom ash, scrubbed water, other residues, fugitive emissions
- Movement of toxic substances from burned waste into incineration products
- Accidents e.g. fires

Landfilling

- No POPs destruction
- Problems with landfills: releases via water, into soils, landfill fires

Technology	Commercial scale	Countries where licensed and/or used for commercial treatment
Gas Phase Chemical Reduction (GPSR)	full	Australia, Canada, USA, Japan
Sodium reduction	full	France, Germany, UK, Netherlands, South Africa, Australia, USA, Saudi Arabia, Japan, New Zealand
Base Catalysed Dechlorination	full	Australia, USA, Mexico, Germany, Spain, New Zealand, Japan
Solvated electron	full	USA
Electrochemical	limited	USA, UK
Catalytic hydrogenation	limited	Australia
Super-critical water oxidation	limited	USA, Japan
Ball milling	demo/limited	Germany, New Zealand

Gas Phase Chemical Reduction - GPSR

Process: Hydrogen reacts with chlorinated organic compounds, such as PCBs, at high temperatures/low pressure yielding primarily methane and hydrogen chloride.

Efficacy: Demonstrated high destruction efficiencies for PCBs, PCDD/Fs, HCB, DDT.

Applicability: All POPs – including PCB transformers, capacitors, and oils. Capable of treating high strength POPs wastes. May not be economic for low level wastes

Licensed: Australia, Canada, USA, Japan

GPSR

- **Emissions:** All emissions and residues may be captured for assay and reprocessing if needed.
- **Concerns:** Use of hydrogen gas, although company has good environmental/regulatory track record. Fate of arsenic/mercury in system. Use of afterburner for burning product gas (methane).
- **Applicability under Stockholm Convention for POPs destruction:** Potentially suitable.

Based Catalysed Decomposition -BCD

- **Process:** A non-conventional heterogeneous catalytic hydrogenation process which reacts organochlorines with an alkali metal hydroxide, a hydrogen donor and a proprietary catalyst to produce salts, water and carbonaceous residue.

BCD Plant, Australia

- **Efficacy:** High destruction efficiencies have been demonstrated for DDT, PCBs and PCDD/Fs.
- **Applicability:** DDT, PCBs, PCDD/Fs. Limited to approximately 15-30% strength PCBs.

BCD

- **Emissions:** All emissions and residues may be captured for analysis and reprocessing if needed.
- **Concerns:** Solid residues not fully defined. A fire in unit operating in Melbourne in 1995. Process difficulties in unit operating in Sydney.
- **Applicability under Stockholm Convention for POPs destruction:** potentially suitable if operated to maximum treatment effectiveness.
- **Licensing:** Commercially licensed in USA, Australia, Mexico, Japan, Spain, Czech Rep.

ITD Facility, Herne, Germany

BCD - Europe

- Spain (lindane reduction)
- Czech Republic (PCDDF/Fs contamination – pesticide production – „Agent Orange“)
- Germany

Spolana Neratovice

BCD - Australia

- Pacific island countries (PICs) - POPs stockpiles (agricultural pesticides and PCBs)
- Moe Project, Victoria (PCB contaminated soils)
- Olympic Site, Sydney (soils – chlorobenzenes, chloropenols)
- …….

BCD – USA, Mexico

- USA
- US Naval Bases
- Landfill (contaminated soils – PCB, PCDD/Fs)
- Soils, pesticides

- Mexico
- PCB contaminated oils

US Navy, Guam

Sodium Reduction (SR)

- **Process:** Reduction of PCB with dispersed metallic sodium in mineral oil. Has been used widely for in-situ removal of PCBs from active transformers. Products of the process include non-halogenated polybiphenyls, sodium chloride, petroleum based oils and water (pH > 12).
- **Efficacy:** Destruction efficiency of the process has not been demonstrated. However the process has been demonstrated to meet regulatory criteria in EU, USA, Canada, South Africa, Australia and Japan for PCB treatment (e.g. In Canada to [PCB] < 2 ppm for treated oil; and [PCB] < 0.5 ppm; [dioxins] < 1 ppb for solid residues).

Sodium Reduction

- **Applicability:** PCBs to 10 000 ppm (also some vendors claim applicable to other POPs, but no data)
- **Emissions:** unknown
- **Concerns:** Lack of information on characterisation of residues. If used for in-situ treatment of transformer oils then will not destroy all PCBs contained in porous internals of the transformer.
- **Applicability under Stockholm Convention for POPs destruction:** potentially suitable, but further information required.
- **Licensing:** Widely available worldwide

Super-Critical Water Oxidation (SCWO)

- **Process:** high temperature (400 – 500 °C) and pressure (25 MPa) process, carried out in a compact totally enclosed system. Decomposition products include CO_2, water and inorganic acids or salts.
- **Efficacy:** Destruction and removal efficiencies > 99,99994 % for treatment of dioxin contaminated waste, and > 99,999 % for treatment of numerous hazardous organic compounds (including chlorinated solvents, PCBs and pesticides)

SCWO

- **Applicability:** all POPs, industrial organic chemicals, agricultural chemicals, and explosives. SCWO has been used for the treatment of sludge and waste water contaminated with PCBs, pesticides, cyanide, halogenated aliphatics and aromatics
- **Emissions:** CO level < 10 ppm, nitrogen oxides, hydrogen chloride or sulfur oxide
- **Concerns:** High content PCBs waste make the residual contents of the process acidic (low pH) – it can cause a corrosion of plant materials and pipes.
- **Licensing:** Japan, USA

Other Non-combustion Technologies

- Challenging area
- New technologies are developing

- problems: limited knowledge and implementation of such technologies

Incineration versus Alternatives

INCINERATION

- Generate/release POPs and other hazardous chemicals to air and land
- Generate large amounts of hazardous waste
- Inappropriate for treating POPs under the Stockholm Convention

ALTERNATIVES

- Allow for testing and reprocessing
- Don´t generate POPs
- Capable of high destruction efficiencies
- Appropriate for treating POPs under the Stockholm Convention

Summary

- Elimination of POPs is the ultimate goal.
- Many traditional disposal technologies are inappropriate for POPs disposal and in some cases are themselves major sources of POPs (e.g. Incineration, landfilling, cement kilns, boilers, plasma, deep well injections)
- Alternative non-combustion technologies are commercially available and come closest to meeting the spirit, intent and obligations of the Stockholm Convention for POPs destruction
- However, thee technologies should not become an excuse for the on-going production of POPs wastes.

Further Information

Stockholm Convention: http://www.pops.int/

UNEP POPs website: http://www.chem.unep.ch/pops/default.html

UNEP BAT / BEP:
http://www.pops.int/documents/meetings/bat_bep/EGBATBEP1/participantinfo/default.htm

IPEN (International POPs Elimination Network): http://ipen.ecn.cz/

IPEN Conference, Prague 2003: http://pops2003.arnika.org/proceedings.shtml

IPEN factsheet Alternatives for POPs Disposal (2nd edition):
http://www.ipen.ecn.cz/index.php?z=&l=en&k=documents&r=viewtxt&id=112&id_rubriky=8

Technical Criteria for Destruction of Stockpiled Persistent Organic Pollutants:
http://www.who.int/ifcs/isg3/d98-17b.htm

Greenpeace information on POPs and non-combustion technologies:
http://archive.greenpeace.org/~toxics/reports/reports.html
http://www.greenpeace.org

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