Non-incineration PCB Destruction Technologies

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Stockholm Convention

- Initially deals with 12 POPs – Aldrin, Dieldrin, DDT, Endrin, Heptachlor, Chlordane, Mirex, Toxaphene, PCBs, HCB, Dioxins and Furans
- Ultimate aim of elimination of by-product POPs
- Sets out requirements for inventory and disposal of PCBs
- Negotiations completed in Johannesburg, South Africa in December 2000
- Adopted in Stockholm on 22-23 May 2001
- Over 100 countries have signed the convention and two have ratified – Canada and Fiji

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 persistent organic pollutants...
- …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 dioxins/furans and other by-product POPs.

Guidance from Stockholm Convention

Based on provisions for POPs disposal, a technology should:

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

GPI Technical Criteria

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

1. An effective destruction efficiency of 100% - taking into account all inputs and potential releases (to air, solid and liquid wastes);

2. Complete containment of all process streams to enable testing and reprocessing if necessary to ensure (1);

3. No uncontrolled releases from the process.

Destruction Efficiency

- Destruction Efficiency (DE) ~ is calculated on the basis of the total mass of POPs fed into a process, versus the sum of the POPs in all products, by-products, and environmental releases (eg. gaseous, solid and liquid) ie. DE considers the total destruction in a given process
- Destruction and Removal Efficiency (DRE) ~ Only considers the POPs in stack gases and ignores releases in solid and liquid wastes

NB. DE and DRE are normally reported as a percentage

Evaluating Technologies

- Based on Stockholm Convention criteria
- 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 Track record/commercial availability
- Safety/OH&S
- Hazardous materials use
- Community acceptability and participation

Summary of PCB Disposal Technologies

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

Technology	Commercial scale	Countries where licensed and/or used for commercial treatment
Gas Phase Chemical Reduction (GPCR)	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, Spain, New Zealand, Japan
Solvated electron	full	USA
Electrochemical	limited	USA
Catalytic hydrogenation	limited	Australia
Super-critical water oxidation	limited	USA, Japan
Ball milling	demo	Germany

GPCR - Eco Logic

- **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, dioxins/furans, 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

GPCR – Eco Logic

- **Emissions:** All emissions and residues may be captured for assay and reprocessing if needed.
- **Concerns:** Use of hydrogen gas, although company has good environmental/safety/regulatory track record. Fate of arsenic/mercury in system.
- **Applicability under Stockholm Convention for POPs destruction:** Potentially suitable.
- **Vendor:** ELI Ecologic International, Ontario, Canada http://www.eco-logic-intl.com

Base Catalyzed Dechlorination 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.
- **Efficacy:** High destruction efficiencies have been demonstrated for DDT, PCBs and dioxins/furans.
- **Applicability:** DDT, PCBs, dioxins/furans. Limited to approximately 15-30% strength PCBs.

BCD

- **Emissions:** Solid residues may be captured for assay and reprocessing if needed.
- **Concerns:** Solid residues not fully defined. Potential for emissions through pressure relief valve. A fire in unit operating in Melbourne, Australia in 1995.
- **Applicability under Stockholm Convention for POPs destruction:** potentially suitable if operated to maximum treatment effectiveness.
- **Licensing:** Commercially licensed in USA, Australia, Mexico, Japan and Spain.
- **Vendor:** BCD Group Inc., Cincinnati, OH, USA, http://www.bcdinternational.com

Sodium reduction processes

- **Process:** Reduction of PCBs 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 polybiphenyl, 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, Japan for PCB treatment (eg. in Canada to [PCB] < 2 ppm for treated oil; and [PCB] < 0.5 ppm; [dioxins] < 1 ppb for solid residues).

Sodium reduction processes

- **Applicability:** PCBs to 10 000 ppm
- **Emissions:** ?
- **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 info required.
- **Licensing:** Widely available worldwide
- **Vendor:** Many, eg. Powertech, Vancouver, Canada http://www.powertechlabs.com

Case Study - Australia

- 1970-80's attempts to build centralized High Temperature Incinerator (HTI) failed because of community opposition
- Government decided to halt HTI proposal and promote non-incineration destruction technologies (1992)
- Community involvement (NAB) and National Management Plans for PCBs, HCB, OCPs
- All PCBs since early 1990's treated in Australia using commercial non-incineration technologies

Case Study - Japan

- In 1989 Japan banned incineration of PCBs
- In 1998 regulations amended to permit non-incineration destruction of PCBs
- 2001 – 12 companies have licensed and/or developed non-incineration technologies for PCB disposal and are in process of construction and obtaining final approvals for use

Summary

- Stockholm Convention requirements favor technologies for PCB disposal which do not form or release POPs.
- Technologies for PCB destruction should be capable of effectively 100% treatment efficiency, and containing all process streams for testing and reprocessing if necessary.
- Non-incineration technologies have been demonstrated to effectively treat and destroy PCBs and other POPs.
- Alternatives to incineration are commercially available.
- In general, the use of non-incineration systems has not engendered the same levels of community opposition as incineration.

Further Information

- Technical Criteria for Destruction of Stockpiled Persistent Organic Pollutants
  http://www.who.int/ifcs/isg3/d98-17b.htm
- Greenpeace information on POPs and POPs destruction technologies
  http://www.greenpeace.org/~toxics/
- Information on Stockholm Convention on POPs
  http://irptc.unep.ch/pops/
- Remediation technologies (USEPA)
  http://clu-in.org
- Scheduled Waste Program - Environment Australia
  http://www.ea.gov.au/industry/chemicals/swm/
- US Army Chemical Weapons Alternative Technology Program
  http://pmcdtech.stoneweb.com/index_main.htm