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IPEN submission on Low POPs Content Levels for the Meeting of the Small Intersessional Working Group (SIWG) on POPs TG

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IPEN reviewed 96 studies, articles and reports related to air pollution control (APC) residues and other waste incineration residues including bottom ash to assess the available information concerning POPs concentrations in these residues and the potential for POPs release to the environment. This information is very important to the determination of Low POPs Content Levels (LPCLs) that must be based on the protection of human health and environment if they are to meet the objectives of the Stockholm convention and the Basel Convention where there are synergies between the establishment of LPCL. Human exposure to POPs as a result of the post incineration management of incinerator residues has been reported via multiple exposure pathways (ingestion, inhalation, dermal etc.), including via food sources. POPs entrained in incineration residues have the potential to become a leading human exposure source for POPs and UPOPs if LPCLs are not set in a conservative manner based on the protection of human health and the environment. International transboundary trade in such residues will increase considerably if weak LPCLs are established thereby expanding potential human exposure and environmental impacts.

Keeping the levels for POPs and other legislation more strict for rules on waste incineration residues in developed countries and less strict level (rules) for their transboundary movement will lead to the situation before which Breivik et al. warned (Breivik, Gioia et al. 2011). So it can lead to export of materials declared as construction materials as nothing like "POPs content level" will stop them at the borders as they will be so high that any waste could move abroad. Gioia exposed problem with potential exports of another problematic wastes to Africa like e.g. ships containing PCBs (Gioia, Eckhardt et al. 2011).

Low POPs content for PCDD/Fs

Before discussing the proposed LPCL for PCDD/DF it is valuable to note some extracts from the literature of the various scenarios in which APC residues and incinerator ash are exposed to the environment and hazards associated with their POPs concentrations.

From review overview of management of air pollution control (APC) residues by Astrup (2008): *"Today solid residues from modern Waste-to-Energy facilities constitute the primary emission route to the surrounding environment. Although bottom ashes are generated in* *larger quantities, the main pollution potential is found in the air-pollution control (APC) residues originating from cleaning the flue gases before emission to air. While a range of different types of APC residues exists the overall properties and environmental concerns are the same, regardless of the incinerator and country of origin. Research and development over the recent decades have produced numerous treatment and disposal solutions for APC residues, some of these only tested in the lab while others are available commercially.*

The documentation of this range of management solutions is generally very poor: public reports may not be available on commercial solutions while thoroughly investigated lab scale processes may never go beyond the lab due to market constraints. In all cases, developers and researchers may claim that their particular solution is the best available. This situation makes it increasingly difficult for stakeholders to compare management solutions, and for operators to select the right treatment and disposal for the residues." …. *"It cannot be recommended that APC residues are landfilled without prior treatment."*

Some papers encourage the use of fly ash and/or air pollution residues in different recycling processes although they omit potentially high levels of PCDD/Fs in such residues (Thipse, Schoenitz et al. 2002, Osada, Tanigaki et al. 2008).

A large number of the studies pays attention to problem of heavy metals leachates. For example; (Aubert, Husson et al. 2004): *„Table 9 shows the total concentrations of the most harmful elements leached. These results are compared with threshold values allowed for leachates from MSWI bottom ashes to be reused in road works in France"*, but there are no results on dioxin leachates. So PCDD/Fs and other U-POPs are not considered as "most harmful elements" leached. We have to ask why? Answer is obvious: There is no strict requirement or limit value for PCDD/Fs or other U-POPs and provisional level set in General Technical Guidelines for POPs waste is at such high level that most of APC residues are below that level.

Leaching behavior of PCDD/Fs and other U-POPs seems to depend on different conditions than heavy metals (Shin and Chang 1999, Kim and Lee 2002, Osako, Kim et al. 2002, Osako and Kim 2004). It was also proven by several studies that standard leaching tests are not suitable for leaching tests on PCDD/Fs leachability. It was proved experimentally that the leachability of PCDD/F increased with increasing DHM concentration in all pH conditions. The highest leachability was shown at the highest pH (Kim and Lee 2002).

For coal firing power plant ash it is suggested that it can be used as enrichment for agricultural land (Jala and Goyal 2006, Pandey and Singh 2010) and by extrapolation the same case may be made for waste incineration fly ash if the POPs content and heavy metal contamination are not taken into account.

Ashes with PCDD/F contamination levels as low as 50 ng TEQ/kg can be risk sources. Even if such ash is "diluted" on soils the PCDD/F can re-accumulate over time with repeated applications. It is therefore alarming that the current provisional 'low POPs' limit established by the Basel Convention on behalf of the Stockholm Convention for dioxin contaminated waste is 15,000 ng TEQ/kg. This is far too high and needs urgently to be re-evaluated and dramatically reduced.

Various jurisdictions apply different thresholds for PCDD/DF containing wastes depending on the disposal, management or destruction option being considered. Zhang et al (2004) cite 1–3 ng I-TEQ/g of PCDD/Fs as an accepted and adequate value for landfill disposal in developed countries[1]. At three magnitudes of order below the current provisional PCDDD/DF LPCL this landfill threshold represents a risk averse regulatory limit that takes into account that all landfills eventually leak with subsequent release of PCDD/DF to the environment through groundwater and other pathways.

Recent paper submitted for discussion about POPs contaminated sites discussed also safe levels of PCDD/Fs and dioxin-like PCBs (DL PCBs) in soil in relation to raising chicken (Bell, Weber et al. 2016): *"Levels of >5 ng TEQ/kg dm would certainly be too high and would require either that production be stopped or free range access restricted."*

Table 1 below shows levels observed in different locations where free range chickens were raised in relation to levels of PCDD/Fs observed in their eggs.

Table 1: Levels of PCDD/Fs in poultry eggs in comparison with levels in waste/soil on the sites where poultry was raised.

Substance	place (country)	level in soil/waste	low POPs level	level in food	limit for food
PCDD/Fs	Newcastle, St. Anthony's (UK)	0.02 ppb	15 ppb	27 ppt	2.5 ppt
PCDD/Fs	Newcastle, Hulne Terrace (UK)	0.910 ppb	15 ppb	31 ppt	2.5 ppt
PCDD/Fs	Maincy (France)	0.011 ppb	15 ppb	121.6 ppt	2.5 ppt
PCDD/Fs	Maincy (France)	0.037 ppb	15 ppb	25.75 ppt	2.5 ppt
PCDD/Fs	Libis (Czech Republic)	0.026 ppb	15 ppb	23 ppt	2.5 ppt
PCDD/Fs	near aluminium plant (Switzerland)	0.013 ppb	15 ppb	12 - 19 ppt	2.5 ppt
PCDD/Fs	Rheinfelden (Germany)	0.377 - 2.168 ppb	15 ppb	12.7 - 514 ppt	2.5 ppt

[1] He, P.-J., H. Zhang, C.-G. Zhang and D.-J. Lee (2004). "Characteristics of air pollution control residues of MSW incineration plant in Shanghai." Journal of Hazardous Materials **116**(3): 229-237.

IPEN supports a LPCL of 1 ng WHO-TEQ/g (1 ppb) for wastes based on the sources noted in this document and the potential for widespread exposure under current proposed LPCLs. This level should include also DL PCBs which were yet omitted in definitions for LPCLs (IPEN suggests to set LPCL of 1 ng WHO-TEQ/g (1 ppb) for PCDD/Fs and DL PCBs). Wastes with levels of PCDD/Fs and DL PCBs above 0.05 ng WHO-TEQ/g (0.1 ppb) should be prohibited to be used on the surface.

However, landfill is only one of many land based management measures for APC residue, fly ash and bottom ash. Due to the physical nature of ash residues (high component of fine and ultrafine particles with POPs and metal adsorption) they can be difficult to control in a range of environmental conditions resulting in dispersal, leaching and even secondary exposures when building products containing residues are eventually demolished or crushed.

Examples of fly ash management and environmental exposure:

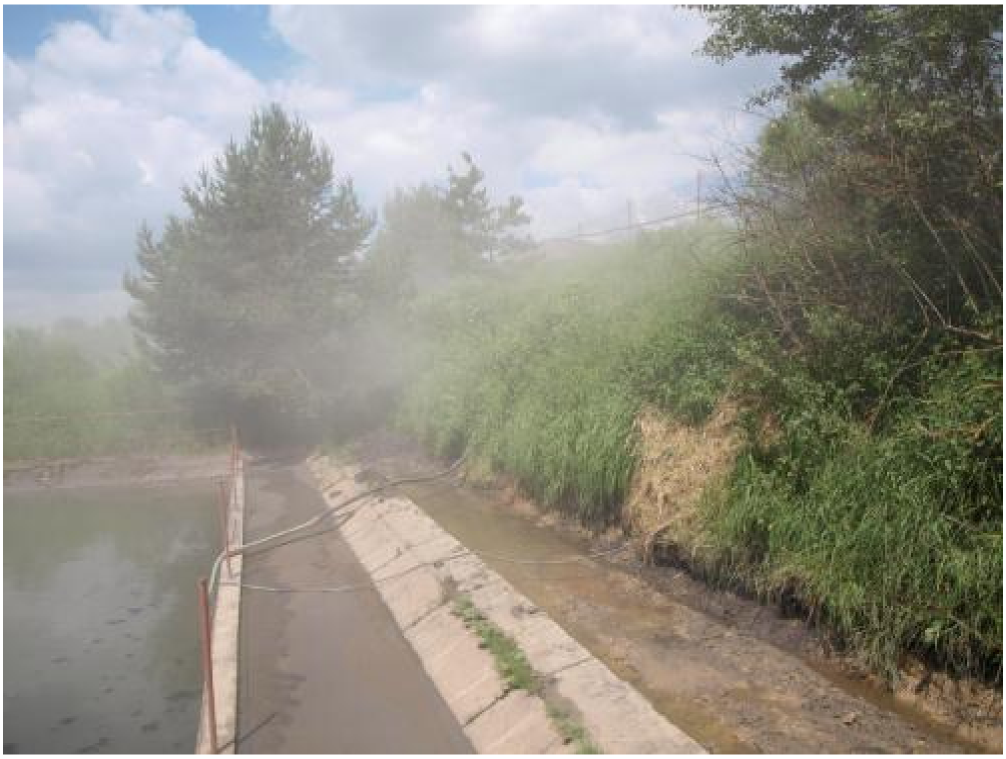

Photo 1: This is neighborhood area of one site in the Czech Republic, where different types of wastes are treated including waste APC residues from waste incineration and metallurgy. Dust is carried out of the area and contaminates surrounding natural ecosystems. In similar case in Taiwan was observed that *"the PCDD/F contents in the surface soils of the landfill site are 460 times higher than that of urban soils and the highest value is 2.8 times higher than the Taiwan soil regulation (1000 ng I-TEQ kg-1). The elevated PCDD/F contents in the soil reveal their potential for causing adverse health risk for humans, including the pathway of resuspension of soil particles and volatilization of PCDD/Fs from soil. The PCDD/F concentrations in the groundwater and the treated landfill leachates of the landfill site for solidified monoliths were both higher than that in the control samples, suggesting its potential to be a PCDD/F source of nearby water environment."* (Wang, Wang et al. 2006)

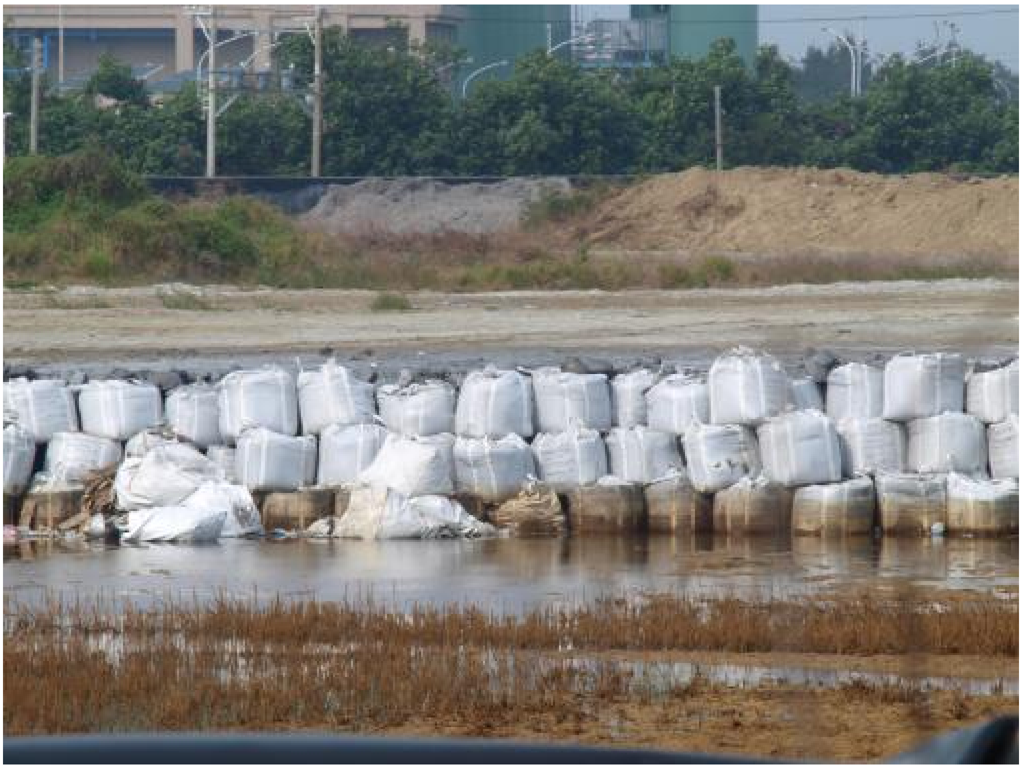

Photo 2: One of the sites, where waste incineration fly ash is landfilled in Taiwan.

Photo 3: Promotion of use of mixed fly ash and bottom ash as undercover for sidewalks in the Czech Republic. Levels of PCDD/Fs in this mixture are about 0.05 – 0.1 ppb in WHO-TEQ. (Source: Letter sent by company Termizo, operating MWI in Liberec to mayors in the region)

Photo 4: Interim storage of mixed fly ash and bottom ash from MWI Liberec, Czech Republic before its use as construction material in one of the municipalities. Levels of PCDD/Fs in this material are 0.05 – 0.1 ppb in WHO-TEQ.

Photo 5: Waste incineration residues dumped next to fish ponds in Tainan, Taiwan.

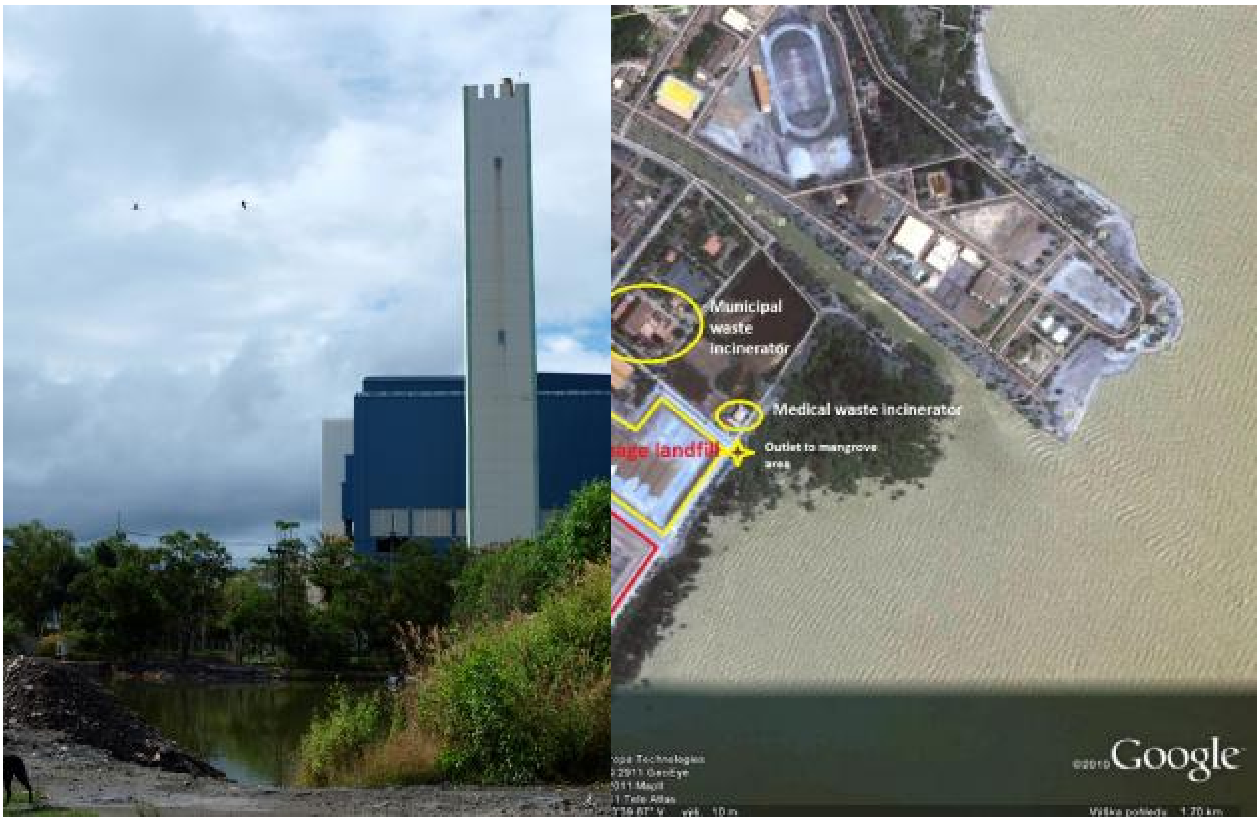

Photo and map 6: Phuket, Thailand. MWI dumped its fly ash and bottom ash right next to mangrove area for long time until 2011.

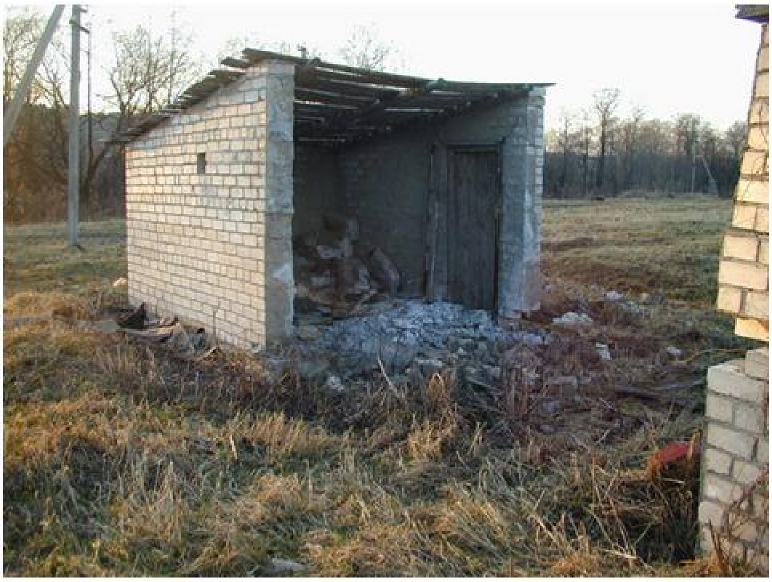

Photo 7: Dumping of waste incineration ash residues in Belaruchi, Belarus in 2007. This mixture of waste was produced by company UTR (Umwelttechnologie und Recycling GmbH & Co. KG) based in Germany and waste was exported to Belarus through Poland. Concentration of PCDD/Fs in that waste was 2.7 ppb in I-TEQ.

Low PCL for PBDEs and HBCD

IPEN strongly recommends that the lower levels of 100 mg/kg for HBCD and 50 mg/kg for PBDEs will be approved as final ones.

The IPEN recommendations are consistent with the conclusions of the extensive report by consultants for the EU (ESWI and BiPRO 2011). The consultants recommended two levels for each of the POPs:

Substance	LPCL 1 (ppm)	LPCL 2 (ppm)	Remark
TetraBDE	10	200	LPCL 2 to be reviewed by 2016
PentaBDE	10	200	LPCL 2 to be reviewed by 2016
HexaBDE	10	200	LPCL 2 to be reviewed by 2016
HeptaBDE	10	1000	LPCL 2 to be reviewed by 2016
PFOS	10	50	LPCL 2 Review by 2016; With stricter limitation for sewage
HBCD	100	1,000	LPCL 2 covers separated waste types

The preferred levels were the lower levels (LPCL1). The higher levels were proposed only as an alternative "which could be set out for a restricted time frame in order to facilitate enforcement".

The recommended levels for each of the PBDEs was 10 ppm. This meant a total of 40 ppm for mixtures of the POP BDEs, lower than but close to the current recommendation of 50 ppm.

The EU has not followed the preferred levels of their own consultants which are based on achievable protection of human health and the environment given current analytical capabilities – nor has the EU presented any further data of assessment to justify the proposed higher levels.

The PBDEs are of similar toxicity to the original POPs (apart from dioxin) and so 50 mg/kg would be consistent with the existing provisional Low POPs levels. HBCD is less toxic that PBDEs and so a slightly higher level can be tolerated.

It is essential to choose the lower levels POP content if levels in recycled products made from wastes containing these POPs is to be kept at a tolerable level. Only last month the German Federal Environment Agency (Umweltbundesamt) published a report (Potrykus, Milunov et al. 2015) which warns against the risks of setting low POPs levels which allow recycling to be contaminated by POPs. The original sentence relates to HBCD but can be applied even more forcefully to PBDEs because brominated dioxins are often formed from the original PBDEs during recycling thus increasing the toxicity in recycled products:

"*During the recycling processes, POPs are usually neither destroyed nor generated. The HBCD content is preserved and entails the risk of a further transfer of HBCD into various plastic* *products, thus resulting in uncontrolled global distribution and the corresponding risks for human health and the environment*"

There is no doubt that the proposals for a 1,000 ppm low POPs level for PBDEs and HBCD would allow exports from developed countries of wastes and recycled products containing these POPs to countries with little or no capacity to detect or treat the POPs wastes.

Most POPs have a proposed limit of 50 ppm but the draft Guidelines propose option of 1000 ppm for HBCD and the PBDEs. However, these new POPs are just as hazardous as the old POPs. Even worse, they are more commonly found in our homes and domestic environments. In addition, IPEN believes that even the 50 ppm low POPs content limit should be tightened as it is not a health-based standard and should be much lower considering the properties of POPs. A proposed LPCL of 10 ppm for PCNs which have similar characteristics and toxicity to PCBs are a case in point. Advances in science including lower detection limits and more comprehensive understanding of the toxicity of POPs (including non-monotonic dose response relationships implicated in endocrine dysfunction) are revealing novel modes of action and new health endpoints that may not have been considered when earlier POPs LPCL were proposed. If PCNs and PCBs have similar toxicity and hazard profiles then consideration should now be given to lowering the PCB LPCL to 10 ppm. In turn, other POPs LPCL classifications should be revised in light of these considerations. Notably consideration should be given to DecaBDE which exhibits toxicity characteristics and intensity at similar levels to PCBs. A Stockholm Convention expert committee evaluation noted that, *"The neurotoxic effects of PBDEs are similar to those observed for PCBs and so children exposed to PBDEs are likely to be prone to subtle but measurable developmental problems."* This implies that limit standards should be at least as stringent for DecaBDE as they are for PCBs (50 ppm). However, given the proposed limit of 10 ppm for PCN which in turn exhibits similar characteristics as both PCB and DecaBDE then there is a case for reviewing the LPCL for both PCB and DecaBDE with a view to setting a 10 ppm limit for each.

IPEN supports a proposed LPCL for PCN of 10 ppm.

A weak low POPs content limit such as 1000 ppm opens the door for permitting the production and sale of products that contain unacceptably high levels of POPs as contaminants. It also facilitates the export of hazardous, POPs-contaminated wastes from developed to developing countries.

Low POP content for PCP and its salts and esters

IPEN supports the recommendations of the UBA consultants (Potrykus, Milunov et al. 2015) to establish a health protective level of 1 ppm for pentachlorophenol (assuming analytical capabilities are available in most jurisdictions to meet appropriate limits of detection in identifying PCP wastes). In the event that the analytic capability is not broadly available then IPEN would be prepared to support 10 ppm consistent with LPCL levels we have proposed for other POPs and which are supported by the references in this document.

Low POP content for HCBD

IPEN supports the recommendation of the UBA consultants (Potrykus, Milunov et al. 2015) to establish a LPCL of 10 ppm or lower. As noted by the consultants an LPCL for HCBD <=10ppm has very minor economic impact but is far more protective of health than current higher proposed LPCLs.

The current proposed level in the EU of 100 ppm is not sufficiently protective of health and as noted in report for UBA (Potrykus, Milunov et al. 2015): "*In order to minimise risks, it would also be possible to set the LPCL for HCBD to 10 mg/kg (or even below) without any practical consequences.*"

Low POPs content level for SCCP

IPEN support the establishment of of LPCL for SCCPs of 10-100 ppm noting that the EU consultants identify capability to recover and dispose materials at this limit which is also analyticaallly feasible. However the consultants identify that their could be economic effects below a 100 mg/kg LPCL as all contaminated rubber would have to be destroyed.

Non-incineration technology for ESM and POPs destruction

Recognising that the incineration of POPs wastes leads to the generation of UPOPs in emissions and especially releases (residues, ash and waste water), it is important that priority is given to the implementation of alternative non-incineration techniques for POPs destruction.

IPEN has reviewed a number of non-incineration techniques that have acceptable Destruction Efficiency (DE) to treat POPs. IPEN does not view Destruction and Removal Efficiencies DRE as a useful measure of destruction capability as this metric includes the fraction of POPs that have been redistributed to process residues such as APC residues, bottom ash and waste water.

Those alternative technoligies that exhibit excellent characteristics for POPs destruction include;

Gas Phase Chemical Reduction (GPCR generation 1) – a proven track record in destroying all commercially available PCBs in Western Australia with demonstrated high DE, negligable emissions, closed lloop process and community support. Also successfully conducted full scale engineering trials on HCB was of high strength. The generation 3 version of the technology is currently available through Canadian vendors ‚True Energy'. The technology has also been successfully used to destroy other POPs as well as munitions and other substances inclusing fluorinated POPs. Data tables on DE for POPs using the GPCR technique are available on request from IPEN.

Super and Sub-critical water oxidation (SCWO)

Data is available demonstrating good DE levels for both Super critical water oxidation (Super CWO) and sub-critical water oxidation (Sub CWO). Data supplied by the Ministry of Environment Japan notes that a number of alternative techniques including Super and sub critical water oxidation were effective for POPs destruction.

Using waste hexachlorocyclohexane (HCH) Sub CWO achieved 99.99999867% DE and for chlordane 99.99999995 % DE.

Supercticial CWO treating HCH achieved 99.99988 % DE and treating chlordane achieved 99.99991 % DE

(Note: concurrent trials by MoE using a hazardous waste incinerator to destroy HCH achieved 99.999700 % DE and a DRE of 99.999998 % revealing a significant shift of POPs to slag and fly ash.)

Base Catalysed Decomposition (BCD)

BCD was able to achieve 99.99930 % DE when applied to HCH waste and 99.99955 % DE when applied to Chlordane waste in the Japanese MoE trials . BCD technology currently operates in Australia and has treated polychlorinated biphenyls (PCB) and organochlorine pesticides (OCP) and equipment and soils contaminated with these substances from within Australia and has also received similar waste from international sources for treatment including PCB from Papua New Guinea and a range of Pesticides including OCP and organophosphate pesticides from other Pacific Island countries. The technology has also operated in the US, Czech Republic and Mexico. It is also applicaable to DDT, HCB, PCBs, PCDDs and PCDFs.[2]

Sodium Dispersion method (Alkali metal reduction)

This process has been used commercially for approximately 20 years. It has been used extensively in particular in North America and in Germany where most of the oil above 50 ppm has now been treated. Plants are also in France, Spain, Iran and Japan. The Japanese MoE trial using this technology[3] resulted in a DE of 99.99990 % for HCH and a DE of 99.9998 % for chlordane.

Vacuum heating decomposition

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[2] Basel Convention (2009) POPs Technology Specification and Data Sheet - Base Catalyzed Decomposition (BCD)http://www.ihpa.info/docs/library/reports/Pops/June2009/BCDSBCLogoMainSheetDEFCLEANVERSION_190109_.pdf

[3] Basel Convention (2009) POPs Technology Specification and Data Sheet - Alkali-Metal-Reduction http://www.ihpa.info/docs/library/reports/pops/june2009/def_alkalimetal_150109_sbclogocleanversion.pdf

The principles of the Vacuum Heating Decomposition are as follows: 1. Heating the objects (such as pesticides) under vacuum condition 2. Pesticides and other POPs are decomposed by pyrolysis and de-chlorination reaction 3. Residual materials are almost inorganic 4. Gaseous fraction emitted by heating objects treated in the alkali reactor which is also under vacuum 5. Chlorine is fixed at alkali reactor as CaCl2 6. Residual materials are cooled in the oxygen and chlorine free condition such as N2 or vacuum[4].

Vacuum heating decomposition trials were conducted by the Japanese MoE resulting in high DEs for the treatment of HCH (99.99999 %) and Chlordane (99.99995 %).

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