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ScienceDirect
Chemosphere 67 (2007) S96–S108
CHEMOSPHERE
www.elsevier.com/locate/chemosphere

National PCDD/PCDF release inventories under the Stockholm Convention on Persistent Organic Pollutants

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Accepted 26 May 2006
Available online 26 January 2007

Abstract

National inventories to estimate releases of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans have been undertaken since the mid 1980s. These inventories were scattered and hard to compare since there was no harmonized method available. With the conclusion of the Stockholm Convention on Persistent Organic Pollutants and its entry into force, Parties to the Convention at the global level, have to establish PCDD/PCDF release inventories and report these results. UNEP Chemicals has developed a methodology that allows developing and developed countries to make estimates of PCDD/PCDF releases into the environment along all vectors. Presently, there are 23 national release inventories available that have been made with this methodology, the Toolkit. Among the most important sources, open fires in agriculture/forests as well as open burning of wastes have been identified as the major sources of PCDD/PCDF. The results from these inventories may serve as the starting point for interventions to reduce or eliminate sources of PCDD/PCDF by application of best available techniques and best environmental practices. The Toolkit will be updated as needs arise.

Keywords: Polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans; Toolkit; Release inventory; Stockholm Convention; Emission factors

1. Introduction

On May 22, 2001, the Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted in Stockholm, Sweden. It entered into force on 17 May 2004 with 50 Parties and 151 signatories. In May 2005, when the Conference of the Parties met for the first time in Punta del Este, Uruguay, 94 countries were Party to the Convention. An up-to-date list of Parties/signatories is available at the Convention's Web Page http://www.pops.int.

The objective of the Convention is "to protect human health and the environment from persistent organic pollutants" (Stockholm Convention, 2001). For intentionally produced POPs, *e.g.*, pesticides and industrial chemicals such as hexachlorobenzene and polychlorinated biphenyls, this will be achieved by stop of production and use. For certain POPs, exemptions will be granted to allow Parties either to produce or use POPs for acceptable purposes. At its WebPage, the Secretariat of the Stockholm Convention maintains a publicly available register of Parties that have submitted notification for specific exemptions as well as for the continued use of DDT for vector control (http://www.pops.int/documents/registers/). For unintentionally generated POPs, such as polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF), measures have to be taken to "reduce the total releases derived from anthropogenic sources"; the final goal is ultimate elimination, where feasible (Stockholm Convention, Article 5 and Annex C). Besides PCDD/PCDF, the Stockholm Convention also includes polychlorinated biphenyls (PCB) and hexachlorobenzene (HCB) in Annex C as unintentionally formed POPs, where the same obligations apply as to PCDD/PCDF for those PCB and HCB that are not from intentional production and use. Under the Convention, Parties have to establish and maintain release inventories of unintentionally generated POPs to prove the

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doi:10.1016/j.chemosphere.2006.05.093

continuous release reduction. Release reduction or minimization of PCDD/PCDF will be achieved by application of best available techniques (BAT) and best environmental practices (BEP). Draft guidelines on BAT/BEP have been developed by an expert group under the Stockholm Convention (Stockholm Convention, 2006).

Since the 1980s, countries made attempts to estimate the emissions of PCDD/PCDF from all sources in their territories. Early inventories were made for Canada (Sheffield, 1985) and later for Germany (Fiedler *et al.*, 1990b; Wintermeyer and Rotard, 1994), Sweden (de Wit *et al.*, 1996) or the USA (Thomas and Spiro, 1996). Since the mid 1990s, national agencies or ministries established emission inventories also due to reporting requirements under international conventions such as the POPs (or Aarhus) Protocol under the UN-ECE Convention on Long-range Transport of Air Pollution (LRTAP) (UN-ECE, 1998) or under the Stockholm Convention on Persistent Organic Pollutants (POPs) (Stockholm Convention, 2001). Recently, a paper was published summarizing inventories for a number of organic pollutants (Breivik *et al.*, 2003).

Typically, national inventories report emissions of PCDD/PCDF in toxicity equivalents (TEQ) most of them using the international toxicity equivalency factors (I-TEF) as established by the NATO/CCMS Working Group on Dioxins and Related Compounds in 1988 (NATO/CCMS, 1988). Japan applies the scheme of the World Health Organization (WHO) (Van den Berg *et al.*, 1998) and also includes the dioxin-like PCB into their emission reporting (Konda, 2001).

In 1999, UNEP Chemicals has published a report summarizing existing dioxin and furan inventories worldwide (UNEP, 1999). At this time, 15 countries had performed PCDD/PCDF inventories and estimated releases from known sources. This UNEP report concluded that based on the available data from these 15 countries and a reference year around 1995, the central estimate of total annual PCDD/PCDF emissions to air was approximately 10 500 g I-TEQ with a lower estimate around 8300 g I-TEQ/a and an upper estimate of approximately 36 000 g I-TEQ/a.

The 1999 situation of PCDD/PCDF inventories was summarized as follows (UNEP, 1999):

- The number of national PCDD/PCDF emission inventories was very small (15 based on national data).
- Most data were available for countries from Western Europe and Northern America. From developing country regions such as Africa, Latin America and Central and Western Asia, there are no data at all.
- Typically, inventories cover emissions to air only; there were only few estimates on releases to water, land or in products. At this time, no estimates for PCDD/PCDF in solid residues were made.
- Amongst the source categories, all countries have addressed municipal solid waste. However, it was also noted that this sector undergoes dramatic changes in technology and thus, PCDD/PCDF emissions change rapidly. Typically, within countries strong downward trends were recognized in countries with modern technology or stringent legislation.
- The inventories were biased in terms of industrial coverage: all countries had estimated their emissions from waste incinerators but other source categories, such as the iron and steel-producing industry, were not taken into consideration. However, some European countries had identified this sector as the major contributor to national dioxin inventories.
- From the few examples on dioxin and furan emissions to water, land and with products it can be concluded that emissions to water only cover wastewaters from the pulp and paper industry. Contamination in products largely is limited to pentachlorophenol (PCP) and the PCDF in polychlorinated biphenyls (PCB) are being ignored.

A general conclusion was that these earlier PCDD/PCDF inventories were not satisfactory for national release reporting. Most inventories were incomplete, out of date or lacked uniform structure. There were no harmonized methods for generating and evaluating data for national PCDD/PCDF inventories. The coverage of sources varied from country to country. Only a very few countries addressed releases other than to air.

Since 1999, some more countries have published or updated their PCDD/PCDF inventories and an amended and updated summary is shown in Table 1, which shows a range between 7000 and 13 000 g TEQ released to air per year.

Since many countries do not have the technical and financial capacity to measure all releases from all potential PCDD/PCDF sources, UNEP Chemicals has developed the "Standardized Toolkit for the Identification of Quantification of Dioxin and Furan Releases" ("Toolkit" for short, UNEP, 2005), a methodology to estimate annual releases without taking of samples or doing dioxin analysis. The Toolkit is being used by countries since 2001. The Toolkit methodology and format is being used by Parties to report national releases of dioxins and furans under the obligations of the Stockholm Convention on POPs. In February 2005, the second edition of the Toolkit was published (UNEP, 2005).

Since 2001, the Toolkit has been introduced to countries in a series of regional training workshops and presently is being applied by countries within their national implementation plans (NIPs) under the Stockholm Convention on POPs. It also has been field-tested by a number of countries receiving assistance from UNEP. No sampling and analyses were undertaken in the course of these projects (UNEP, 2003; Argentina, 2004; Cuba, 2004; Paraguay, 2004; Fiedler, 2003b, 2004). With this methodology, annual releases can be estimated by multiplying process-specific default emission factors provided in the Toolkit with national activity data. This paper summarizes the results of the national release inventories undertaken with the Toolkit. Among others, it also serves as an orientation for other