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LONG-TERM ASSESSMENT OF PCB EMISSIONS FROM LARGE SCRAP METAL RECYCLING PLANTS IN THE FLEMISH REGION (BELGIUM)

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Introduction

In the beginning of the past decade, intensive monitoring campaigns of the Flemish Environmental Agency (VMM) have revealed elevated levels of dioxin-like PCB in deposition samples at a few 'hot spots' in the Flemish region, which were linked with scrap metal recycling activities. Further investigations by the Environmental Inspectorate Division (EID), including a measurement campaign at a limited number of scrap metal recycling plants ([1,2,3]), revealed that mainly diffuse emission sources have a major impact on the environmental contamination of PCB. These diffuse emissions are mainly caused by the dispersion of PCB-contaminated dust. Major sources of these emissions include deflagration, handling of scrap, and manipulation and outside storage of dry flue gas cleaning residues and the shredder light fraction (SLF) or "fluff". In the subsequent years, the EID ordered the shredder plant operators to initiate an action plan to reduce the environmental contamination by PCB.

Materials and methods

In the Flemish region, the general and sector-related environmental conditions for industrial activities are all integrated in VLAREM II (first published in 1995), which is an implementing order of the 1985 Environmental Licence Decree. The Flemish environmental legislation is based upon the principle of prevention of pollution, nuisance and damage. The EID is the authority responsible for the enforcement of the Flemish environmental health legislation. The EID aims to reach a high-level, planned and co-ordinated enforcement, by combining a preventive and a repressive approach.
Dioxin-like PCB are analyzed by an accredited in-house method of a commercial lab, based on HRGC/HRMS.

Results and discussion

Following the actions taken by the EID described above, the VMM continued to monitor on a monthly basis the environmental deposition levels of PCB in the vicinity of most of the scrap recycling plants, and this 4 to 6 times a year. Since 2012, next to PCB126, all other dl-like PCB's are measured. Based on these long-term observations, by 2013 it became clear that the scrap recycling sector was still emitting significant amounts of dl-PCB (at some sites, peak levels exceeding 200 pg TEQ/m^2.day were measured) (4).
However, 2 shredder plants exhibited in their vicinity a clear positive trend regarding 'PCB-deposition performance'. Mean deposition levels down to below 20 pg TEQ/m^2.day were measured, over a period of several years. It was no coincidence that exactly those 2 plants applied systematically and conscientiously effective dust-reducing measures on their site. It In this same period, a new general environmental legislation regarding controlling of non-ducted dust emissions was approved (VLAREM II , Section 4.4.7.), including very detailed and extensive prescriptions on handling and transport of dust-producing substances, thus providing new leverage to enforce extra dust-reducing measures, where necessary.
Both these new and crucial elements prompted the EID to setup a new action plan to further reduce the PCB emissions in Flanders. This consisted of the following steps:
1. Perform a benchmark inspection tour, covering all 11 large metal scrap recycling sites (including 9 shredder plants), spread over the Flemish territory.
2. Perform a PCB measurement campaign on all sites. Assess for all sites the current (ducted and non-ducted) emissions of PCB by stack measurements, and multiple measurements of: depositions samples (jointly with the VMM), waste water samples, and sweep samples of on-site dust-producing substances. Thus, a comprehensive collection of both indicator PCB (iPCB) and dl-PCB data could been gathered.

3. Based on the results of the two above actions, enforce all necessary measures to reduce the environmental contamination by PCB, based on a level playing field. Both a strict control and acceptance procedure of the incoming material has to be put in place, as well as the strict implementation of extra dust-reducing measures, next to an optimal operation of the waste water treatment plant.
4. Perform follow-up inspections to monitor the progress of implementing the enforced measures, as well as continue the deposition measurements to monitor the evolution of the PCB site emissions. This last step is still ongoing. It is hoped and expected that the positive effect of both the primary and secondary measures soon will become visible.

Highlights and conclusions of the PCB emission assessment:

- Stack emissions: the shredder stacks exhibited very low concentrations of dl-PCB; all values ranged between the detection limit (0.001 ng TEQ/Nm^3) and 0.15 ng TEQ/Nm^3. These good results can partly be explained by the state-of-the-art flue gas cleaning systems the shredders have in place nowadays. Correspondingly, the dust levels in the stacks were always lower than 5mg/Nm^3. These results confirm that duct emissions are a minor source of PCB.
- Samples of on-site dust-producing substances: At all 11 sites, traces of PCB could be detected in the samples, albeit with large variations between sites and between the origin of the samples. For iPCB, values (sum of 7) ranged between 0.2 and 32 mg/kg dry material (DM); for dl-PCB, values ranged between 40 and 660 ng TEQ/kg DM. Over the last 10 years, a slight decrease of PCB-levels in these type of substances can be observed (for comparison, see e.g. data in ref (2)). Nevertheless, these figures illustrate that the presence of PCB is still a potential environmental issue for the whole scrap recycling sector.
- Waste water samples: 4 out of 11 sites were exceeding the emission limit value for iPCB of 0.14 µg/l (sum of 7), due to the bad operation of their waste water treatment plant. This is a known issue for this sector (3). There is strong evidence that the PCB-content in the water is correlated with the level of suspended solids, indicating the PCB are adsorbed on the particle surfaces, rather than dissolved in the water. Thus no significant out-leaching of individual congeners occurs, which is confirmed by the typical PCB fingerprint (see below) that could be found in these water samples.
- Characterization and identification of the PCB fingerprints: The whole dataset of iPCB and dl-PCB fingerprints, in all media (air, water, solid), collected by EID and VMM over the time span of several years, was treated statistically (5). It was shown that all the detected PCB, independent of location, medium or sampling time, belong to the same 'population'. A typical resulting fingerprint of the dl-PCB, in this case of the deposition samples, is displayed in figure 1.

Figure 1. Relative abundance of the dl-PCB congeners of 41 deposition samples. The different colors represent different sampling locations and/or different points of time. Error bars represent one standard deviation.

This means that either the detected PCB originate from the same source(s)/application, or that only the most weathering-resistant congeners have been measured. It is currently not clear which option is the most likely.
This resulting fingerprint could be reproduced by a mixture of 33% Aroclor 1254 and at least 33% of a relatively low-chlorinated Aroclor (1221, 1232 and/or 1242). These Aroclors were mainly used as isolation liquids in (large industrial) capacitors and transformers all over the western world.

This recent assessment made it once again clear that large scrap metal recycling plants are still a potential source of the unintentional release of PCB in their surroundings, even 30+ years after the PCB production ban. This can result in increased environmental (air/water) and food chain PCB levels. Whether this problem is unique en limited to the Flemish territory, is highly unlikely.

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