NEW POLICY IN FLANDERS TO LINK ENVIRONMENTAL LEVELS OF PCDD/F AND DIOXIN-LIKE PCBS TO HEALTH

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Introduction

Food consumption is the most important route for human exposure to dioxins (PCDD/F) and PCBs. Currently, the food chain is still contaminated by PCDD/F and PCBs through the precipitation of these pollutants on plants, soil and water. To lower the human uptake of PCDD/F and PCBs, the environmental levels of PCDD/F and PCBs have to be reduced. These environmental levels can be monitored by deposition measurements.
Since 1995 the Flemish Environment Agency (VMM) manages a large deposition measurement network to assess the environmental levels of PCDD/F. In 2002 the analysis of the dioxin-like (DL) PCB126 was included in this network.
In 2010 VMM adopted a new measurement strategy in order to improve the link between environmental deposition levels and their impact on human health.
This paper focuses on the environmental levels of PCDD/F and DL-PCBs in Flanders. These environmental levels are estimated to threshold values for the deposition of PCDD/F and DL-PCBs.

Materials and methods

For a period of 30 ± 2 days samples were collected in Bergerhoff deposition gauges, as described in the German VDI 2090/1 standard. The content of the 3 gauges is pooled and analysed as one sample after removal of coarse objects. The solid fraction is filtered over a pre-extracted glass fibre filter and dried overnight at 55°C. The water fraction is extracted 2 times with toluene. The filter is spiked with internal ^{13}C standards, and extracted by soxhlet for 24 hours with the dried toluene extract of the water fraction. The extract is concentrated and cleaned by column chromatography on Mixed silica and Alumina B Super I. ^{13}C-1,2,3,4-TCDD and 1,2,3,7,8,9-HxCDD are used as the syringe spike. The 17 PCDD/F congeners with 2,3,7,8-Cl-substitution and PCB126 are analysed by HRGC-HRMS. Gas chromatography is done on a DB5-MS column of 60 m x 0.25 mm x 0.1 µm. The instruments used are all HP6890GCs with Micromass Autospec Ultima mass spectrometers. The detection limit of the congeners are below 1 pg/m².day, fulfilling the requirements of the VDI 2090 standard.

Results and discussion:

Emission inventory of PCDD/F

Since the early 1990s, large efforts have been made in the Flemish region to reduce the presence of PCDD/Fs in the environment. Stack emissions from major sources, such as waste incinerators, iron sintering plants and non-ferrous metal plants were strongly reduced. This is reflected in the large reduction of the dioxin emissions measured in Flanders. From 1990 to 2009 the yearly dioxin emission decreased from 490 g I-TEQ to 42 g I-TEQ. This corresponds with a reduction of 91 %. The share of the emissions caused by domestic sources increased from 7 % in 1990 to 74 % in 2009, due to strong reductions in industrial sectors.
Although large emission reductions were observed, on some locations still high PCDD/F depositions are measured in Flanders.

Measurement strategy to monitor environmental levels of PCDD/Fs and DL-PCBs in Flanders

In 1995, the Flemish Environment Agency started a systematic PCDD/F monitoring program to measure the dioxin deposition in Flanders. PCB126, which is the most toxic congener of the DL-PCBs, is included in this program since 2002. From available measurement data of DL-PCB deposition in Flanders, it appears that there is a fairly constant ratio of 0,7 between TEQ from PCB126 and total TEQ from all DL-PCBs in deposition samples. Therefore, the total TEQ deposition of DL-PCBs is estimated from the analysis of PCB126 in the deposition samples.

In 2010 VMM adopted a new measurement strategy in order to improve the link between environment and health. The measuring points are divided into 2 categories, related to land use. Measuring points located near potential sources in industrial areas have a minor impact on health but give information about the source. Measuring points established in nearby agricultural of residential areas, assess the impact on health near these industrial areas. The depositions of the latter are estimated to threshold values for the deposition of dioxins and PCBs.
In 2010, 151 samples were taken on a total of 33 locations. 12 sampling points were set in industrial areas, 21 were located in nearby agricultural or residential regions. The deposition is measured during 4 to 6 months on the majority of sampling points.

Deposition of dioxins and DL-PCBs in Flanders

As deposition measurements are primarily performed in places where high depositions are presumed, the levels are not to be considered as a representative for air quality throughout Flanders.
In 2010, the average deposition is 10 pg WHO-TEQ/m².day for PCDD/F and 30 pg WHO-TEQ/m².day for DL-PCB. However, the dispersion is much larger for DL-PCBs than for PCDD/F: the maximum value is 925 pg WHO-TEQ/m².day for DL-PCB and 50 pg WHO-TEQ/m².day for PCDD/F (Figure 1).

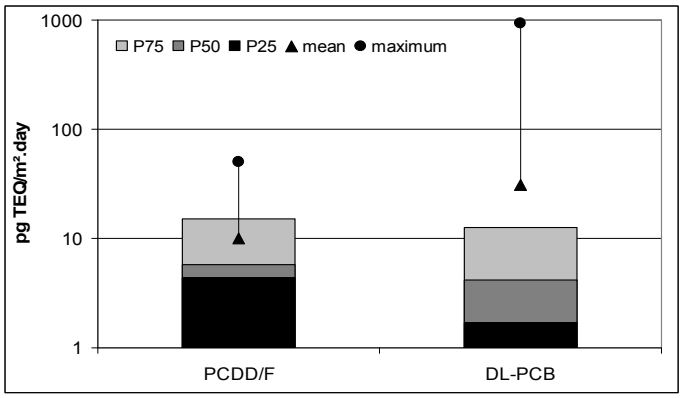

Fig. 1: Deposition of PCDD/F/DL-PCB in Flanders in 2010

In the period 2002-2010, the lowest levels of PCDD/F+DL-PCBs are measured in rural areas (1,5-12 pg WHO-TEQ/m².day with an average of 5,0 pg WHO-TEQ/m².day). In urban regions, slightly higher depositions are found (3,6-21 pg WHO-TEQ/m².day with an average of 9,9 pg WHO-TEQ/m².day). DL-PCBs contribute about 40 % to the total TEQ. A small decrease of the PCDD/F burden during the last decade can be observed in the deposition samples of rural and urban sites.

Measurements of the deposition of PCDD/Fs and DL-PCBs near metal shredder plants

Since 2003, measurements are performed in the vicinity of shredder plants processing electronic and electrical scrap material.

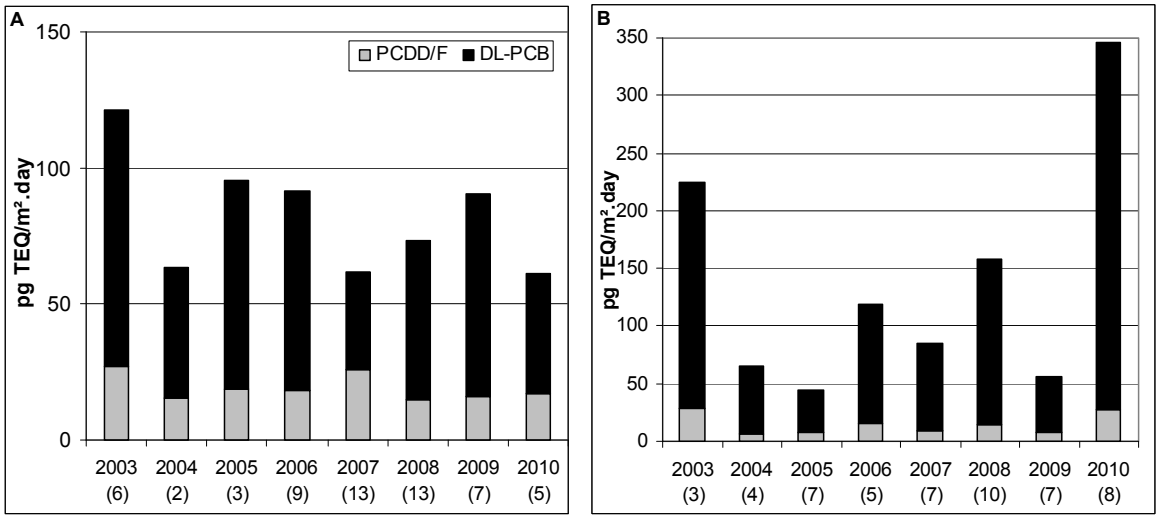

Fig. 2: Deposition of PCDD/F/DL-PCB near 2 scrap metal shredder plants (n= number of measurements)

In Figure 2 the average deposition measured near 2 different shredders is shown. Although the figures are influenced by the size of the plants, the distance of the gauges to the sites and the meteorological conditions during the measurements, it is clear that quite a distinctive PCDD/F/DL-PCB-pattern is measured on these measurement points. Near these shredders, the contribution of the DL-PCBs is distinctively higher with shares from up to 90 % to the total TEQ. Evaluation of the available emission data led to the conclusion that diffuse sources play an important role in the contamination of the region. A number of actions to be taken by the shredder plant operators were enforced by the Environmental Inspection Section (EIS). These were mainly focused on limiting the formation and emission of dust through good housekeeping and improved manipulation. Figure 2 illustrates however no declining trend in the average deposition in the period 2003-2010. The average deposition fluctuates from year to year. This means that the dust reducing actions are not quite effective.
In order to get information about the size of the polluted area, several samples were taken in the SW-NE axis with regard to the shredder. Six measurement campaigns were performed. The results indicate that the highest PCDD/F/PCB-depositions were found in and limited to the immediate neighborhood of the plant. Near the plant deposition levels go up to 200-400 pg TEQ/m².day. The deposition falls back to less than 50 pg TEQ/m².day on a distance of 700m (Figure 3).

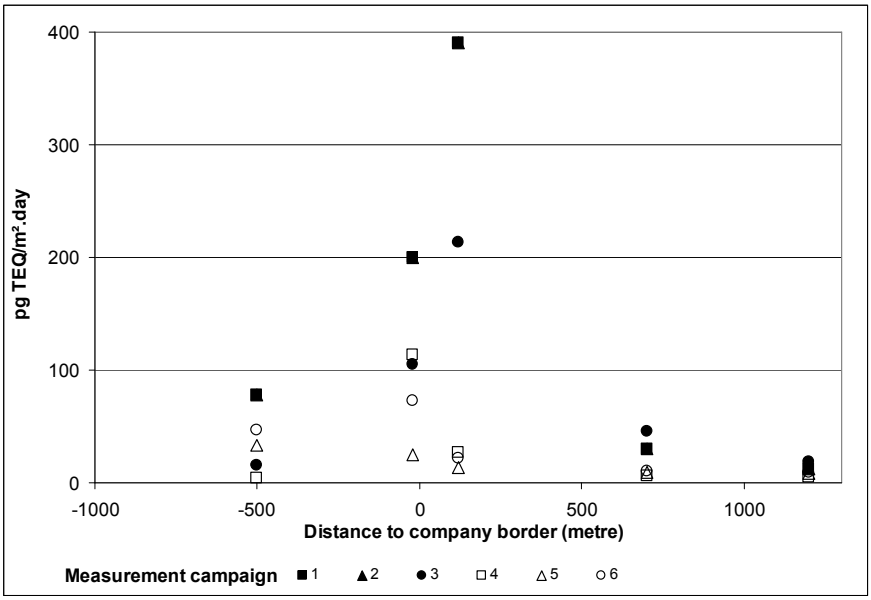

Fig. 3: Relation between deposition of PCB126 and distance to shredder plant

Exceedance of the proposed threshold values

In 2001 the European Commission adopted a Community Strategy for dioxins, furans and PCBs[1]. This Dioxin Strategy consists of actions for reducing the presence of dioxins, furans and PCBs in the environment. In this strategy the Tolerable Weekly Intake of 14 pg WHO-TEQ/kg.week for the group of PCDD/Fs and DL-PCBs proposed by the EU-SCF is taken in account. The VMM calculated threshold values to evaluate the deposition of PCDD/Fs and DL-PCBs, taking the TWI in account[2].
As PCDD/F/PCB are primarily taken up by food, only depositions from agricultural and residential areas are evaluated to the threshold values.
In 2010, several deposition campaigns were organised in residential or agricultural areas. The exceedance of the monthly-allowed threshold value is presented in Figure 4. This threshold was exceeded in 15 % of the samples. The high depositions are frequently found on the same measuring locations.
The exceedance of the threshold value can be attributed, in most of the samples, to either high values of PCDD/Fs or DL-PCBs. In one quarter of the samples a minor elevation of both PCDD/F and DL-PCBs led to the exceedance of the threshold value when the sum of the pollutants is taken in account.

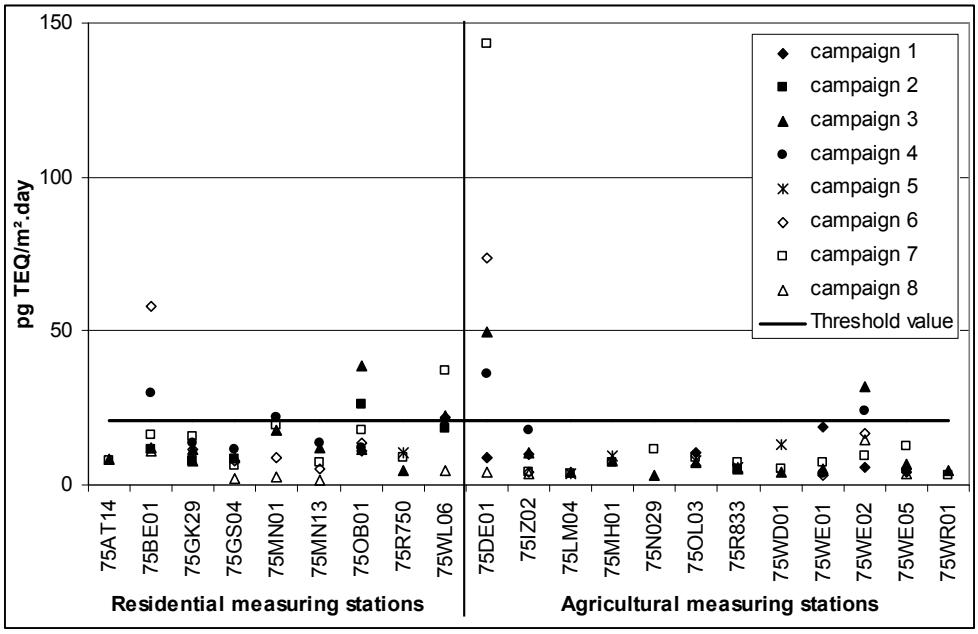

Fig. 4: Exceedance of the monthly-allowed threshold value for deposition of PCDD/F/DL-PCBs

Future actions

There is a collaboration between the governmental agencies for environmental monitoring (VMM), environmental enforcement (EIS) and food chain monitoring (FAVV). High depositions have led to the screening of nearby industrial plants and resulted in the detection of primarily unknown emission sources. The impact of the subsequently enforced sanitation program is assessed by new deposition measurements. Additionally, sampling locations for food products are often chosen based on the deposition data. On the other hand, emission data provided by the EIS or food data provided by the FAVV are often used to select new deposition locations. This exchange of data and measurement strategies should be further improved in order to lower the concentrations in the environment and subsequently in the food chain with a decline of PCDD/Fs and PCBs in humans as a final outcome.

Acknowledgements:

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References:

1. COM(2001)593 final
2. Desmedt M, Roekens E, De Fre R, Cornelis C, Van Holderbeke M. (2008); *Organohal. Comp.* 70:001232