DEPOSITION NEAR A SINTERING PLANT: PRELIMINARY COMPARISON BETWEEN TWO METHODS OF MEASUREMENTS BY DEPOSIMETERS

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As a case-study the local impact measurement of a sintering plant concerning the human exposure to air PCDD/F pollution is in progress, through the use of two types of deposimeters (conventional and wet & dry). This paper deals with some preliminary results and some differences that must be taken into account when the two types of instruments are used..

Keywords: PCDD/F, sintering plant, deposimeter, wet & dry deposition.

1. Introduction

The sector of sintering plants, in the European Union, is considered today one of the major potential contributors to the atmospheric release of PCDD/F and consequent depositions. Anyway the emissions of a plant depend on many factors: characteristics of the input, sintering process, prevention and removal of PCDD/F from the gaseous stream. The local impact of a plant depends also on the variability of release through diffused emissions, secondary emissions and conveyed gases, as each stream can be related to a different way of dilution into the atmosphere. The high variability of parameters that can affect the local impact from a sintering plant makes it interesting the adoption of measuring instruments, such as deposimeters, in order to contribute to the understanding of the human exposure in the surrounding area.

The present paper refers to an Italian case-study whose PCDD/F deposition measurements are in progress using two types of deposimeters placed in a selected site. Preliminary and expected values are discussed taking into account seasonality and operativity of the plant [1].

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2. Materials and methods

The choice of the site for deposimeter positioning resulted from the adoption of an atmospheric diffusion model [2] specifically implemented and the analysis of the territory in order to select an area potentially exposed to the plant emissions.

A vetropyrex Depobulk® deposimeter [3] with its body in glass (Fig. 1) was selected, able to capture the overall deposition of PCDD/F generally in a period of one month around. A special ring avoids interferences from birds excreta.

Fig. 1. Conventional deposimeter: before installation (left) and on the roof (right).

In the same position, called "far", the second kind of deposimeter was installed: two vessels for collecting dry and wet depositions (Fig. 2) [4] characterize this particular technology. The vessels work alternatively "in absence" (dry) or "in presence" (wet) of atmospheric rainfall with the aid of an atmospheric rainfall sensor located on a mobile cover.

An additional Depobulk® device was positioned in a site selected thanks to the diffusion model results in order to check the incidence of the sintering plant form diffuse emissions. This site has been called "close".

Fig. 2. Wet&dry deposimeter on the roof of the selected building

The first period of parallel sampling was organized from March 2011 to June 2011, synchronizing the deposition characterization with the activity of the plant (that stopped 5 weeks for the summer closure in August-September). An accurate cleaning was planned each time when the deposimeters had to operate. Rainy periods were observed in details in order to avoid an overflow of the collected water for the conventional deposimeter (data were taken from a local meteorological station). Each amount of PCDD/F measured in the collected mass was divided by the surface of the deposimeter and the period of characterisation.

The "far" site chosen for the PCDD/F deposition characterization is inside the area of a primary school coupled with a kindergarten. The reason of the choice was related to the location of the school, generally downwind the sintering plant when the plant is operating, to the proximity to the emission source, to the sensibility of the receptor (children) and to the demographic density of the area.

The "close" site was chosen at the limit of the private area of the sintering plant. For reasons related to the cost of electricity, the plant operates from 8 p.m. to 8 a.m. during weekly days and 24 h d^{-1} during the weekend [1].

3. Preliminary results

The first step of the activities was the verification, by diffusion modeling, of the area of interest for the PCDD/F depositions. The "far" site shown in Fig. 3 was selected as representative both of the depositions from the stack and of the diffused emissions (not conveyed). The "close" site of Fig. 3 was selected as representative mainly of the diffused emissions incidence. The first is at a distance of around 1400 m (from the stack) and the second at a distance of around 700 m (from the stack; the plant buildings develop from the stack towards the village).

Fig. 3. Selected positions for the deposimeters (close and far from the plant).

Generally the influence of a plant on the PCDD/F concentration in the surrounding area could be detected by measuring higher values of deposition close to the installation. This is what was detected in the case-study, as shown in Fig 4, for three different periods of the year in spring and early summer:

- Period 1: 36 days, month : March - April 2011;
- Period 2: 40 days, month : April - May 2011;
- Period 3: 41 days, month : May - June 2011.

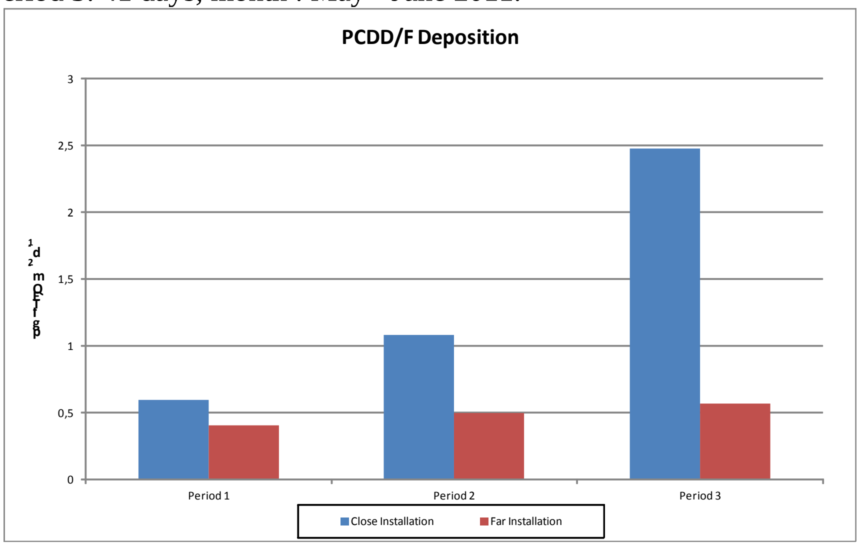

Fig. 4. Values of deposition close and far from the plant.

These values remained below some limits available in the literature: in the Flanders a range of 3.4 – 14 pg_{TEQ} m^{-2} d^{-1} is proposed [5] while in Germany a value of 15 pg_{TEQ} m^{-2} d^{-1} is taken into account [6]. The values found are similar to of lower than the ones measured in rural areas: in Denmark a range of 2.2 – 3.3 pg_{TEQ} m^{-2} d^{-1} was found in rural forest sites [7].

From the graph in Fig. 4 it is clear that the plant may have some influence on air pollution of the surrounding area but a deeper analysis must be made to verify its role. To this concern, a further comparison of analyses made in two distinct periods (period of operation and period of inactivity of the plant for holiday reasons) will help to understand its role.

These analyses were planned but results are not yet available. Also the preliminary results from wet & dry deposimeters are not yet available but some considerations can be made concerning the expected results. Indeed these low values of deposition can create some problems in the analyses.

The main problem can be identified in the detection limit of the instruments used to perform the analyses. Dividing the depositions on two devices (vessels) it could happen that the concentration values for a part of the dioxins and a part of the furans are each below the detection limit with an occurrence higher than the one resulting from conventional deposimeters. To this concern it is interesting to carry out a preliminary check to understand which apportionment between wet & dry deposition can cause a drop in concentrations below the detection limit. With reference to the detection limit of the analytical method of *EPA 1613 B 1994* PCDD/F of 10 fg sample^{-1}, it is interesting to see when the division between wet & dry deposition lowers the value of concentration below this limit.

With reference to the area described above, analyses of three different depositions of about 40 days in a PCDD/F deposimeter Depobulk® were used as starting point [8].

For each analysis an hypothetical distribution was calculated between wet & dry deposition, with the aim to find the percentage for which there is a concentration value below the limit of detection LOD (10 fg sample^{-1}) called "percentage limit obtained" (PLO) (Tab. 1).

The distributions are assumed from 100% dry to 5% dry (95% wet), calculated in steps of 5%.

Table 1

Percentage Limit Obtained values – PLO- for three analyses

	Period 1		Period 2		Period 3	
	Conc. (pg sample^{-1})	PLO	Conc. (pg sample^{-1})	PLO	Conc. (pg sample^{-1})	PLO
2,3,7,8 TCDD	< l.o.d.	100	0.010	95	< l.o.d.	100
1,2,3,7,8 PeCDD	0.012	80	0.443	NR	0.021	45
1,2,3,4,7,8 HxCDD	0.047	20	0.016	60	0.032	30
1,2,3,6,7,8 HxCDD	0.580	NR	0.099	10	0.091	10
1,2,3,7,8,9 HxCDD	0.096	10	0.031	30	0.047	20
1,2,3,4,6,7,8 HpCDD	1.130	NR	4.733	NR	2.520	NR
OCDD	13.500	NR	21.260	NR	9.380	NR
2,3,7,8 TCDF	1.040	NR	1.105	NR	0.494	NR
1,2,3,7,8 PeCDF	0.357	NR	0.116	5	0.162	5
2,3,4,7,8 PeCDF	0.015	65	0.139	5	0.443	NR
1,2,3,4,7,8 HxCDF	0.224	NR	0.138	5	1.010	NR
1,2,3,6,7,8 HxCDF	0.238	NR	0.279	NR	0.950	NR
2,3,4,6,7,8 HxCDF	1.090	NR	< l.o.d.	100	1.190	NR
1,2,3,7,8,9 HxCDF	0.017	55	0.016	60	0.016	60
1,2,3,4,6,7,8 HpCDF	3.820	NR	2.683	NR	4.560	NR
1,2,3,4,7,8,9 HpCDF	0.395	NR	0.044	20	0.228	NR
OCDF	0.880	NR	0.620	NR	4.240	NR

In the favorable event that the limit of detection is not reached with any distribution percentage, NR (Not Reached) is shown in the tables. The combination of these values can cause some problems in obtaining a complete fingerprint of the depositions if the distribution wet & dry is not favorable.

6. Conclusions

Conventional deposimeters can generate important information in order to study the incidence of a plant. Additional information can come from wet & dry devices, to be used for a deeper dispersion modeling analysis. Preliminary analyses of expected data from wet & dry deposimeters can halp in choosing the lasting of the sampling.

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