ATMOSPHERIC LEVELS OF PCDD/PCDF DURING THE TEST PHASE OF A MUNICIPAL SOLID WASTE INCINERATOR, IN PORTUGAL

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Introduction

In the municipal solid waste (MSW) management plan adopted for Oporto, in Portugal, it was built a MSW incinerator with the capacity of 400 000 ton.a^{-1} commonly referred as LIPOR II. Trial burns were performed at LIPOR II during the summer and fall of 1999 and regular operation started in January 2000. An External Monitoring Plan (EMP) for the LIPOR II was designed with the objective of assessing the potential impact over the environment of the construction and operation of this facility[1].

One of the main concerns of the EMP is to fulfil the lack of information about the atmospheric levels of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD and PCDF). The present paper focuses on the PCDD and PCDF atmospheric data obtained until December 1999, prior to the operation of the MSW incinerator and during the trial burns.

Description of the project

During 1998 and 1999, IDAD performed an extensive environmental monitoring program in the region of Oporto. Monitoring will continue through 2000-2001. The EMP includes 4 sub-programs: atmosphere, water (surface and underground), noise and biomonitoring sub-programs[2].

A vast range of parameters are being analysed in each sampling station, with a specific averaging period and sampling frequency, including metals, non-methane volatile hydrocarbons, acid compounds, particulate matter, dioxins and furans, etc. PCDD/PCDF levels reported in this paper correspond to 72 hr average.

Results and Discussion

PCDD and PCDF levels

A total of 39 samples are reported in the present paper, 24 corresponding to the baseline period between June 1998 and July 1999, prior to the operation of the LIPOR II and 15 from the tests period, that occurred between August and December 1999. Figure 1 shows the total PCDD/PCDF air concentrations obtained by the EMP and represented in a temporal scale. It must be noticed that results represented in the Figure 1 were obtained in different sites and, in some cases, different years.

This Figure indicates that air concentrations are higher during the winter months for both sampling periods - baseline and tests. The mean value and the upper and lower limits with a confidence interval of 95% were calculated for the baseline and tests periods and for winter and summer seasons and are represented in Figure 2. The non-homogeneity of the data represented in Figure 1 is confirmed by the extent of the error bars of Figure 2.

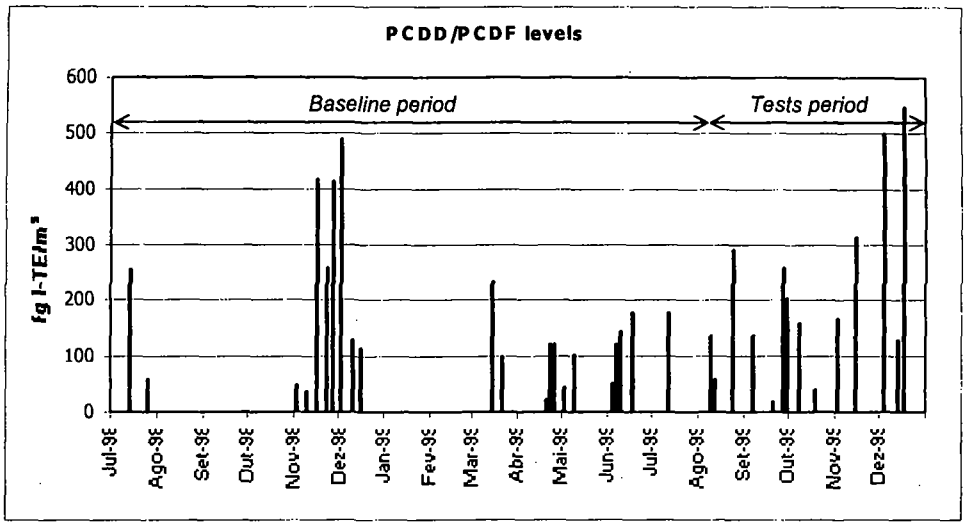

Figure 1 - Environmental levels of dioxin and furans in Oporto atmosphere (fg i-TE/m^3)

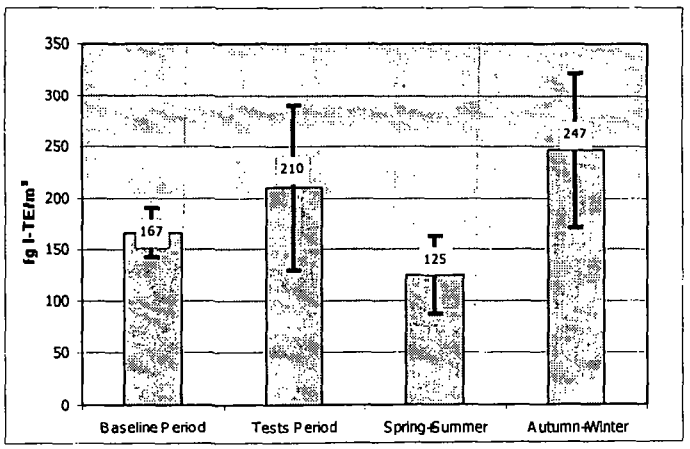

Figure 2 - Environmental levels of dioxin and furans for specific periods (fg i-TE/m^3)

The referred figure shows that the average PCDD/PCDF concentration increased with the start up of the MSW incinerator (from 167 fg I-TEQ/m^3 to 210 fg I-TEQ/m^3), but this increase is not statistically significant. When comparing the results obtained for summer (125 fg I-TEQ/m^3) with winter (247 fg I-TEQ/m^3) it can be said that the increase is more noticeable and, it is statistically significant at 95%. It is important to refer that 67% of the tests period samples were collected during the winter months when the air ambient PCDD/PCDF levels are usually higher, and 63% of the samples that characterise the baseline period were collected in summer. The bigger contribution of winter samples to the tests period could be the main reason for the increase of the average concentration and not only the start up of the incinerator.

Average results calculated for each sampling site, as well as a short description of the sampling stations are presented in Table 1. Considering either the sampling period or the season, the analysis of the data shows a systematic increase of atmospheric levels of PCDD/PCDF, over the different sampling sites.

Table 1 – Average, minimum and maximum PCDD/PCDF air concentrations per period and season of the year for the different sampling sites (fg I-TEQ /m^3)

Local	Period	Average Concentration	Minimum	Maximum	Number of samples
Oporto	Baseline	179	46	417	6
9750 m	Tests	198	18	499	10
SSE	Summer	158	18	306	6
urban	Winter	211	39	499	10
Crestins	Baseline	206	36	490	9
500 m	Tests	-	-	-	0
NNW	Summer	130	52	255	5
sub-urban	Winter	300	36	490	4
Araújo	Baseline	132	23	234	5
2500 m	Tests	194	129	258	2
SE	Summer	107	23	178	4
rural	Winter	207	129	258	3
V.N. Telha	Baseline	103	44	144	4
3200 m	Tests	270	60	548	3
NNW	Summer	94	44	144	5
rural	Winter	376	204	548	2

PCDD/PCDF air concentrations ranged from 18 fg I-TEQ/m^3, in Oporto in Summer, to 548 fg I-TEQ/m^3, in V. N. Telha during the winter months. The average values for the tests period and for winter are greater than in the baseline period and summer respectively.

Homologue and Congener Patterns

Atmospheric samples can be translated into congener profiles which represent the distribution of total PCDD and PCDF present in a mixture. The average PCDD/PCDF patterns for this case study (LIPOR II) were calculated from the baseline period and the tests period samples. Average contributions made by each of the 2,3,7,8-substituted congeners to the I-TEQ value of the air samples are plotted in Figure 3.

By observing the Figure, it can be mentioned that there is not a significant difference between the congener patterns obtained for the baseline period and the tests period. The congeners 1,2,3,7,8 Penta CDD and 2,3,4,7,8 PentaCDF make the greater contributions, while 1,2,3,7,8,9 HexCDF, 1,2,3,4,5,7,8 HepCDF and OCDF are of negligible importance. Error bars for a confidence level of 95% shown in Figure 3 are quite small, which indicates that samples selected in this analysis are very homogenous. Nevertheless it is noticeable a significant increase of 2,3,7,8-TCDF during the test phase and a reduction of the fraction of 2,3,7,8-TCDD.

The congener profiles as well as the homologue patterns were very homogeneous from site to site, from period to period and from season to season. It should, however, be remembered that the

sampling period was 3 days which reduces the effect of site specificity due to the existence of different meteorological conditions.

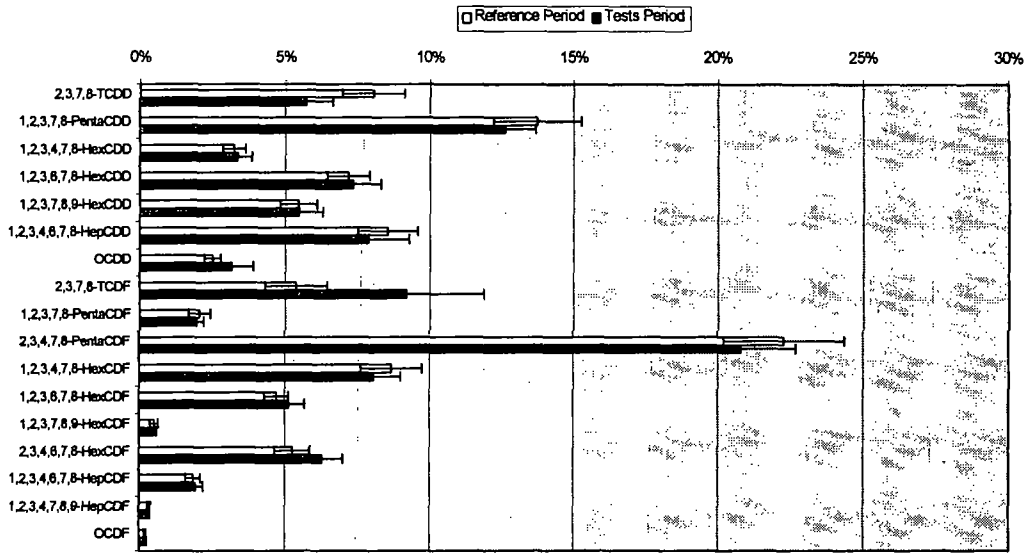

Figure 3 – Percentage contribution of the 2,3,7,8-substituted congeners to the I-TEQ for the total air concentrations

Conclusions

PCDD/PCDF levels measured in the atmosphere of Oporto were relatively high with an average value corresponding to a urban area with important pollutant sources. Results obtained indicate a temporal variability of the PCDD/PCDF levels with higher concentrations during winter. The relatively long sampling period used may explain the reduced spatial variability of the data reported. Comparison of the congener profile does not show any significant changes with the exception of the tetra-chlorinated species.

Acknowledgements

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References

1. Coutinho, M., Conceição, M., Borrego, C. and Nunes, M , *Atmospheric impact assessment and monitoring of dioxin emissions of municipal solid waste incinerators in Portugal*, Chemosphere, Vol. 37, 2119-2126, 1998.

2. Coutinho, M., Bóia, C., Borrego, C., Mata, P., Costa, J., Rodrigues, R., Gomes, P. and Neves, M. *Environmental Baseline Levels of Dioxins and Furans in the region of Oporto*, Organohalogen Compounds, Vol. 43, 131-136, 1999.