Atmospheric emissions of PCDD/PCDF and heavy metals in the Oporto urban area

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Introduction

During the last decade waste production in Portugal increased at a higher rate than the capacity available in the waste treatment and elimination systems. Important efforts have been put in the creation and development of efficient municipal solid waste (MSW) collection systems. Presently Portugal is one of the EU countries with the lowest municipal solid waste *per capita* production. Nevertheless economic development caused an increase on waste production of *circa* 40% between 1985 and 1993 [1].

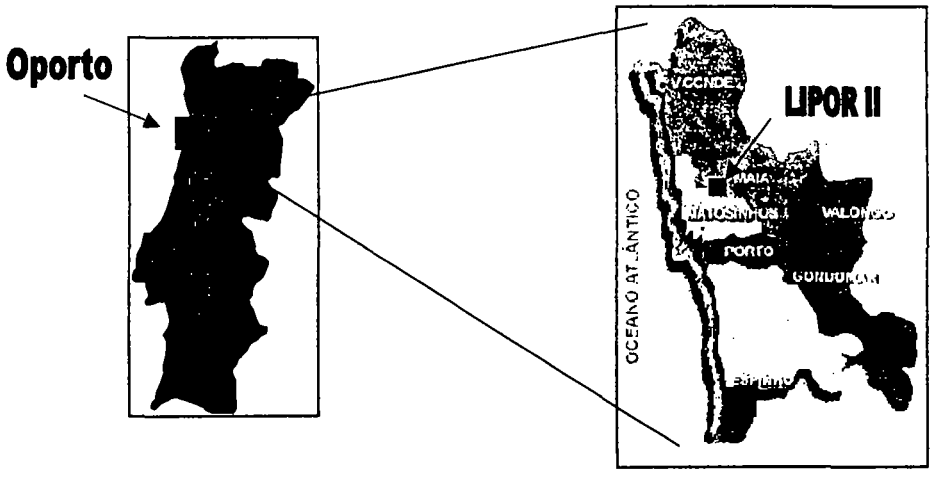

Figure 1 - Location of the metropolitan area of Oporto and of the LIPOR II incinerator.

In the MSW management plan adopted for the metropolitan area of Oporto (see Figure 1) it was decided to build a MSW incinerator with the capacity of 400 000 ton.a^{-1} refered as

LIPOR II. Oporto is the second most populated region of Portugal, with a total population of *circa* 945 000 inhabitants.

An External Monitoring Plan of LIPOR II has been designed with the objective of assessing the potential impact over the environment of the construction and operation of the facility, of following the evolution of public health and the psycho-social reactions of the population. One of the main concerns of the population is related with PCDD and PCDF emissions caused by the operation of the incinerator. As a result of this situation, IDAD - Institute of Environment and Development prepared an emission inventory of PCDD/PCDF for the region of Oporto [2] in order to establish a baseline value for the emission of these compunds. Simultaneously, the same methodology was applied in the quantification of the atmospheric emissions of heavy metals.

Methodology

The first stage of this project was an extensive literature research to study the processes of dioxin formation as well as identify the sources of these compounds. As a result of this study a set of different industrial sectors was selected for further analysis which includes the following activities: municipal waste incineration, hospital waste incineration, coal combustion, oil combustion, vehicle exhaust, tobacco, tar production, land filling, sinterization processes, cement industry, non-ferrous metal industry and crematories.

The estimates presented for the atmospheric emissions of PCDD/PCDF and heavy metals was based in the application of emission factors. No specific monitoring work was performed during this project. Nevertheless emission factors are still the best methodology available to build emission inventories at a regional scale, particularly when several activities are considered [3].

Emissions factors selected show a large range between different authors. The dispersion on the results published are dependent from the technology assessed, age of the industries and obviously from the existence of gas treatment systems. In some cases, particularly in the studies published about heavy metals emissions, a difference of 1 to 200 in the estimate for the emission factors can be found between different authors.

Results

The estimates for the emissions of PCDD/PCDF produced in the LIPOR region are presented in Table 1. No data is presented for sinterization processes and cement industry because these activities are not present in the region. Cremation is negligible.

Total emissions of PCDD/PCDF are situated in the range between 8.5 and 31.9 g/a. Major contributors are the hospital waste incineration and activities related with non-ferrous metal industries. Non-ferrous metal industry has been recently cited in other studies [4] as one of the main sources of PCDD/PCDF for Germany and Sweden. LIPOR II wil be responsible for approximately 1% of the total emissions of PCDD/PCDF of the region.

Table 1 - Emission sources of PCDD/PCDF in the region of Oporto.

Source	Annual emission (mg I-TEQ/a)	Average fraction (%)
Municipal waste incineration	197	1.0
Hospital waste incineration	3200 - 26400	73.2
Coal combustion	64 - 184	0.6
Oil combustion	171	0.8
Vehicle exhaust	303	1.5
Tobacco consumption	1.0	0
Tar production	4.2	0
Land-filling	68	0.3
Non-ferrous metal industry	4576	22.6
TOTAL	**8583.9 - 31903.9**	**100.0**

Table 2 - Emission sources (kg/a) of heavy metals in the region of Oporto.

Source	As	Ni	Cd	Hg	Cu	Cr	Pb	Se	Zn
Municipal waste incineration	985		197		1970*				
Hospital waste incineration	0.04 0.38	0.13 12.6	0.08 1.76	0.75 25.1	0.34 7.5	0.13 8.8	3.8 75.4	0 0.1	7.5 125.7
Coal combustion	10.4 36.3	5.2 323.8	5.4 28.5	48.2 112.9	15.5 362.6	5.2 181.3	111 1380	5.2 23.3	88 1901
Oil combustion	233.6	11680	194.7	58.4	194.7	545.1	428.3	9.7	234
Vehicle exhaust		569 4376	167.5 313.8		569 5107	0 146	22500	14.6	3578 5692
Non-ferrous metal industry	38.5 6462.4	77.4 307.7	15.7 757.6	73.9 83.5	170 539	201 1018	2354 9475	23.0	9394 41980
TOTAL	**13599 24417**		**762 1773**		**6568 43936***			**52.5 70.7**	**13301 49933**

* The estimate for municipal solid waste incinerators includes the emissions of Manganese (Mn).

An estimate of the emissions of heavy metals are presented in Table 2. Results are presented for nickel, arsenium, cadmium, manganese, mercury, copper, chromium, lead, selenium and zinc. To be coherent with national regulations on emissions of municipal waste incinerators data was aggregated in the following groups: (Ni + As), (Cd + Hg) and (Mn + Cu + Cr + Pb). Table 3 presents the fraction of heavy metals emissions caused by the municipal waste incineration. Data available suggests that municipal waste incineration emissions are particularly significant in groups II and III. LIPOR II incinerator could be responsible for an increase of more than 25% of the emissions for these groups of heavy metals.

Table 3 - Fraction of emissions of heavy metals from municipal waste incineration.

Group	Heavy metals	Municipal waste incineration
I	Ni + As	4.0 - 7.2%
II	Cd + Hg	11.1 - 25.9%
III	Mn + Cu + Cr + Pb	4.5 - 42.8%

This increase could be caused by an incomplete emission inventory which can eventually exclude some significant sources. Moreover the dispersion of values presented by the emission factors shows the uncertainties included in this evaluation.

Conclusions

An inventory of the atmospheric emissions of PCDD/PCDF and heavy metals for the Oporto region is presented in this paper. Comparison of the emissions forecasted for a new municipal waste incinerator with total regional emissions shows that the operation of the new incinerator could cause an increase of atmospheric emission of cadmium and mercury, as well as manganese, lead, chromium and copper. Increase of PCDD/PCDF emissions is neglegible.

References

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