A COMPARATIVE STUDY OF PCDD/F EMISSIONS FROM MEDICAL AND INDUSTRIAL WASTE INCINERATORS IN MEDELLÍN-COLOMBIA (SOUTH AMERICA).

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Introduction

Municipal waste management often combines different strategies such as recycling, composting, thermal treatment or landfill disposal. In Colombia, urban solid waste is landfill disposed but, industrial and medical wastes are incinerated. The total medical and pathological wastes generated in this zone are about 1643 ton/year from which 1022 ton/year are incinerated [1] in six plants operating in Medellín metropolitan area. As a result, new regulations governing stack gas emissions have been enforced with the aim of reducing air pollutant emissions. Few incinerators are equipped with a gas-cleaning system and thus, most do not have any cleaning system. Medical waste incineration has been recognized as one of the major known sources of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDF) [2]. To the best of our knowledge, there are not reports about emissions of dioxins and furans from the incineration sector in Colombia.

The first aim of this work was to evaluate PCDD/PCDF emissions from the largest incinerators operating in Medellín (Colombia). In this contribution we report results obtained from three incinerators (A, B and C). The incinerated waste in plant A consisted of polymerization sludge, whereas in plants B and C medical and pathological residues were incinerated. Common medical wastes include dirty bandages, culture dishes, plastic, surgical gloves and instruments (including needles) as well as human tissue.

Materials and Methods

Stack gas samples were collected using a filter/condenser method [2, 3]. XAD-2 (Supelco), previously cleaned, was used as an adsorbent. The sampling process was controlled by spiking the XAD-2 with a standard sampling solution formed by a mixture of labelled PCDD/PCDFs (EN-1948-SS from Wellington Laboratories, Canada). Table 1 summarizes sampling conditions.

Extraction, clean-up and instrumental analysis were carried out in the Mass Spectrometry Laboratory, Dept. of Ecotechnologies (CID-CSIC) in Barcelona. Prior to the extraction process samples were spiked with labelled PCDD/PCDF standards described in EN-1948 method. Analysis was carried out by HRGC-HRMS on a GC 8000 series gas chromatograph coupled to an Autospec Ultima mass spectrometer (Fisons Instruments) with a positive electron impact (EI+) source. The analyser mode was selected ion monitoring (SIM) at 10000 resolving power. A DB-5 (60m, 0.25 mm ID, 0.25 μm, film thickness) fused silica capillary column (J&W Scientific, CA, USA) was used. The temperature program was: 140 ºC (1 min) to 200 ºC (1 min) at 20 ºC/min, then at 3 ºC/min to 300 ºC and held isothermally for 20 min at 300 ºC [2, 3].

Table 1. Sampling conditions.

	Plant A	**Plant B**	**Plant C**
Capacity (kg/h)	40-70	150	40-70
Control system	Heat exchanger Scrubber Cyclone Bag filter Activated carbon	Electrostatic precipitator (ESP)	none
Combustion Temperature (ºC)	700	850	850
Post-combustion Temperature (ºC)	950	1100	1050
Stack gas temperature (ºC)	73	450	400
Fuel	Natural gas	Natural gas	GLP

Results and Discussion

Table 2 lists the concentrations in ng I-TEQ/Nm^3 emitted from each incinerator. The concentrations in the incinerator B and C are significantly higher than the permitted limit in Colombia of 1.0 ng I-TEQ/Nm^3.[4]. Although incinerator A is in compliance with the limit in Colombia this value is high in comparison with the international limit. They demonstrate a deficient control system which is confirmed by observing the high stack gas temperature of plants B and C, favouring "de novo synthesis" (see Table 1). Another factor identified in the literature that affect PCDD/PCDF emissions is combustion conditions [5, 6]. In order to destroy PCDD/PCDF or prevent their formation, the combustion efficiency requires a combination of high temperatures, available oxygen, high heating value fuel, and long residence time [6]. Even with these optimised combustion conditions end-of-pipe flue gas treatment is still required to meet PCDD/PCDF international emission limits of 0.1 ng/Nm^3.

Table 2. Concentrations of PCDD/PCDF in emissions from incinerators.

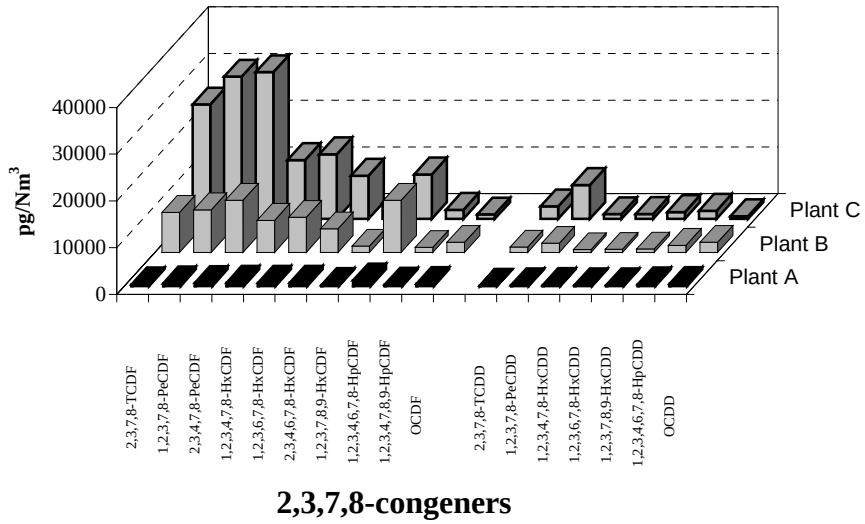
INCINERATOR	**ng I-TEQ/Nm^3**
A	0.843
B	16.2
C	30.3

Experimental evidence suggests that combustion temperatures greater than 900 ºC are necessary for destroying PCDD/PCDF. Moreover, an insufficient supply of oxygen or poor air/fuel mixing will promote PCDD/PCDF formation. However, large mass burning units may have poor air/fuel mixing due to the lack of fuel processing or poorly designed air distribution systems [5]. Low combustion temperatures and high excess of air (14-18 %) are the typical operating conditions. The high stack gas temperature in plants B and C, could be originated because of the large mass of air burned.

PCDD/PCDF concentrations determined in plant A were lower than those found in plants B and C. Although plant A has a control system for gas treatment, the levels of PCDD/PCDF are high. Consequently, it is necessary to improve the control system and the conditions of the combustion process. These results are in agreement with data reported in the literature for plants with no gas-cleaning system or whose gas-cleaning system was based only on the use of ESP [2].

PCDD/PCDF profiles are shown in Figure 1. They are similar in the three plants. Most of the emissions are dominated by 2,3,4,7,8 PeCDF. Combustion byproducts exhibit great similarities as expected in a typical combustion profile [2] characterized by a major contribution of 2,3,7,8-PCDFs versus 2,3,7,8-PCDDs, with a ∑PCDF/∑PCDD relationship of about 4:1 expressed in I-TEQ.

Figure 1. Comparative distribution of PCDDs/PCDFs (TEQ) in three gaseous emissions of incinerators collected in Medellín, metropolitan area.



Conclusion

This study evidences that PCDD/PCDF concentrations are exceeded in the incinerator B and C, the incinerator A is in compliance with the limit of 1.0 ng I-TEQ/Nm^3 [4]. However, the law will be more severe in Colombia and the limit will be 0.1 ng I-TEQ/Nm^3 in the next years. Therefore, cleaning systems are urged, in parallel to measures for enforcing and improving environmental regulations.

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