STUDY OF IMMISSION LEVELS AT A SPRAY-DRIED CLAY POWDER PLANT

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1. INTRODUCTION

The need to know the environmental impact of industrial ceramic facilities requires performing a study of the pollution of the sector, evaluating immission levels (air quality) by means of an environmental control network and determining the emission levels of the emission sources at the industrial plants. For this reason a study has been conducted of the air quality at a spray-dried clay powder plant. The atmospheric particulates from the ceramic processes that run at the studied company stem from two types of emissions:

EMISSIONS		ORIGIN
Fugitive		Conveying and handling of raw materials and finished products.
Channelled	Cold	Multiple points and/or extraction outlets throughout the manufacturing process.
	Hot	High-temperature industrial processes.

Table 1. Classification of emissions and their origin. Source: Monfort et al. 2001

The following toxic elements have been considered in view of their relation with the ceramic process:

ELEMENT	ORIGIN
Boron (B) Lead (Pb) Zinc (Zn) Barium (Ba)	Cleaning water and water from recycled material used in slip preparation. Most of these elements are retained in the spray-dried powder granules and the rest is partly entrained by the water that evaporates in spray drying.
Fluorine (F)	Clays. The fluorine emission arises as a result of the decomposition of the micaceous minerals (muscovite and illite) and kaolinitic minerals in clays during the firing process from 500-600ºC.
Arsenic (As) Nikel (Ni) Cadmium (Cd)	Fossil fuel combustion processes and emissions in high-temperature ceramic processes. Fossil fuel combustion processes to obtain energy. In ceramic colours and glazes.

Table 2. Origin of the elements

2. METHODOLOGY

The sampling period was three months and the following equipment was used: settleable particle capturing instrument, PM10 capturing equipment and cascade impactor. The capturing instruments were installed at 7 sampling points in the company, detailed below:

SAMPLING ZONE	SAMPLING POINT	SITUATION
Spray-dried powder facility	Spray driers 2,3,6	Indoor
Milling facility	Workshops MTC2, MTC4	Indoor
Charging facility	Charge no. 3	Indoor
Parking	Scale	Outdoor

Table 3. Sampling locations

The concentration levels of particulate matter were determined by gravimetry; arsenic, nickel, cadmium, lead, zinc and barium concentrations were determined by ICP-MS, and boron and fluorine concentrations by visible spectrophotometry. The PM10 fraction of the particulate of all the toxic elements was analyzed. Mineralogical analysis was conducted of the collected atmospheric particulate, by X-ray diffraction (XRD), thus identifying the major mineral phases.

3. RESULTS

To evaluate the concentrations obtained at the indoor locations, we used the Limit Values of Occupational Exposure recommended by the Ministry of Work and Social affairs for the evaluation and control of risks inherent to exposure, mainly by inhalation, to chemical agents in the workplace. For the outdoor sampling point we used Directive 1999/30/EC, which establishes the limit values for particulates and lead in ambient air, and a draft European Directive that will shortly legislate the concentration levels of the toxic elements: arsenic, cadmium and nickel. Tables 4 and 5 detail the concentration levels found for each pollutant and each type of location.

TYPE OF PARTICLE		INDOOR		Limit	OUTDOOR	
(particle size)	ALV	value	Range	Average	Range	Average
Settleable (mg/m^{2}day)	----	38000-555000	223000	----	760-1820	1000
PST (µg/m^3)	10000	7601-10903	8616	----	210-378	297
PM10 (µg/m^3)	10000	1128-3506	2707	40	160-307	283
PM2.5 (µg/m^3)	3000	865-1545	1194	----	59-106	84
PM1 (µg/m^3)	----	146-319	230	----	17-28	24

Table 4. Concentration levels of the different particulate fractions.

		FRACTION PM10				
ELEMENT	ALV	INDOOR		Limit	OUTDOOR	
		value	Range	Average o	Range	Average
Arsenic (ng/m^3)	100000	24-79	45	6	20-70	38
Nickel (ng/m^3)	1000000	42-147	94	20	11-24	8
Cadmium (ng/m^3)	10000	0.5-5.0	3.0	5	2.0-6.0	4.0
Lead (ng/m^3)	100000	364-1362	707	500	298-1004	564
Zinc (ng/m^3)	10000	291-2095	977	----	574-2680	1342
Barium (ng/m^3)	500000	203-669	333	----	57-110	77
Boron (µg/m^3)	-----	0.100-0.600	0.370	----	0.007-0.050	0.030
Fluorine (µg/m^3)	1600	0.80-1.80	1.25	----	0.50-0.80	0.67

Table 5. Concentration values of the analyzed toxic elements.

Higher concentration values were obtained at the indoor sampling points for all the particle size ranges. The major components detected in the mineralogical analysis of the particulates matched the minerals that comprise the clays used for the manufacture of ceramic bodies. The concentration levels for the chemical elements analyzed were higher inside the plant except for cadmium and zinc. Taking into account the results obtained, the implementation of a series of corrective measures is proposed.

STAGE	CORRECTIVE MEASURES
Raw materials Reception.	-Control of fugitive emissions in the open air storage stages. -Wetting of the clay raw materials (yards and trafficked areas). -Creation of hedges in the conveying and storage areas. -Asphalting of paths. -Cleaning of truck wheels and undersides. -Transport of materials in closed systems. -Construction of sheds near the plant for slip preparation. -Installation of extraction systems.
Preparation of raw materials and drying by spray drying.	-Treatment of gases effluents in cyclones. -Use of pneumatic systems for raw materials transport. -Installation of extractors to avoid dust scatter. -Keeping the plant floor clean.

Table 6. Proposed corrective measures.

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