Long term monitoring of a Waste-to-Energy facility in Porto

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Abstract

As an output of the Environmental Impact Assessment process of the construction and operation of the LIPOR II facility, an External Monitoring Program (PMExt) has been running since 1998. At the time of its conception, the LIPOR II PMExt program, which consists of three different and complementary plans (Environmental Monitoring Plan, Public Health Monitoring Plan and Psycho-Social Monitoring Plan), had as a main goal to follow up and assess the effects of the construction and operation of LIPOR II over the surrounding environment. The three sector plans were designed independently. The inter-relations between the several sectors underlie their design. An example of this is the direct relationship between the potential environmental contaminations and public health. This program has been subject to several changes and revisions since 1998 that resulted from analysis of data acquired over the years, as well as from the need to answer to the requirements of national and EU legislation. During this period of follow up it has been possible to observe not only the temporal evolution of the effects of the facilities operation, but also the fact that the PMExt program has proved to be an important management tool, allowing to evaluate and refine any operating conditions of LIPOR II, in order to minimize negative impacts and enhance positive ones.

Keywords: Lipor II; Environmental monitoring; Baseline levels; PCDD/PCDF

1. Introduction

As part of the municipal solid waste (MSW) management plan adopted for Porto, a state-of-the-art MSW incinerator, known as the Lipor II project, was constructed. Trial burns were performed at Lipor II during the summer and fall of 1999 and regular operation stated in January 2000. The Lipor II External Monitoring Program (PMExt) was designed with the objective of fulfilling the lack of information about baseline levels prior to the operation of the MSW facility and assessing the potential effects over the environment, public health and human behaviour. To accomplish this, the PMExt integrated the following three sub-programs: environmental monitoring plan, public health monitoring plan, and psychosocial monitoring plan (Coutinho *et al*., 1998).

2. Description of the project

The implementation and operation of activities of the PMExt since its beginning has been settled at IDAD and involves the participation of various entities in the study of several sectors. The three plans include the study of various environmental features, as well as the study of psycho-social and public health aspects regarding this project.

The activities of the environmental monitoring plan are centralized at IDAD since the beginning of the monitoring program in 1998 and include 4 sub-programs: atmosphere, water (surface and underground), noise and biomonitoring. These features were still split into two subjects: the environmental, including sampling and analysis of air and water samples, agriculture soil and sediments, noise measurements, and the biological, with sampling and analysis of products such as cabbage leafs, corn, potato, eggs and milk.

To establish the environmental baseline levels over different material media, IDAD performed during 1998, several monitoring campaigns of various pollutants in the region of Porto. Monitoring activities continued within the trial burns period performed during the summer of 1999 and regular operation, started at January 2000. This plan included parameters for which have been defined legal limit values, for example, SO_2, NO_X, CO, O_3 in atmospheric samples and the BOD5 and pH in water samples, having also included monitoring of potential marker species (dioxins and furans, heavy metals) in all media.

One of the main environmental concerns related to MSW treatment and disposal facilities is the emission of dioxins and furans (PCDD/PCDF). This was an issue of great concern when activities to be included in the PMExt were outlined (Coutinho *et al*., 1998). Baseline monitoring campaigns of PCDD/PCDF was crucial at the time, having been carried out in different matrices, from air quality (Coutinho *et al*., 2001; 2000), river sediments and soil in the environmental sub-program to a variety of biological media (Coutinho *et al*., 2002).

The main goal of the public health monitoring plan is to assess the potential risks to the public health associated to the regular operation of the MSW incinerator over healthy people in its influence area. This program includes two different and complementary sub-programs: biological surveillance and the identification of risk factors. In biological surveillance, samples of human milk and blood are collected to measure the concentrations of certain pollutants (dioxins and furans and heavy metals). The screening of risk factors and adverse effects also takes place through questionnaires concerning smoking habits, cancer mortality incidence levels, among others (Calheiros *et al*., 2002).

In the psycho-social monitoring plan, local people were invited to answer specific questionnaires two times a year. The questionnaires are focused in three identified hot spots: noise, risk perception and atmospheric pollution. The psycho-social indicators considered essential to human life quality, like stress, anxiety and depression, have been assessed.

3. Results and discussion

As a result of increased knowledge of the environmental impact of the Lipor II facility, PMExt has undergone several revisions and adaptations of its structure, in 2001, 2004, 2007 and recently, at the beginning of 2011.

Concerning air quality monitoring, changes were made according to new legislative framework, having included monitoring of polycyclic aromatic hydrocarbons (PAH) in 2004 and continuous monitoring of total gaseous mercury (TGM) and benzene in 2007. Data collected over the years has shown an important reduction in atmospheric levels of PCDD/PCDF in the Porto region. One of the important outcomes of PCDD/PCDF monitoring in ambient air was the relationship established between high levels measured until the first quarter of 2001 and the closure of the S. João hospital waste incinerator at that time (Coutinho *et al*., 2006).

Atmospheric concentrations of most pollutants (heavy metals, PCDD/PCDF, PAH, benzene) have shown a strong seasonal variability, mainly related to an increase in combustion sources in the winter (fireplaces) associated with thermal inversions. Legally binding parameters, like some of the metals monitored (Pb, As, Cd, Ni), benzene and benzo(a)pyrene, have revealed mean values considerably lower than their respective limit values. Other pollutants, such as PCDD/PCDF, TGM and the remainder heavy metals and PAH have shown values equivalent to the ones found in several rural or semi urban areas of Europe.

Historical data on water quality has shown no significant changes compared to the baseline situation of water quality used for irrigation (surface water) and drinking water (groundwater). Results obtained from water monitoring didn't identify any kind of contamination of surface water or groundwater due to the operation of Lipor II.

At the time of its conception, the biomonitoring subprogram was outlined to assess the degree of contamination of biological species and their support medium in an area potentially affected by the operation of Lipor II. Cross-sectional analysis of the results obtained in the different biological matrices indicates no contamination due to the operation of Lipor II. Given the ready availability of agricultural soils for collection, and the fact that sampling may be performed directly by the monitoring personnel, results have been consistent, proving soils to be good indicators of environmental quality in the surrounding of Lipor II.

A positive output of the PMExt biomonitoring program was the implementation of a complementary project in the Northern area of Portugal, where an inventory of PCDD/PCDF sources and study of PCDD/PCDF contamination pathways was established and a wide range of samples, from ambient air to cows milk and eggs, were collected for PCDD/PCDF analysis.

During the PMExt, the main conclusion of the noise monitoring program is that the operation of Lipor II does not induce serious problems of noise pollution in the surroundings of the facility, except at one location (closest to Lipor II) where the legal criteria is sometimes exceeded. This non-compliance is closely related to the fact that the residual noise levels are quite variable. Results have shown a measurement uncertainty associated with high residual noise, suggesting a large variability in measurements. Road traffic from the nearby highway is also responsible for strong daily fluctuations in measurements.

The main change in this environmental sub-program was the inclusion, in 2007, of a continuous monitoring network, consisting of sites selected from the noise map of the surroundings of Lipor II. This network has increased the degree of knowledge of factors that influence noise levels in the nearby surroundings of Lipor II, as well as the capacity to intervene in the management and communication of noise levels measured. Continuous monitoring of noise has helped in the identification of some noise sources at each monitoring location, revealing that Lipor II is not one of these sources.

The results from the public health monitoring plan have shown that there is no deterioration in terms of exposure of people close to the facility when compared to data from the period prior to the start of regular operation of Lipor II (Calheiros *et al*., 2002). This is illustrated by the levels of dioxins and furans found in breast milk and human blood, where no significant differences have been observed in comparison to control groups for the same years. An important reduction of lead content in both newborns and their mothers has been observed and related to the decision to eliminate leaded gasoline.

Over the years, the psychosocial monitoring of Lipor II has shown a stabilization of attitudes towards the facility and, after a first phase of apprehension and increased perception of risk (during the first phase of operation), levels have stabilized to low values. However, it is known that risks associated with incineration processes have the potential of social amplification. This social amplification is likely to increase as a reaction to local environmental events or events elsewhere in the country. Therefore, this monitoring plan has undergone revision and is now carried out every 2 years.

One must keep in mind that the PMExt was designed with the objective to monitor and evaluate the effects produced by the construction and operation of Lipor II. However, the fact that Lipor II is located in a highly industrialized and densely inhabited area, has been considered when evaluating potential sources of contamination.

In summary, results obtained from the PMExt have shown that the regular operation of Lipor II has not brought an increased risk of pollutants to health, such as PCDD/PCDF, considering their direct relation to waste-to-energy facilities. The PMExt has also allowed that communities and decision makers be informed of the level of population exposure to parameters considered in the program, information that without this monitoring program would not exist. With the data collected from the

several programs and sub-programs it has been possible to have a complete characterization and understanding of the surrounding environment. Monitoring of important pollutants, such as PCDD/DF, has produced a series of information that otherwise would not have been known. The interrelationship of the programs has helped to integrate information and introduce, when necessary, any corrective measures.

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