

ENVIRONMENTAL LEVELS - POSTERS

MONITORING FOR PCDD/FS IN SOILS IN THE VICINITY OF AN IRON ORE SINTERING PLANT

Raymond Fisher, Amanda Horne, Alistair N. Haines, and David R. Anderson

Corus R, D & T, Swinden Technology Centre, Rotherham S60 3AR, United Kingdom.

Introduction

The production of steel is energy intensive and involves a number of high temperature processes which raise the possibility of PCDD/F formation. In order to assess the potential for the release of PCDD/F from its operating plants, and to aid the development of appropriate control strategies, Corus in the UK (formerly British Steel plc) established a dedicated unit at its Swinden Technology Centre in Rotherham for the sampling and analysis of trace organic micropollutants. The unit was set up in 1995 and initial work was concerned primarily with developing an inventory of PCDD/F emissions from integrated iron and steelmaking operations, such as cokemaking, iron ore sintering, and basic oxygen steelmaking (BOS), the preliminary results of which were reported earlier¹. The initial emissions inventory confirmed that iron ore sintering was probably the most important source of PCDD/F emissions in the steel industry, as reported elsewhere². Subsequently work has been focused on developing an understanding of the factors influencing the formation of PCDD/Fs in the sintering process³ and in evaluating the environmental impact⁴ of PCDD/F emissions in the environment. From these studies⁴, the mean PCDD/F concentration in the main stacks of sintering plants operated by Corus in the UK was 1.21 ng I-TEQ/Nm³ for 94 measurements, which is slightly above the achievable release limit of 1 ng I-TEQ/Nm³ specified by the Environment Agency in the UK for new plant. This paper is concerned with the environmental impact studies and presents details of an initial soil sampling survey that was carried out around a 4 Mt/annum iron ore sintering plant in the United Kingdom.

Methods and Materials

Selection of Sampling Positions

The sampling locations were selected on the basis of dispersion modelling of the emission from the sinter plant main stack. The dispersion modelling calculations were performed by use of the ADMS dispersion model as recommended by the UK Environment Agency and this indicated three points where the stack emission would be expected to have particular impact which were located approximately 1.5 km ENE, NNW and SW of the source in decreasing order of magnitude. Sampling was therefore carried out at the three points highlighted by the dispersion calculations and background sampling was also carried out at a rural location 15 km south of the works. Data required for the model viz., mass emission rate, waste gas temperature and flow etc., were obtained during emission sampling programmes.

Soil Sampling

The samples were taken with a stainless steel coring device. At each location four cores of about 5 cm diameter were extracted to a depth of about 10 cm at the corners of a 1 m square. Each core was wrapped in clean aluminium foil, labelled and then placed in a polyethylene bag for transportation to the laboratory. The cores were processed to remove vegetation, invertebrates and litter, and the top 5 cm of material, including the root mat, was removed with a sharp knife to

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yield samples of representative surface soil. The prepared materials were spread out on separate, labelled stainless steel trays and dried in air. The dried samples were ground in a pestle and mortar for several minutes, after discarding any large stones. The ground material was passed through a 2 mm sieve to remove smaller stones and transferred to a clean amber glass jar for storage prior to analysis.

Analysis for PCDD/Fs

A 5 to 10 g portion of prepared soil was taken and spiked with an internal standard mixture of fifteen $^{13}\text{C}_{12}$ -labelled PCDD/Fs in accordance with US EPA method 1613B. The spiked samples were extracted by accelerated solvent extraction with toluene using a Dionex ASE 200 system. The extracts were subjected to a clean-up procedure that consisted of a multi-layer column containing activated silica, 31% 1M NaOH-silica and 44% H_2SO_4 -silica followed by separation of PCDD/Fs from other organochlorine compounds on a Florisil mini-column. A recovery standard containing 1,2,3,4-TCDD and 1,2,3,7,8,9-HxCDD was added prior to analysis by HRGC-HRMS on a Micromass Autospec Ultima system equipped with Hewlett Packard 5890 GC and a DB5-MS column.

Results and Discussion

The mean PCDD/F in soil concentrations are summarised in Table 1.

Table 1 PCDD/F Results from a Soil Survey Around an Iron Ore Sintering Plant

Sampling location relative to the sinter plant	PCDD/F mean concentration (ng I-TEQ/kg)
NNW	12.5
SW	4.3
ENE	24.6
SE (background site)	7.4

The results shown in Table 1 confirm the predictions of the dispersion model with regard to the relative impacts at each of the ground level PCDD/F concentration maxima, i.e., ENE (24.6 ng I-TEQ/kg) > NNW (12.5 ng I-TEQ/kg) > SW (4.3 ng I-TEQ/kg). The background soil concentration was 7.4 ng I-TEQ/kg which is slightly higher than the PCDD/F concentration of 4.3 ng I-TEQ/kg found at the site SW of the sinter plant stack.

These data may be compared to the results of other soil surveys in the United Kingdom. A soil survey⁵ was undertaken by Her Majesty's Inspectorate of Pollution (now the UK Environment Agency) and the mean background concentrations were found to be 6.2 and 30.2 ng I-TEQ/kg for rural and urban sites respectively. The mean data for all sites in the present survey fall within this range, suggesting minimal environmental impact from the sintering process. Significantly higher levels of PCDD/Fs in soil have been found in the vicinity of waste incineration installations (MWI). PCDD/F concentrations in soil around MWIs in Hampshire in the UK⁶ were in the range 0.6 to 160 ng I-TEQ/kg and levels of up to 680 ng I-TEQ/kg were observed in the vicinity of a chemical waste incinerator⁷ in the United Kingdom. The observed increases in soil PCDD/F concentrations around the iron ore sintering plant measured here are relatively small compared to those for MWI and chemical waste incinerator (CWI) plants.

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To put these data in a context it is necessary to compare them with published standards or guidelines for PCDD/Fs in soil. The only reference values that are available to date⁸ are those in the Netherlands and Germany and are shown in Table 2.

Table 2 European Limits and Reference Values for PCDD/F Concentrations in Soils⁸

Germany	ng I-TEQ/kg		Netherlands (guidance only)	ng I-TEQ/kg
Children play areas	<100			-
Urban	<1,000		Residential	<1,000
Industrial	<10,000		Reclaimed land	50
			Aquatic sediments	100
Farming	40		Dairy farming	10

Inspection of the data in Table 1 shows that the soil PCDD/F concentrations in the vicinity of the sinter plant are all lower than those recommended in Germany for agricultural soils. The soil PCDD/F concentrations largely exceeded the Dutch guideline of 10 ng I-TEQ/kg for dairy farming, but were below the guidelines listed for other land uses. It should be emphasised that the Dutch limit for dairy farms would be difficult to meet even in rural locations of the United Kingdom where, as already mentioned, the mean background soil concentration for rural locations is 6.2 ng I-TEQ/kg, probably as a result of the long industrial heritage and population density of the United Kingdom.

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