MOBILITY OF CHLOROFLUOROCARBONS IN DEPOSITS OF SHREDDER WASTES FROM PLASTIC AND METAL UTILIZING INDUSTRIES

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Abstract. Chlorofluorocarbons (CFCs) are used as propellants in spray cans, as refrigerants and as blowing agents for plastic foams, which are finally dumped together with solid wastes in landfills. We found shredder waste from plastic and metal utilizing industry to be highly contaminated with F12 (CF2Cl2) and less with F11 (CFC13). By means of model calculations with one dimensional diffusion models, we were able to estimate the amount and rate of outgassing of CFCs. The models were validated with measured vertical gas concentration profiles. From our results we conclude that deposition of shredder wastes containing CFCs results in a quick loss of these substances to the atmosphere with half-lives of ~ 2 d. In order to reduce CFC emission from landfills, contaminated wastes should be covered with compacted adsorbing layers (e.g., sewage sludge) immediately after their deposition.

1. Introduction

Chlorofluorocarbons (CFCs) have recently been identified as the principal agents reducing the O3 layer of the atmosphere (Molina and Rowland, 1974; NRC, 1984). Khalil and Rasmussen (1987) have found the residence time of F11 (CFC13) in different types of closed cell polyurethanes to be extremely long, probably more than 100 yr. In their experiments they used freshly manufactured, unbroken foams exposed to atmospheric pressure and room temperature (21 to 27 °C). In our investigation we attempted to determine the fate of chlorofluorocarbons (CFCs) in used plastic foams after their deposition in a landfill.

The study area (Figure 1) is an active sanitary landfill located to the south of Nürnberg (West Germany). The landfill covers an area of 30 000 m² and is subdivided into different sections containing rubble, slag from municipal waste incineration and industrial sludge. Shredder refuse from metal and plastic foam utilizing industries are dumped together with sewage sludge and domestic wastes in an impervious area almost in the middle of the landfill. Leachates of the landfill are controlled by several groundwater monitoring wells. The mean groundwater flow direction is northwest (Figure 1).

2. Materials and Methods

To detect contaminated areas, landfill gas samples were drawn by means of a mobile pipe device at grid points covering the landfill. Grid point distances were 50 m. All samples, unless otherwise stated, were taken at a depth of 1 m below the surface.
Up to 200 mL of landfill gas was sucked through a microcolumn packed with XAD-2 resin. This resin was used to adsorb and concentrate volatile organic halocarbons. In the laboratory the columns were eluted with 0.4 to 0.8 mL of n-Pentane. Quantification and identification of the extracted compounds were done by GC-ECD and GC-MS. A more detailed discussion of the analytical methods will be presented elsewhere (Haderlein and Pecher, 1987).

3. Results

The grid sampling pattern revealed several CFC-contaminated areas (Figure 2). We measured unexpectedly high concentrations of F12 in landfill gas from the impervious section. The maximum value of F12 was 1.5 g m$^{-3}$. F11 was found in lower concentrations, approximately 10% of F12. To obtain a better understanding of the behavior of CFCs, we sampled two vertical profiles from the shredder waste area. One was drawn immediately after deposition of waste and the other 5 days later (Figure 3). The first profile showed a steep increase in F12 concentration from the surface to a depth of about 40 cm, after which the concentration remained constant. The second profile (5 days later) revealed a quite different shape. Concentrations of F12 were much lower and