Influence of Linear Alkylbenzene Sulfonate (LAS) as Organic Cosolvent on Leaching Behaviour of PCDD/Fs from Fly Ash and Soil

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1. Introduction

Disposal of the incineration residues is a rapidly grown problem [1,2]. Development of a decisive criteria to evaluate the environmental behaviour of fly ash deposit becomes very important. Leaching tests are often used to simulate mobility under dump conditions. Linear alkylbenzene sulfonate (LAS) have been found to increase water solubility of chemicals [3]. A large amount of LAS is disposed to sewage and removed during primary and secondary sewage treatment. Low but measurable concentration of LAS has been reported in river and estuarine sediment. Therefore, the influence of LAS as elute on the leaching of PCDD/Fs was investigated in this study. Whether the transport mechanism of PCDD/Fs is caused by adsorption on infilterable fine particles will also be checked and discussed.

2. Experimental

2.1 Leaching tests

The leaching experiments are depicted in figure 1. The vessel supplied this leaching system with LAS from which percolated the two columns by gravity. The percolation flow rate was 20±5ml/h. The infiltration capacity of the soil was not overridden because a supernatant in soil columns could not be observed during leaching experiments.

(1) The first experiment was carried out according figure 1. The second column only contained discs filter and 20g seasand without soil. The fly ash eluted with pure water and LAS water.

(2) The second experiment was performed with soil columns of 4cm and 18cm length, respectively. The column eluted by LAS water. After finishing the experiment the soil columns were frozen (-80^{0}C). The column of 18cm length was carefully cut into layers of 2cm depth, the column of 4cm length was mixed and analysed as a whole. The leachate was sampled in a glass vessel and analysed as a whole.

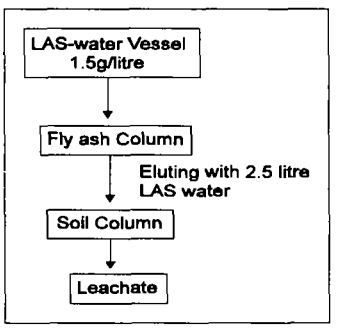

Figure 1 Schematic plot of the leaching experiments

2.2 PCDD/Fs Analysis

The PCDD/Fs analysis procedure include in Figure 2 [41]:

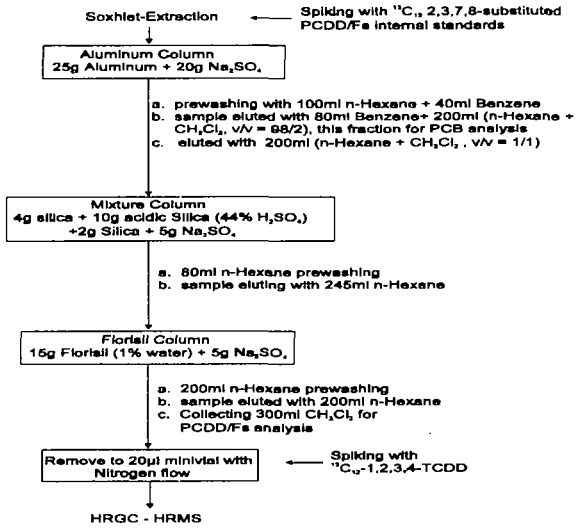

Figure 1 Clean-up procedure of PCDD/Fs analysis

3. Results and Discussion

The PCDD/Fs pattern of unleached fly ash is shown in figure 3 and all homologues are present in sufficient amounts. It was suitable for the leaching experiment. The homologue profile of leachate from the fly ash without soil is plotted in figure 4. Obviously all homologues have been leached by the LAS water at considerable amounts (figure 4) much more than that leached by the pure water.

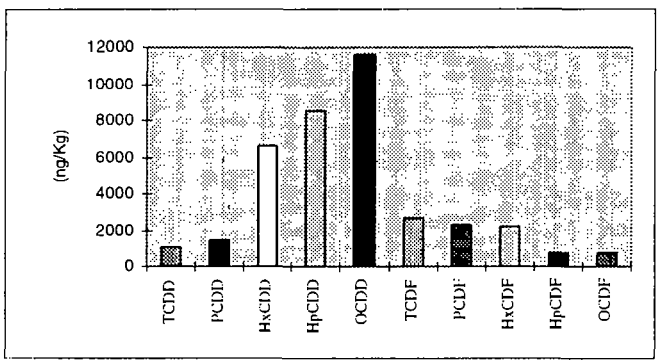

Figure 3 PCDD/Fs pattern of the unleached fly ash

In fact the content of PCDD/Fs in the leachate by pure water is nearly nothing. This results indicate the transport of particles is not so important to the leaching of PCDD/Fs in the fly ash and soil. The mechanism can be explained that LAS above the critical micelle concentration (CMC=0.5g/l) as cosolvent enhance the water solubility of PCDD/Fs.

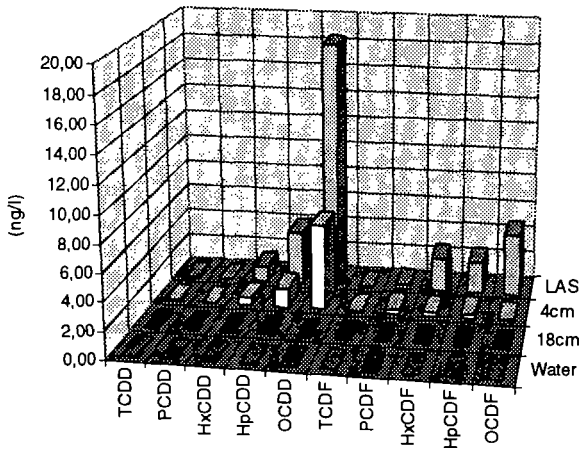

Figure 4 PCDD/Fs pattern of the leachate from the fly ash leached through the 4cm and 18cm soil column and leachate with LAS and pure water without soil

From figure 4, the pattern of PCDD/Fs congeners in the leachate is surprisingly shifted to high chlorinated PCDD/Fs which is in contrast to the corresponding water solubility of the PCDD/Fs. The concentrations of higher chlorinated PCDD/Fs are far above their water solubility [5,6].

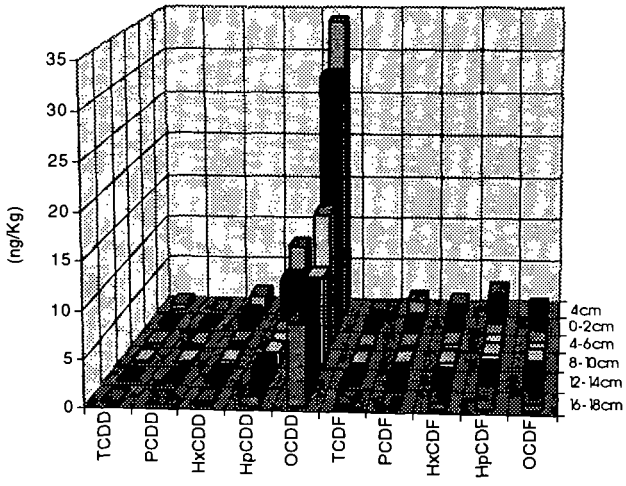

Figure 5 PCDD/Fs congeners in 4cm length column and the vertical distribution in the 18cm soil column.

Figure 5 shows the results if a soil column of 4cm length was added following the fly ash column. Again significant amounts of PCDD/Fs could be measured in the leachate. In the soil column of 18cm length, the content of PCDD/Fs is not so high, but the amount of the congeners is also higher than their solubility. This fact are also found in the leaching report by the fire-extinguishing water [4]. All of these leaching results for LAS water are different from the findings for leaching with distilled water [7,8].

To clear the PCDD/Fs profile in column, the leaching experiment using 18cm soil column was performed. Figure 5 shows the pattern of leachate and distribution of PCDD/Fs congeners in different soil depth. The high chlorinated PCDD/Fs like hexa-, hepta- and octa-CDD/Fs break through the column whereas the tetra- and penta- homologues are not leached to that extent. This finding is consistent with the results of the leachates.

The content of PCDD/Fs congeners in the column is decreasing from the top to the bottom. For the column of 4cm length, the content of PCDD/Fs is nearly same as that in the top of 18cm length column, but a significant maximum in one layer could not be observed (Figure 5). An ultimate breakthrough could be postulated for these compounds.

In conclusion, the abnormal behaviour of the PCDD/Fs under leaching condition with LAS water in this study can be explained that the surfactant LAS enhance the water solubility. Every year, a large amount of detergent containing LAS was used and then discharged to the soil, water and sediment, i.e. via sewage sludge. It must be mentioned that the solubility enhancement to the high toxic pollutants like PCDD/Fs and possibly other compounds with similar properties will result in a rapid transportation and lead to severe environmental problems.

4. References

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