# ADSORPTION OF THE COMPONENTS OF HAZARDOUS WASTE ON CLAY AND SOIL

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**Abstract**

The hazardous waste site of an aluminium plant is going to be closed and recultivated. The aim of this work is to study the adsorption of the main components of the hazardous waste on the clay used as insulation of the site, and also on the surrounding soil types.

The investigations were carried out on eight different kinds of waste samples. After analysing the samples with different methods and devices (Inductively Coupled Plasma Spectrometer, potentiometer and spectrophotometer) it was found that all samples contained sodium, aluminium and fluoride. The very dangerous cyanide was detected in one sample. Static equilibrium experiments were carried out in order to study the adsorption of these components (except for fluoride) on the different adsorbents.

Two different media were used: distilled water and acetate-buffer (pH=4,5). All the components adsorbed quite well except for cyanide. The ions were bound in higher amounts on the soil because its organic content is about twice as much as the clay has. Adsorption from distilled water was more efficient than that from the buffer. This means that in case of acid rain fewer amounts of the components can adsorb.

## Introduction

Hungary has already decided to join to the European Union. Still we have a whale of things to improve, especially in the fields of environmental protection. Therefore we examined a small but important segment of the environment acted by people. During our experiments wastes generated in an inorganic industrial process were examined. These wastes are considered to be hazardous according to the contemporary Hungarian rules. The aim of this work is to study the binding properties of the typical compounds of the wastes.

The wastes are selected and placed in the company's own landfill in different deponies. The landfill has clay insulation with about 30-50 cm thickness, drainage system, and monitoring system.

The majority of the wastes consist of inorganic compunds. According to our earlier disquisition it can be set out that the main components of all types of the wastes are sodium, aluminium and fluoride. One sample also contains cyanide, which is examined because of its hazardous properties.

Adsorption experiments were done on the material used for insulation of the landfill and soil samples taken from next to the landfill.

## Methodology

*Static equilibrium experiments*

Model solutions were prepared in a given concentration range. Each solution contained only one of the examined components. The measurements were carried out with distilled water. The experiments with sodium were repeated with acetate-buffer (ammonium-acetate, pH= 4,5). The function of the buffer was to model the acid rain. In case of aluminium pH=5,5 was found the best for the experiments. The pH was adjusted with acetate-buffer again.

The adsorbents were left to swell in distilled water or in the buffer for 24 hours before the solutions were put on them. Then the samples were shaken for one hour, left for 24 hours and centrifuged. The supernatant liquids were analysed. Sodium and aluminium were analysed with Inductively Coupled Plasma Spectrometer (ICP). Cyanide was determined after a colour reaction with spectrophotometer.

*Thin layer chromatography*

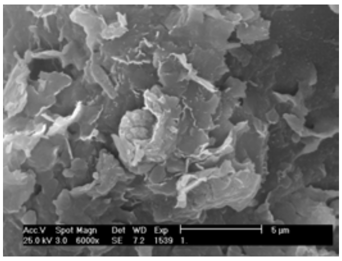
A thin layer of soil or clay suspension was drawn on a 20 cm long glass plate and left to dry for a day. 1000-3000μg of the examined component was put on the layer. Then it was put into a chamber containing the eluent.

The length of the running was 10 cm. The plate was dried and the sample was analysed. Sodium was analysed with Scanning Electronmicroscope. Cyanide was checked with a colour reaction of ninhydrin.

*The adsorbents*

Illustration1: Electronmicroscopic photo of the adsorbents

The clay



The soil

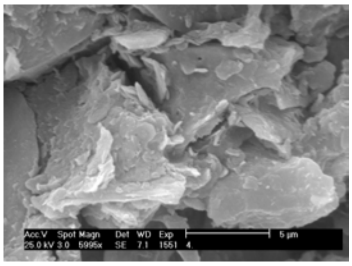


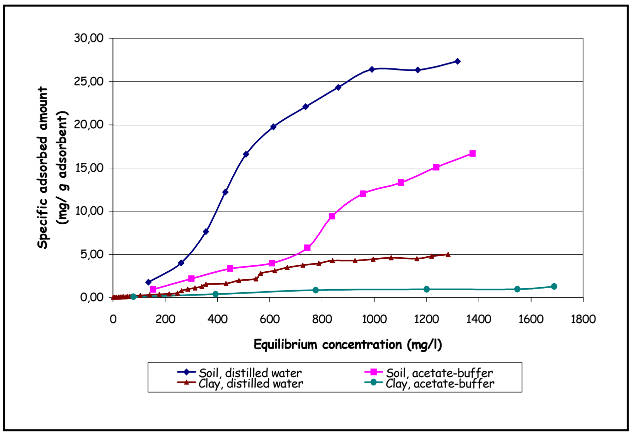
Table1:Characterization of the adsorbents

| Attributes | Soil | Clay |
|---|---|---|
| pH | 7,8 | 8,25 |
| BET surface($m^2/g$) | 11,89 | 24,21 |
| Typical pore diameter (nm) | 4 | 4 |
| Average pore diameter (nm) | 6,7 | 6,4 |
| TOC | 9,68 | 4,24 |
| **Components** | **Quantity (m/m %)** | |
| Muscovite | 5,7 | 15,1 |
| Calcite | 1,9 | 14,7 |
| Quartz | 30,4 | 15,1 |
| Dolomite | 2,9 | 5,4 |
| Albite | 3,6 | 0,8 |
| Microcline | 3,1 | 1,0 |
| Clinochlore | 4,5 | 14,8 |
| Kaolinite | 1,7 | 3,2 |
| Montmorillonite | 37,0 | 20,8 |
| Amorphous | 9,2 | 9,1 |

## Results

*Adsorption of sodium*

Figure 1: Isotherms of sodium adsorption

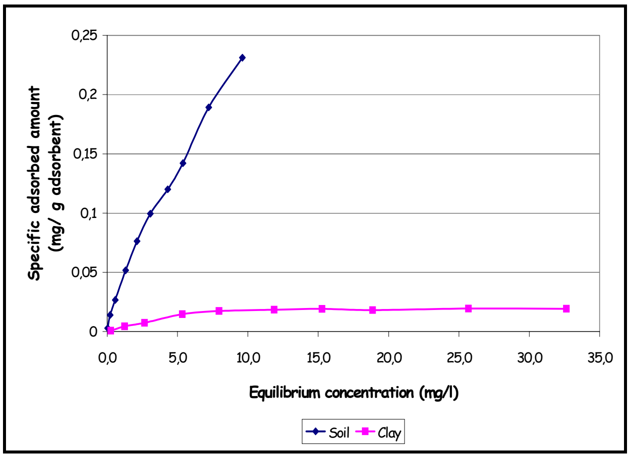



The soil adsorbes the sodium better than the clay.The adsorption is more effective from distilled water than from the acetate-buffer.

Since the role of the buffer is to act for acid rain the results mean that under the effect of acid rain sodium will be more mobile.

*Adsorption of cyanide*

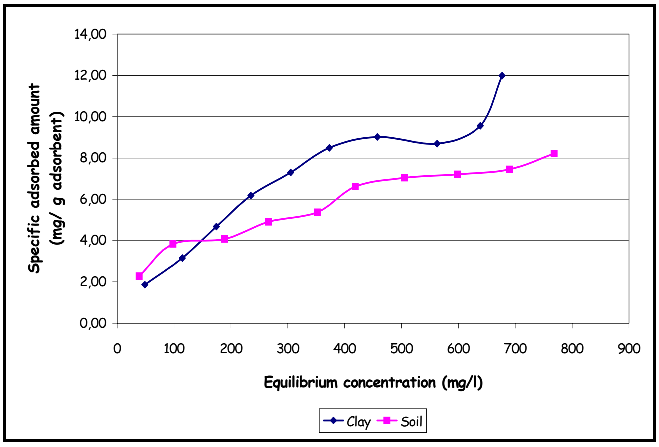
Figure 2: Isotherms of cyanide adsorption




Distilled water could only be used, otherwise HCN would formed at the pH of the buffer.
Cyanide binds better on soil than on clay.
The adsorption of cyanide is less effective than that of the other investigated ions.

*Adsorption of aluminium*

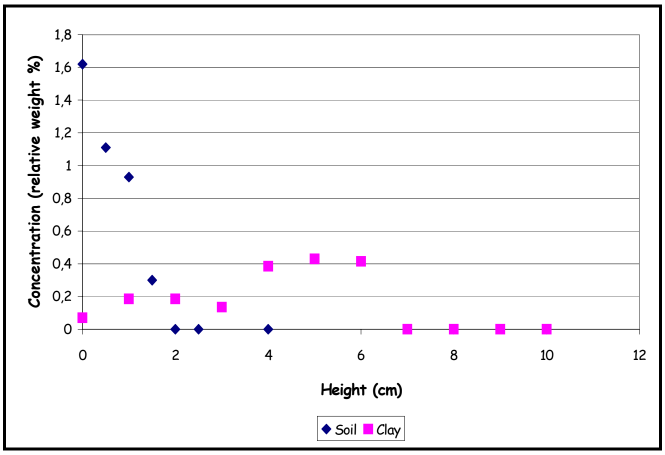
Figure 3: Isotherms of aluminium adsorption




Adjusting of pH to 5,5 was neccessary because the alumi-nium-chloride could not be dissolved or the pH decreased very much.
Adsorption of alu-minium is better on clay than on soil.

*Results of the Thin Layer Chromatography experiments*

Figure 4: TLC results




Sodium: The stain ran about 5 cm on clay and hardly moved from the baseline on soil. Mobility of sodium is bigger on clay than on soil.
Cyanide: The stain was visible for some seconds only. The center of the stain was at 6cm on soil and at 8,5 cm on clay. Mobility of cyanide is bigger on clay than on soil again.
Aluminium: It has not been investigated yet.

## Conclusions

- Most of the examined components were adsorbed better on soil than on clay. It can be caused by the higher organic content of the soil.
- The adsorption is worse in case of acetate-buffer than in case of distilled water. This can mean that acid rain increases the mobility of the compounds.
- The TLC mostly shows the expected results: mobility of cyanide is higher than that of sodium. Still these measurements have to be repeated with longer running way of the eluent.

## Future plans

- The TLC measurements will be gone ahead with.
- Mixture adsorption will be done to check the competition of the components.
- Dynamic equilibrium experiments will be carried out too.

## References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