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Passive sampling for landfill characterization

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The implementation of EU Council Directive on the landfill of waste requires waste handling companies to develop landfill characterization programs. Most of the present monitoring programs based on the sampling of the basic parameters, metals and some organic compounds two times per year by grab sampling. There are currently considerations to use passive sampling methods in Water Framework Directive (WFD) to gain an understanding about the time weight average concentrations of bioavailable priority pollutants in the surface water. Therefore we included passive samplers such as Semipermeable Membrane Devices (SPMDs) and Diffusive Gradients in Thin Films (DGTs) in the new landfill characterization program in the four landfills in Örebro County, Sweden.

The concentrations of priority substances including 16 PAHs, 7PCBs, oil, 14 heavy metals and toxicity were determined using SPMDs and DGTs in the leachate of the municipal landfills. The concentrations of PCDD/F, WHO-TEQ PCBs, PCBs and HCB were determined in the landfill biogas and air over the landfill.

METHOD

The quality of the leachate was determined in the three municipal waste landfills. Landfills serve from 7 to 23 thousand people. Landfill leachate from the dam is collected in to the leachate reservoirs and transported to the municipal waste water treatment plant.

Standard SPMD PRC (performance reference compounds) and SPMD with ultra clean triolein for toxicity were deployed in the leachate reservoirs for the 21 days in November 2005 (Fig.1A). SPMDs were obtained from the Exposmeter AB, Sweden.

DGTs were deployed in the leachate ponds for 10 days In November 2005 (Fig 1B).

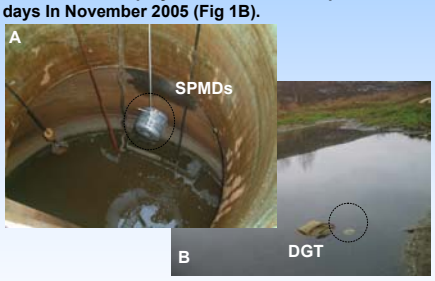

Figure 1. A: SPMD deployment into the leachate reservoir; B: DGT deployed in leachate dam

Sampling of the air from the 0.7 m^2 covered surface and at 1.5 m over the landfill was conducted in the middle size municipal landfill which serves 250 thousand people and produces 4 000 000 m^3 biogas per year. SPMD PRCs were deployed inside biogas tube for 21 day.

Figure 2. A: SPMD deployment in the air; B: SPMD deployment in the biogas tube

After sampling the SPMDs and DGTs were stored in the freezer (-20°C).

The SPMDs PRC and for toxicity were dialyzed and subsequently SPMDs PRCs analyzed according to the standard procedures using GC/MS, GC/MS/MS and HPLC/FLD. The target analytes in this study were 72 PCB congeners, 16 PAH compounds and oil for the membranes deployed in the leachate, PCDD/F compounds, HCB and 72 PCBs for the membranes deployed in the air.

For bioassays evaluation SPMD for toxicity extracts were transferred into an acetone-DMSO (1:1) mixture.

Resin gel from DGT was treated with 1M HNO3 solution before analysis. Analysis of extract was performed using ICP – AES and ICP – SFMS.

CONCLUSION

❖Passive samplers such as SPMDs and DGTs are useful tool for the characterization of the bioavailable pollution in the landfill leachate and air during few weeks period.

❖Results suggested that toxicity measurement in combination with the chemical analysis should be included into landfills characterization programs.

Comment: conclusions about the quality of the landfill leachate will be made after the second characterization stage in May 2006.

RESULTS

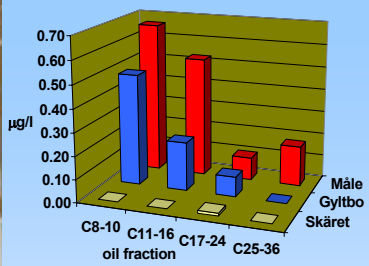

Figure 3. Oil concentration in the landfill leachate

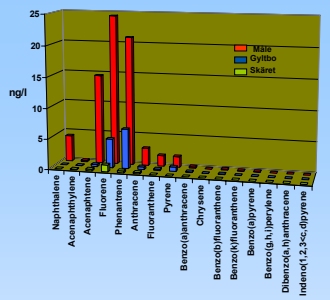

Figure 4. 16 PAH concentration in the landfill leachate

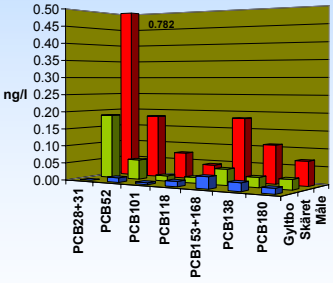

Figure 5. 7PCB concentration in the landfill leachate

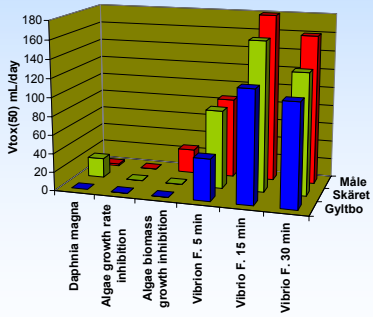

Figure 6. Toxicity of the landfill leachate

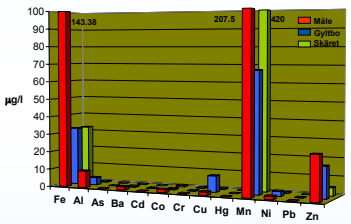

Figure 7. 12 metals in the landfill leachate

Low molecular mass oil was leaching during the sampling period from the Måle and Gyltbo landfills (Fig 3).

Low molecular weight PAHs were dominating in all three landfills. The highest concentration of the SumPAH was in the Måle - 71ng/L and lowest in the Skäret- 2 ng/L (Fig 4).

In average 1,4 ng/L of 7PCBs were leaching from Måle, while from the Gyltbo only 0,11 ng/L (Fig 5). Tri-chlorinated PCBs were dominating in the Måle sample which might be indication of fresh source of PCBs. Also hexa- and heptachlorinated PCBs were leaching from all three landfills, which is quite unusual.

Leaching of Fe and Mn is dominating from all three landfills (Fig 7).

Toxicity for Microtox was highest in all three landfills with the Vtox(50) value in average of 150 mL/d (Fig 6). Toxicity in Skäret was as high as in Måle, however according chemical analysis concentration of target compounds were lowest in Skäret.

Table 1. Results of the air sampling in landfill [1]

	Air in the cover (0.35 m^2). Potential evaporation	Air over the landfill. Potential evaporation	Biogas	Background value
PCDD/F WHO-TEQ (pg WHO-TEQ/m^3)	0.0000041	0.000013	0	0.0009
PCB WHO-TEQ (pg WHO-TEQ/m^3)	0.0067	0.015	0.0013	0.0074
Total PCB WHO-TEQ (pg WHO-TEQ/m^3)	0.0067	0.015	0.0013	0.0083
PCB_7 (ng/m^3)	0.13	0.13	0.24	0.1
Total PCB (ng/m^3)	0.33	0.33	100	0.32
HCB (ng/m^3)	0.073	0.044	2.4	0.05

It was very low evaporation of PCDD/F, PCB and HCB from the landfill surface. Sampling was done only on the 0.35m^2 since another sampling device was stolen.

Results of the biogas analysis showed elevated concentrations of total PCB and HCB. Total PCB concentration was 100 ng/m^3. Which means, that with the production of biogas 40 000 000 m^3 emissions of PCBs would be around 0.4 g/year. Since biogas usually is burned in different processes it can lead to the formation of PCDD/F.

Reference: 1. 1. Survey of sources for unintentionally produced Chemicals: PCDD/F, PCB and HCB. P-A Bergqvist, Mats Tysklind, Stellan Marklund, Annika Åberg, Kristina Sundqvist, Morgan Näslund, Ingalill Rosen, Palina Tsytsik, Henrik Malmström, Ingemar Cato. Publication number MK 2005:01, Environmental Chemistry, Umeå University