ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN A WASTE COLLECTION CENTRE USING MULTISORBENT ADSORPTION AND GC/MS THERMAL DESORPTION SYSTEM

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INTRODUCTION

Volatile organic compounds (VOCs) released by waste treatment systems may lead to major impacts such as toxic air levels, discomfort incidents and annoying odours. The main objectives of this work were to identify and quantify selected VOCs, emitted during waste collection and processing, to control exposure hazards. An analytical method, previously developed and validated in our laboratory, for the determination of VOCs within a wide range of volatility and polarity and with variable concentrations was used.

MATERIALS AND METHODS

Sampling

Custom packed glass multi-sorbent cartridge tubes (Carbotap 20/40, 70 mg; Carbopack X 40/60, 100 mg and Carboxen 569 20/45, 90 mg) were connected to an air collector pump sampler for the retention of VOCs.

Dynamic personal samples were taken in four sites of a waste collection centre: recycled materials classification room, waste unloading area, evaporation zone and osmosis plant. Besides, an ambiental sample of the facilities was taken.

Desorption and analysis

Analysis of VOCs was performed by Automatic Thermal Desorption (ATD) coupled with capillary Gas Chromatography (GC)/ Mass Spectrometry Detector (MSD), using a Perkin Elmer ATD 400 (Perkin Elmer, Boston, Massachusetts, USA) and a Thermo Quest Trace 2000 GC (ThermoQuest, San Jose, California, USA) fitted with a Thermo Quest Trace Finnigan MSD (Figure 1). VOCs standards were prepared in methanol and injected at 30˚C on the multisorbent-tubes under an inert Helium gas flow (100 ml min^{-1}) using a conventional gas chromatograph packed column injector. The instrumental settings and operating conditions are shown in Table 1.

TD		*GC*	
Desorption temp.:	300 ºC	Capillary column:	DB-624 (60 m x 0.25 mm x 1.4 µm)
Desorption time:	10 min	Temperature program:	40 ºC (1 min), 6 ºC/min until 230 ºC (5min)
Transfer line:	200 ºC	Carrier gas:	He (19.1 psi)
Cold trap sorbent	Tenax TA +Carbotrap		
Cold trap low:	-30 ºC		
Cold trap high:	300 ºC	*MS*	
Desorption flow rate:	He (50 ml min^{-1})	Interface:	250 ºC
Inlet split:	4 ml min^{-1}	Ionization source:	200 ºC
Outlet split:	7 ml min^{-1}	Ionization mode:	Electron impact
Split ratio:	12 %	Electron energy:	70 eV
		Mass range	20 - 300 amu

Table 1. - Instrumental settings and operating conditions.

RESULTS

More than 80 substances from different chemical families were identified (Figure 1) and about 45 were quantified (Table 2).

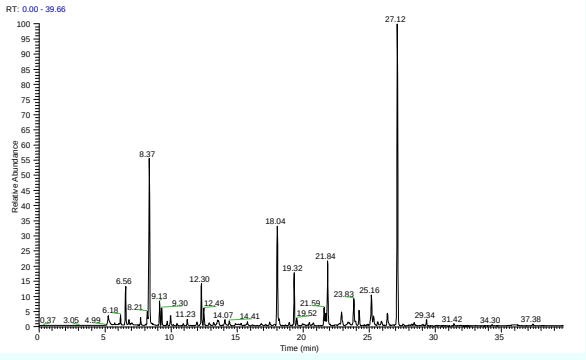

Figure 1. - Total ion chromatogram of sample in the waste unloading area.

ug/m³	Ambiental	Recycling room	Evaporation zone	Osmosis plant	Waste unloading area
Aliphatic hydrocarbons					
n-Hexane	0,10	0,35	0,24	0,19	5,91
n-Decane	0,43	39,41	1,33	0,90	39,87
Aromatic hydrocarbons					
Benzene	1,67	0,35	0,40	0,38	3,00
Toluene	4,15	30,96	5,10	3,17	211,19
Ethylbenzene	0,44	9,65	0,99	0,43	36,09
m+p-Xylene	1,20	29,92	1,94	1,03	141,27
o-Xylene	0,42	7,34	0,62	0,38	19,87
Propylbenzene	0,03	1,84	0,11	0,05	2,52
1,3,5-Trimethylbenzene	0,05	3,78	0,16	0,08	7,42
1,2,4-Trimethylbenzene	0,85	12,87	0,65	0,28	19,38
Furan	1,33	0,83	1,09	0,54	2,87
Cumene	0,60	3,02	0,20	0,12	9,81
Naphthalene	0,05	0,44	0,06	0,02	0,19
Chlorinated hydrocarbons					
Carbon tetrachloride	0,42	0,54	0,49	0,31	0,44
Trichloroethylene	0,09	0,14	0,14	0,06	6,64
Tetrachloroethylene	0,26	0,29	0,38	0,19	168,69
1,1,1-Trichloroethane	n.d.	n.d.	n.d.	n.d.	1,22
p-Dichlorobenzene	0,07	0,31	n.d.	n.d.	0,06
Alcohols					
Ethanol	1,97	897,14	7,97	10,91	1673,11
Isopropanol	0,48	89,70	4,09	5,58	122,69
1-Butanol	0,30	3,11	0,81	0,35	40,07
2-ethyl-1-hexanol	1,23	5,76	0,86	0,63	0,83
Ketones					
Acetone	4,22	64,97	9,40	20,98	182,38
Methylisobutylketone	0,24	11,02	0,48	0,47	17,59
Cyclohexanone	0,25	37,97	0,41	17,38	11,49
Acetophenone	0,22	0,26	0,19	0,16	0,12
Esters and glycol ethers					
Ethyl acetate	1,39	22,81	2,27	1,26	117,83
Butyl acetate	0,53	89,16	0,97	0,79	30,05
1-methoxy-2-propanol	0,20	13,27	0,12	0,33	15,50
2-butoxyethanol	0,43	20,41	0,52	0,22	12,47
Aldehydes					
Hexanal	0,16	7,51	0,41	0,36	2,33
Benzaldehyde	1,30	1,27	0,47	0,30	2,55
Heptanal	0,34	6,42	1,58	1,30	4,46
Octanal	1,49	40,00	9,96	1,85	89,88
Acids					
Formic acid	22,17	11,83	16,71	14,15	12,93
Acetic acid	73,68	161,62	101,91	106,32	95,25
Terpenes					
α-Pinene	0,19	15,47	0,68	0,53	51,03
Limonene	0,20	75,28	0,72	0,80	620,00
p-Cymene	0,05	3,09	0,11	0,10	10,80
DL-Camphene	0,02	1,06	0,05	n.d.	1,53
Sulphur compounds					
Carbon disulfide	0,82	0,16	0,24	0,93	1,96
Isothiocyanatocyclohexane	0,15	n.d.	0,40	n.d.	n.d.
Benzothiazole	0,36	1,71	0,14	0,15	0,15
Ethers					
tert-Ethylbutylether	0,32	1,14	0,75	0,31	16,91
Tetrahydrofurane	0,04	11,72	0,41	3,79	8,77
Isocyanates					
Isocyanatocyclohexane	0,40	19,13	0,50	n.d.	150,78
Total	125	1755	177	198	3970

Table 2. - Concentrations of selected VOC.

CONCLUSIONS

Results indicate that VOCs concentrations in different sites were low. High concentrations were found in the recycling materials classification zone and in the waste unloading area. The most significant compounds are limonene (0.2-620 µg/m3), ethanol (2-1673 µg/m3), toluene (3-211 µg/m3), acetone (4-182 µg/m3), tetrachloroethylene (0.2-169 µg/m3), octanal (1.5-90 µg/m3) and n-decane (0.4-40 µg/m3), but all them were below known effect level.

REFERENCES

Ribes et al. 2007. *Journal of Chromatography A*, 1140, 44-55