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QUALITATIVE DETERMINATION OF VOLATILE ORGANIC COMPOUNDS FROM MUNICIPAL SOLID WASTE DISPOSAL SITES

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Introduction

Volatile organic compounds (VOCs) are found in all urban and industrial areas, in gaseous form, distributed in the atmosphere, but can also be liquids or solids, distributed in water and soil matrices, under normal conditions of temperature and pressure. Waste disposal is a global problem, and areas around recycling centers are rich sources of volatile organic compounds. VOCs from waste accumulate and persist in the soil and it is well known that volatiles from the decomposition of waste are classified as very hazardous compounds. Although qualitative information on the types of VOCs identified in waste matrices is well documented in the literature, the quantitative assessment is poorly defined. In unforeseen circumstances, such as environmental accidents, in which garbage remains uncollected for a long time, VOCs have not been thoroughly studied. The aim of this paper was to determine the types and levels of VOCs eliminated by various solid wastes.

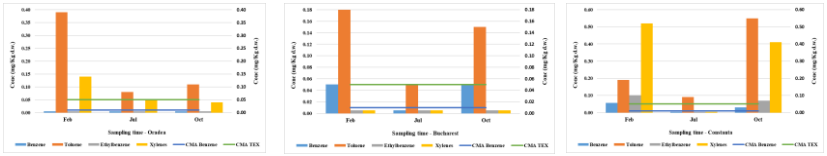
Materials and methods

High-purity VOCs mixture (60 volatile organic compounds, > 98.3%) analytical standards were obtained from Agilent. 4-bromofluorobenzene and 2-bromo-1-chloropropane were used as internal standards for VOCs analysis and they were acquired from LGC Standards. Sodium chloride and phosphoric acid were acquired from Sigma Aldrich (Germany). VOCs analysis were performed using an Agilent 7890B GC (split/splitless injector) coupled to a triple quadrupole mass spectrometer (Agilent 7010B) (Agilent Technologies). For all compounds, the detection limit for the mass (m) were 0.005 mg/Kg. Solid waste samples were taken from three different locations in Romania (Oradea, Bucharest, Constanta) in February, July and October 2021. Two grams of each solid waste were weighed into the headspace vials over which a NaCl / H_3PO_4, pH = 3, saline solution was added. A GC-MS/MS analytical method fully verified and validated was used for quantitative determination of a class of volatile organic compounds, namely BTEX (Benzene, Toluen, Ethylbenzene and Xylenes) from solid waste matrices.

Results and conclusions

The values obtained were compared with the values declared in the environmental law. The maximum allowed concentration (MAC) in environmental legislation for Benzen is 0.01 mg/kg dw, while for Toluene, Ethylbenzene and Xylenes 0.05 mg/kg dw. Samples collected from Oradea site were dominated by Toluene in concentration between 0.08 and 0.38 mg/Kg d.w. and between 0.05 and 0.14 mg/Kg

d.w. for Xylene.For Benzen and Ethylbenzen the concentration values were lower than the MAC (Figure 1a). The major compound in the samples collected from Bucharest site proved to be Toluene, the values varying between 0.05 and 0.18 mg/Kg d.w. followed by Benzen (0.05 mg/Kg dw) in the samples collected in february and october. The values determined for the other BTEX compounds, Ethylbenzene and Xylene were lower than the method LOQ (Figure 1b). Solid waste samples collected from Constanta site were dominated by Toluen and Xylene, with concentration values in the range of 0.09 – 0.55 mg/g d.w. and 0.52 and 0.41 mg/g d.w. in february and october. Values higher than LOQ were observed for Benzen and Ethylbenzene, also in samples taken in february and october, whith levels up to 0.056 mg/g d.w. for Benzen and up to 0.10 mg/g d.w. for Ethylbenzene (Figure 1c).



a b c

Fig.1. BTEX occurrence in the solid waste samples collected from: a. Oradea; b. Bucharest; c. Constanta

These findings suggest the need for regionally tailored control strategies to reduce BTEX levels and mitigate their environmental impact. The high values recorded are mainly due to BTEX contamination from spills involving the release of petroleum products such as petrol, diesel and crude oil in waste storage areas. Backtracking analysis showed that BTEX compounds varied greatly between different regions, but generally showed high values for samples taken from the Constanta area, a heavily oil-exploited area (Figure 2). The variations in the observed VOC concentrations can also be explained by the variation in the type of waste sampled. Moreover, the analysis of the evolution of VOC concentrations as a function of temperature shows a strong decrease in VOC concentrations in the samples taken, when the temperature exceeded approximately 15 °C.

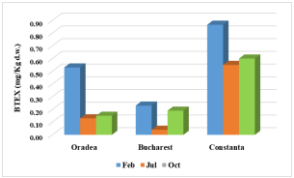


Fig.2. The BTEX concentration determined for each site.

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