ECOLOGICAL CHEMISTRY AND ENGINEERING A

Vol. 16, No. 5/6 2009

Zbigniew MAZUR[1], Jarosław TROCHIMIUK[2],
Wojciech LIPIŃSKI[3] and Teofil MAZUR[1]

CHEMICAL CONTAMINATION OF SOIL RESULTING FROM THE STORAGE AND DISASSEMBLY OF MOTOR VEHICLES

SKAŻENIA CHEMICZNE GLEBY W WYNIKU SKŁADOWANIA I DEMONTAŻU POJAZDÓW SILNIKOWYCH

Abstract: The objective of this study was to determine the degree of chemical contamination of light soil used as a disposal site for storing motor vehicles unfit for operation. Dismantled motor vehicles and parts of motor vehicles were stored in sector A, while worn-out, inoperable motor vehicles were stored in sector B. Heavy metal content was 5.3-fold higher in soil from sector A than in soil from sector B. The greatest differences were observed between the two sectors with respect to the content of copper, lead, chromium and zinc, while the slightest – with regard to the content of nickel, cadmium and mercury. Taking into account the total content of heavy metals, the investigated soils may be considered chemically degraded.

Keywords: soil contamination, heavy metals, motor vehicles

Motor vehicles that are no longer used or operated are stored in areas specifically designated for this purpose. Parts of disassembled vehicles are often stored at unroofed facilities or in the open area. This may lead to local soil contamination with both mineral and organic compounds. The paper presents the results of studies on the content of heavy metals and selected macronutrients in light soil used as a disposal site for collecting and storing dismantled motor vehicles and motor vehicle parts.

[1] Department of Environmental Chemistry, University of Warmia and Mazury in Olsztyn, pl. Łódzki 4, 10–718 Olsztyn, Poland, tel. +48 89 523 3542, email: zbigniew.mazur@uwm.edu.pl

[2] General Staff of the Polish Army, ul. Niepodległości 218, 00–909 Warszawa, Poland, tel. +48 60 197 9341, email: jarekt@poczta.onet.pl

[3] National Agrochemical Station in Warsaw, ul. S. Żółkiewskiego 17, 05–075 Warszawa, Poland, tel. +48 22 773 5242, email: wlipinski@schr.gov.pl

Materials and methods

The study was conducted at a facility located in town N, where scrapped motor vehicles and their parts are sorted and pre-processed. The facility is divided into two sectors, A and B. Dismantled motor vehicles and parts of motor vehicles are stored in sector A, while worn-out, junked or discarded motor vehicles are stored in sector B. Soil samples taken at a depth of 0–25 cm. Four composite samples were prepared for each section. P and K contents were determined by Egner-Riehm method, pH in 1 mol HCl · dm^{-3}, contents of heavy metals by the AAS method after acid-base extraction, trace mercury with the AMA 254.

Results and discussion

The disposal site for collecting and storing dismantled motor vehicles and motor vehicle parts was located on light soil developed from loose sand (sector A) and slightly loamy sand (sector B). Soil particle size distribution [%] in sectors A and B was as follows:

Size fractions	Sector A	Sector B
Sand (2.0–0.05 mm)	92.91	83.84
Silt (0.05–0.002 mm)	6.38	14.74
Clay (< 0.002 mm)	0.71	1.39

An analysis of selected agrochemical properties of soil revealed considerable differences between the two sectors (Table 1).

Table 1

Content of organic carbon and available nutrients in soil, and soil reaction

Property	Unit	Sector A		Sector B	
		mean	range	mean	range
Organic C	[g · kg^{-1}]	4.3	2.0–7.2	10.1	6.3–16.6
Available P	[mg · kg^{-1}]	51.7	11.7–73.0	107.0	58.1–131.1
Available K	[mg · kg^{-1}]	40.2	15.8–72.2	82.4	56.8–108.7
Available Mg	[mg · kg^{-1}]	14.9	10.5–15.5	23.0	17.5–27.5
Reaction	pH	7.8	7.7–7.9	7.5	7.4–7.7

Soil samples collected in sector B contained 2.4-fold more organic carbon, over 2-fold more available phosphorus and potassium and 1.5-fold more available magnesium than soil samples taken in sector A. However, it should be noted that the content of the above nutrients in soil varied widely.

The main indicator of chemical contamination is the concentration of metals displaying a variable degree of toxicity in soil. The investigated soils differed considerably with respect to heavy metal content (Table 2).

Table 2

Heavy metal content of soil [mg · kg^{-1}]

Metal	Sector A			Sector B		
	minimum	maximum	mean	minimum	maximum	mean
Pb	7.2	319.8	163.5	9.2	31.4	20.3
Cd	0.18	1.04	0.61	0.27	0.56	0.41
Zn	39.8	1305.0	672.4	57.4	241.4	149.4
Cu	4.84	1868.0	936.4	9.25	61.8	35.5
Mn	122.0	378.6	250.3	119.4	224.7	172.0
Ni	5.10	46.6	25.8	5.70	16.31	11.0
Cr	9.53	251.7	130.6	7.87	35.5	21.7
Hg	0.028	0.066	0.047	0.033	0.051	0.042

Mean values show that soil in sector A contained 5.3-fold more heavy metals than soil in sector B. There were significant differences between the two sectors as regards the concentrations of particular metals. In soil samples collected in sector A the content of copper, lead, chromium and zinc increased 26.3-, 8.0-, 6.0- and 4.5-fold, respectively, compared with soil samples taken in sector B. The content of nickel, cadmium and mercury rose from 2.3 to 1.1 times. The minimum heavy metal contents determined in the investigated soil exceeded the permissible limits for light soils [1], which indicates that their maximum concentrations can be considered highly toxic.

The mean percentage share of particular heavy metals in their total content (100 %) is illustrated in Fig. 1.

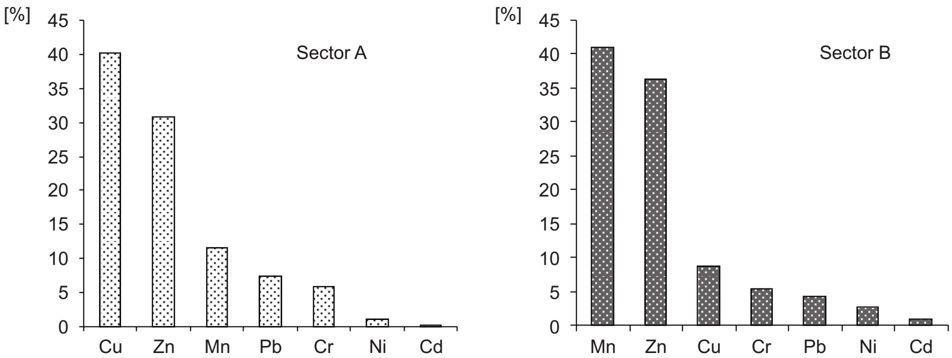

Fig. 1. Percentage share of heavy metals in their total content

In soil from sector A copper accounted for as much as 43 %, compared with 8.6 % in soil from sector B. Although the manganese content of soil was higher in sector A, the percentage of this element in the total content of heavy metals in soil was lower than in sector B. The percentage content and relative share of zinc were comparable in both analyzed soils.

The results of laboratory analyses confirmed that the investigated soils were contaminated with heavy metals to a different degree. Soil remediation aimed at its restoration to useable condition requires a method enabling the effective removal of one or more heavy metals whose concentrations exceed toxicity thresholds [2, 3].

The assessment of the chemical contamination of soil indicates the need to continue research in this subject. Such investigations contribute to environmental pollution reduction and may provide important data for thematic reports [4, 5].

Conclusions

1. The storage of worn-out or dismantled motor vehicles and motor vehicle parts results in the chemical degradation of soil.

2. The concentration of heavy metals (primarily copper and zinc) is substantially higher at sites used for storing parts of dismantled and inoperable motor vehicles than at sites used for storing junked, worn-out motor vehicles.

References

[1] Gorlach E. and Mazur T.: Chemia rolna. Wyd. PWN, Warszawa 2001.

[2] Kabata-Pendias A., Piotrowska M. and Witek T.: Ocena jakości i możliwości rolniczego użytkowania gleb zanieczyszczonych metalami ciężkimi. IUNG Puławy 1993, Seria **P(53)**, 5–14.

[3] Motowicka-Terelak T. and Terelak H.: Zesz. Probl. Post. Nauk Rol. 1995, **422**, 68–74.

[4] Draniewicz B.: Recykling pojazdów wycofanych z eksploatacji. Wyd. C.H. Beck, Warszawa 2006, 328 pp.

[5] Osiński J. and Żach P.: Wybrane zagadnienia recyklingu samochodów. WKŁ, Warszawa 2006, 144 pp.

SKAŻENIA CHEMICZNE GLEBY W WYNIKU SKŁADOWANIA I DEMONTAŻU POJAZDÓW SILNIKOWYCH

Katedra Chemii Środowiska, Uniwersytet Warmińsko-Mazurski w Olsztynie

Abstrakt: Badania miały na celu określenie skażeń chemicznych gleby lekkiej, na której składowano pojazdy silnikowe wycofane z eksploatacji. W sektorze A składowano zdemontowane pojazdy i ich części, a w sektorze B gromadzono pojazdy wycofane eksploatacji. W glebie sektora A sumaryczna zawartość metali ciężkich była 5,3 razy większa niż w glebie sektora B. Szczególnie duże różnice stwierdzono w zawartości miedzi, ołowiu, chromu i cynku, a najmniejsze niklu, kadmu i rtęci. Ogólna zawartość metali ciężkich sprawia, że gleby te należy zaliczyć do zdegradowanych chemicznie.

Słowa kluczowe: skażenie gleby, metale ciężkie, pojazdy silnikowe