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## IDENTIFICATION OF AROMATIC HYDROCARBONS AND POLYCHLORINATED BIPHENYLS FROM SOLID WASTE LANDFIL

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**Abstract:** Organic and inorganic wastes are solid wastes why are generated because urban society rapidly increasing production of artifact, becoming useless or unwanted. Rapidly this thing lost their value, became waste and a major cause of pollution. Solid waste disposals represent a significant source of polychlorinated biphenyls and aromatic hydrocarbons released into the environment. The biggest problem of waste disposal is leachate. Leachate is primarily result of precipitation that penetrates through the soil and waste, enters the composition of groundwater and contaminates it. The result is soil pollution with polychlorinated biphenyls and aromatic hydrocarbons. Because these pollutant cannot be biodegraded could lead to serious consequences. Polychlorinated biphenyls and aromatic hydrocarbons have a huge negative impact on the environment. these pollution because of their chemical nature represent a potential risk for the environment, animals and people. Numerous studies have shown their negative impact when they reach the environment. The concentration of aromatic hydrocarbons and polychlorinated biphenyls was examined after sampling from open dumpsite at the territory of the city of Leskovac, Republic of Serbia collected around solid waste. Aim is to understand contamination caused by leachate migration from mentioned dumping. These analysis and soil research is an important process that includes the examination of soil quality, as well as the detection of potentially harmful substances and pollution. This paper aims to determination of the quality of the soil, detection of contamination and identification of hazard and harmful substances in the soil samples. Presents the results of soil sampling and laboratory analysis at a closed landfill in the territory of the city of Leskovac in accordance with the the Regulation on maximum permissible values of pollutants, of harmful and hazardous substances in the soil (Official Gazette of RS, no. 30-2018 and 64-2019). Based on the test results, given in Regulation on maximum permissible values polluting substances, harmful and hazardous substances in the soil (Official Gazette of the RS, no. 30-2018 and 64-2019), it was determined that concentrations of aromatic hydrocarbons were detected in the analyzed soil samples and polycyclic aromatic hydrocarbons. However, the obtained values of these parameters do not exceed the maximum permissible values, but their existence and contamination can lead to serious consequences. The paper provides useful information for further planning of remediation measures, closed landfill management and environmental protection.

**Keywords:** aromatic hydrocarbons, polychlorinated biphenyls, waste, landfill.

### 1. INTRODUCTION

Inappropriate disposal of waste is serious environmental problem. Waste at the landfill on the city of Leskovac, whose soil quality is being tested, contains a wide variety of waste. This waste contains harmful and hazardous substances some of them, whose existence is examined in this paper are polychlorinated biphenyls and polycyclic aromatic hydrocarbons, which directly or indirectly leads to serious degradation of ecosystems. Polychlorinated biphenyls are toxic and dangerous. Once in soil, they remain for 10 years or more. It has been shown that they do more harm than good, because of that polychlorinated biphenyls are banned in most countries of the world. Incomplete combustion of fossil fuels leads to production of polycyclic aromatic hydrocarbons. Once they reach the soil, they stay in it for a long time. The paper examines the existence and influence of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, chrysene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d) pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene. After sampling the soil from the landfill at the territory of the city of Leskovac, in this paper the quality of the soil was examined. The content of polychlorinated biphenyls and polycyclic aromatic hydrocarbons was identified. The obtained results were then analyzed in relation to the maximum permissible and remediation values of polluting, harmful, and hazardous substances in the soil given in the Regulation on maximum permissible values of polluting substances in the soil.

## 2. MATERIALS AND METHODS

This research was done in the territory of the city of Leskovac. Satellite view of the sampling points was presented on Figure 1.

*Figure 1. Satellite view of sampling points*



Source: by Google maps

The soil sampling, transport, and storage procedure was done according to criteria applicable in the Republic of Serbia and standard ISO 18400. Sampling of the soil was carried out by first cleaning the surface of the soil from plant remains, then a pit was opened in the surface layer of the soil in the shape of a square. First, a 2-3 cm thin layer of soil was cut. The lateral pieces of the plants were removed with a knife so that a 4.6 cm wide soil sampling site was prepared. After preparation, the soil was removed for sampling at a depth of 50 cm. The individual samples thus obtained are placed in a glass container, where they are later crushed and homogenized.

### 2.1. Laboratory analyses of soil samples

The presence of polychlorinated biphenyls in the test samples was tested using the accredited ISO 10382 method. Presence of aromatic hydrocarbons and polycyclic aromatic hydrocarbons in soil samples was examined using the ISO 18287 standard method.

### 2.2. Legislative framework of the Republic of Serbia

Republic of Serbia defined the priority organic polluting compounds that are controlled in sediment, when the Government of the Republic of Serbia adopted the Regulation on maximum permissible values of pollutants. The Regulation defines maximum permissible values for priority organic pollutant compounds in sediment, their target, and both maximum permissible value (SWsb) and remediation value. Maximum permissible values (SWsb) represent the amount of toxic or harmful substances to which the human organism, animal, or plant organisms can be exposed without harmful consequences and for a long time. Remediation value (IWsb) is the threshold value for the concentration of the pollutant in the sediment above which there is an unacceptable risk to the aquatic ecosystem, soil, and human and animal health. As a result of the harmonization of the Serbian with the legislation of the European Union in 2014, the Regulation on maximum permissible values of priority and priority hazardous substances was adopted. The content of pollutants was examined in a correlation with the corrected maximum permissible and remediation values given in the "Official Gazette of RS", no. 30/2018 and 64/2019“.

## 3. RESULTS

Laboratory results are given in Tables 1.

*Table 1. Results of testing samples for the content of polychlorinated biphenyls and polycyclic aromatic hydrocarbons*

Parameter	01	02	03	04	05	06	07	08	09
<b>Polychlorinated biphenyls (,PCB) mg·kg<sup>-1</sup></b>									
PCB 28	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
PCB 52	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
PCB 101	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
PCB 138	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

PCB 153	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PCB 180	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
PCB <sub>Stotal</sub>	<0.015	<0.015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015
<b>Polycyclic aromatic hydrocarbons (PAH), mg·kg<sup>-1</sup></b>									
Naphthalene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Acenaphthylene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Acenaphthene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluorene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Phenanthrene	0.004	0.004	0.006	0.003	0.003	0.004	0.004	0.003	0.003
Anthracene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluoranten	<0.003	0.003	0.004	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Pyrene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chrysene	0.006	0.006	0.006	0.007	0.006	0.005	0.005	0.006	0.006
Benzo(a)anthracene	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	0.004	0.003	0.003
Benzo(b)fluoranthene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(k)fluoranthene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(a)pyrene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Indeno(1.2.3-c,d)pyrene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dibenzo(a,h)anthracene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Benzo(g,h,i)perylene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
PAH <sub>total</sub>	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
<b>Aromatic hydrocarbons (BTEX), µg·kg<sup>-1</sup></b>									
Benzene	0,023	0,014	0,022	0,029	0,017	0,033	0,024	0,020	0,011
Toluene	0,098	0,039	0,041	0,086	0,025	0,098	0,050	0,026	0,0064
Ethylbenzene	0,0059	0,0067	0,0044	0,0079	0,0055	0,0067	0,0063	0,0068	0,014
Styrene	0,017	0,012	0,029	0,038	0,0089	0,054	0,017	0,017	0,013
Xylene	0,031	0,021	0,029	0,034	0,027	0,058	0,038	0,029	0,022
BTEX <sub>total</sub>	0,18	0,092	0,13	0,20	0,084	0,25	0,14	0,099	0,066

Source: Author's research

Based on the obtained soil test results represented in given Table 1. concentrations of polychlorinated biphenyls and polycyclic aromatic hydrocarbons are detected in the tested samples but the concentration of polychlorinated biphenyls was detected at the lowest level. As for Polycyclic aromatic hydrocarbons, the concentration was approximately the same in all analyzed samples, but does not exceed the maximum permissible concentration.

Based on "Official Gazette of RS", no. 30/2018 and 64/2019 the concentration of aromatic hydrocarbons and polychlorinated biphenyls was compared and with corrected maximum permissible and remediation value and given in Table 2.

**Table 2. Maximum permissible and remediation values for aromatic hydrocarbons and polychlorinated biphenyls**

Aromatic hydrocarbons (BTEX), µg·kg <sup>-1</sup>	SWsb	IWsb
Benzene		
Toluene	10	10
Ethylbenzene	30	50000
Styrene	30	100000
Xylene	100	25000
PAH <sub>total</sub>	1	40
PCB <sub>Stotal</sub> *	0.02	1

\*Sum of: Anthracene, benzo (a) anthracene, benzo (k) fluoranthene, benzo (a) pyrene chrysene, phenanthrene, indeno (1,2,3-cd) pyrene, fluorescents, naphthalene, benzo (g, h, i) perylene

Source: Author's research

#### 4. DISCUSSIONS

Even though, the obtained values of these parameters do not exceed the maximum permissible values these pollutant concentrations can have a negative impact on the environment. Because PAHs are resistant to biodegradation, they are persistent organic pollutants. They have a strong adsorption power on solid soil particles and sediments, which can lead to their dissemination in different parts of the environment on a global level.

## 5. CONCLUSIONS

After the sampling and laboratory analyzes of soil samples at the closed landfill in the territory of the city of Leskovac based on test results and Regulation on limit values of polluting substances, harmful and hazardous substances in the soil (Official Gazette of the RS, no. 30-2018 and 64-2019), it was determined that the analyzed samples contained concentrations of aromatic hydrocarbons and polycyclic aromatic hydrocarbons. However, the obtained values of these parameters do not exceed the limit values. This contamination in the future can lead to serious degradation and negative influence to environmental and human health. Monitoring of this open dumpsite is necessary in order to protect further contamination.

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