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Book of Abstracts

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Bioremediation of Complex Contaminant from Petroleum Industry in an Artificial Soil Substrate

Tatjana Šolević Knudsen; Jelena Avdalović, Srđan Miletić; Mila Ilić, Jelena Milić, Vladimir Beškoski, Miroslav M. Vrvić

The objective of this research was to investigate the efficiency of bioremediation of complex contaminant from petroleum industry in an artificial soil substrate. The artificial soil substrate was prepared as a mixture of sand and sawdust. A complex contaminant from petroleum industry was added to make the final mass of the experimental biopile of 45 kg. During the experiment, the biopile was inoculated with multiplied consortia of microorganisms, isolated from the complex contaminant. Reinoculation was carried out every thirty days. The pile was mixed once per month to achieve the effect of aeration. Compounds of nitrogen, phosphorus and potassium were used for biostimulation. The results of this experiment were compared with the results of analyses of a control pile, which was prepared in the same way as the biopile but without inoculation, aeration and biostimulation. The experiment lasted 110 days.

Total Petroleum Hydrocarbons (TPH, as per method ISO/TR 11046:1994) in the biopile and the control pile were analyzed at the beginning, after 60 days, and at the end of the experiment. Total decrease of TPH in the control pile at the end of the experiment was 5.56 %. The analysis of the biopile showed a total decrease in TPH of 54.75 %. In order to investigate changes in distribution and abundances of different compounds during this experiment, TPH extracts from the biopile were analyzed by gas chromatography – mass spectrometry (GC-MS). The GC-MS analysis of TPH extract from the biopile at the beginning of the experiment showed that dominant compounds in this contaminant were isoprenoids and petroleum polycyclic aromatic hydrocarbons (PPAH): naphthalene, phenanthrene, dibenzotiophene and pyrene, and their C1-C4 alkylated homologues.

At the end of the experiment, most of the PPAH were reduced in abundances, and some of them were completely removed. The results of this research showed that bioremediation of petroleum pollutant dispersed in the artificial soil substrate can remove as much as 55 % of total petroleum hydrocarbons in 110 days. Considering the fact that the only compounds affected in this research were PPAH, it can be concluded that the procedure described can remove up to 55 % of PPAH from petroleum pollutant in relatively short period, which makes it especially attractive in environmental applications.

[1] Avdalović Jelena, Doctoral Dissertation, Generating of soil in the process of bioremediation, Faculty of Chemistry, Belgrade, 2015 (in Serbian); [2] ISO/TR 11046:1994 International standard: soil quality - Determination of mineral oil content - Method by infrared spectrometry and gas chromatographic method.

Notes

BIOREMEDIATION OF COMPLEX CONTAMINANT FROM PETROLEUM INDUSTRY IN AN ARTIFICIAL SOIL SUBSTRATE

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INTRODUCTION

Bioremediation is a process based on the natural capacity of microorganisms to degrade or transform toxic substances into less toxic or harmless products.

The objective of this research was to investigate the efficiency of bioremediation of complex contaminant from petroleum industry in an artificial soil substrate.

EXPERIMENTAL

The artificial soil substrate was prepared as a mixture of sand and sawdust. A complex contaminant from petroleum industry was added to make the final mass of the experimental biopile of 45 kg. During the experiment, the biopile was inoculated with multiplied consortia of microorganisms, isolated from the complex contaminant. Reinoculation was carried out every thirty days. The pile was mixed once per month to achieve the effect of aeration. Compounds of nitrogen, phosphorus and potassium were used for biostimulation. The results of this experiment were compared with the results of analyses of a control pile, which was prepared in the same way as the biopile but without inoculation, aeration and biostimulation. The experiment lasted 110 days.

Total Petroleum Hydrocarbons (TPH, as per method ISO/TR 11046:1994) in the biopile and the control pile were analyzed at the beginning, after 60 days, and at the end of the experiment.

In order to investigate changes in distribution and abundances of different compounds during this experiment, TPH extracts from the biopile were analyzed by gas chromatography – mass spectrometry (GC-MS).

RESULTS

Total decrease of TPH in the control pile at the end of the experiment was 5.56 %. The analysis of the biopile showed a total decrease in TPH of 54.75 %.

The GC-MS analysis of TPH extract from the biopile at the beginning of the experiment showed that dominant compounds in this contaminant were isoprenoids and petroleum polycyclic aromatic hydrocarbons (PPAH): naphthalene, phenanthrene and dibenzotiophene, and their C1-C4 alkylated homologues (Figures 1 - 4).

At the end of the experiment, most of the PPAH were reduced in abundances, and some of them were completely removed (Figures 1-4).

Table 1. Decrease of TPH in the control and biopile during the experiment.

	Day of the experiment	TPH	Degraded TPH (%)
Control pile	0. day	21.05	0
	60. day	20.39	3.14
	110. day	19.88	5,56
Biopile	0. day	18.01	0
	60. Day	13.74	23.71
	110. day	8.15	54.75

CONCLUSIONS

The results of this research showed that bioremediation of petroleum pollutant dispersed in the artificial soil substrate can remove as much as 55 % of total petroleum hydrocarbons in 110 days. Considering the fact that the only compounds affected in this research were PPAH, it can be concluded that the procedure described can remove up to 55 % of PPAH from petroleum pollutant in relatively short period, which makes it especially attractive in environmental applications.

REFERENCES:

Avdalović Jelena, Doctoral Dissertation, Generation of soil in the process of bioremediation, Faculty of Chemistry, Belgrade, 2015 (in Serbian).

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ACKNOWLEDGMENTS:

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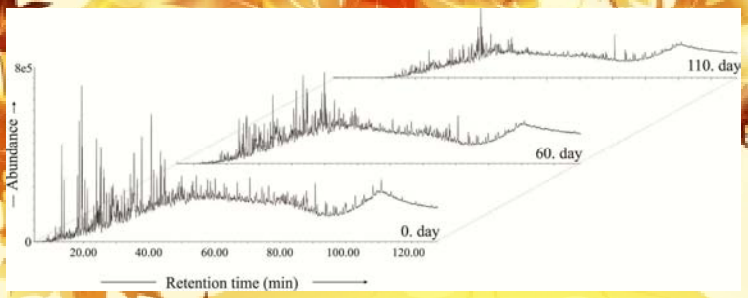

Figure 1. Total ion chromatograms of the TPH extracts isolated from the biopile during the experiment.

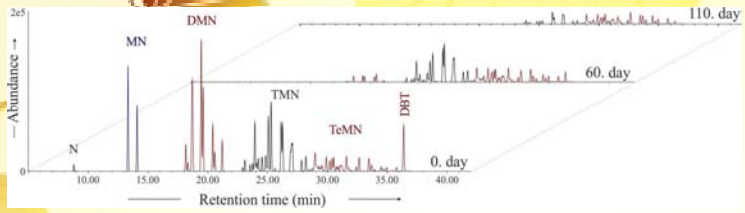

Figure 2. GC-MS chromatograms of ions *m/z* = 128 (naphthalene – N), *m/z* = 142 (methyl-naphthalenes – MN), *m/z* = 156 (dimethyl-naphthalenes – DMN), *m/z* = 170 (trimethyl-naphthalenes – TMN) and *m/z* = 184 (tetramethyl-naphthalenes – TeMN and dibenzotiophene – DBT) of the TPH extracts isolated from the biopile during the experiment.

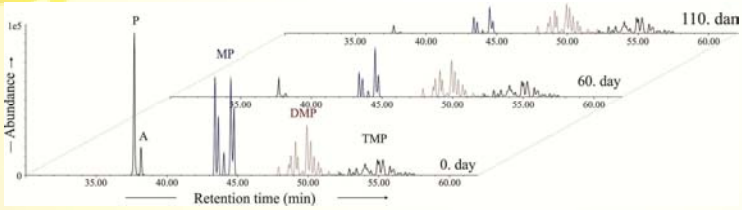

Figure 3. GC-MS chromatograms of ions *m/z* = 178 (phenanthrene – P and anthracene – A), *m/z* = 192 (methyl-phenanthrenes – MP), *m/z* = 206 (dimethyl-phenanthrenes – DMP) and *m/z* = 220 (trimethyl-phenanthrenes – TMP) of the TPH extracts isolated from the biopile during the experiment.

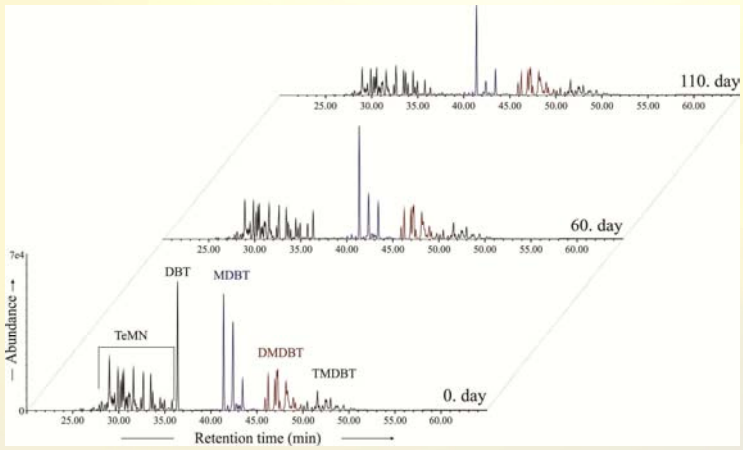

Figure 4. GC-MS chromatograms of ions *m/z* = 184 (dibenzotiophene – DBT), *m/z* = 198 (methyl-dibenzotiophenes – MDBT), and *m/z* = 212 (dimethyl-dibenzotiophenes – DMDBT) of the TPH extracts isolated from the biopile during the experiment.