GABRIELA LYČKOVÁ, RADMILA KUČEROVÁ,
PETER FEČKO, IVA PEČTOVÁ
Technical University of Ostrava, Czech Republic

BIODEGRADATION OF PAHS, PCBS AND PHC IN SEDIMENTS FROM THE MANMADE WATER COURSE OF ČERNÝ PŘÍKOP IN THE MUNICIPAL TERRITORY OF THE OSTRAVA CITY (CZECH REPUBLIC)

The work deals with biodegradation of polycyclic aromatic hydrocarbons, polychlorinated biphenyls and petroleum hydrocarbons in sediment samples from Černý příkop. The sediments from Černý příkop represent a considerable ecological burden on the territory of the City of Ostrava, they are contaminated with a broad range of organics. Standard pure bacterial cultures *Pseudomonas putida* a *Rhodococcus sp.* were used for biodegradation. The resulting data should correspond with the data specified by the Act N°294/2005 Coll. on the conditions of land filling and using wastes on the surface.

Изучено биохимическое разложение полициклических ароматических углеводородов, полихлордифенилов и нефтяных углеводородов в образцах осадочных пород с территории Черного Прикопа (Černý příkop). Осадочные породы Черного Пикопа представляют собой значительную экологическую угрозу на территории г.Острава; они загрязнены широким спектром органических веществ. Стандартные очищенные культурные бактерии *Pseudomonas putida* рода *Rhodococcus* использовались для биохимического разложения. Полученные данные должны соответствовать показателям, предписанных Актом № 294/2005 Coll., определяющим условия подземного захоронения и использования отходов на поверхности.

The work deals with biodegradation of polycyclic aromatic hydrocarbons, polychlorinated biphenyls and petroleum hydrocarbons in sediment samples from Černý příkop. The sediments from Černý příkop represent a considerable ecological burden on the territory of the City of Ostrava, they are contaminated with a broad range of organics and as far as their organic structure is involved, they markedly differ from other soils.

The sediments quality must correspond with a respective standard so that sediments composition in this artificial drainage channel was in compliance with requirements for its further utilization. The limits specified in the Act N°294/2005 Coll. on the conditions of land filling and using wastes on the surface, pose an unambiguous criterion for evaluation of the resulting sediments quality. The conclusions and contingent drafts of measures were elaborated as the basis for further long-time monitoring.

The sediments of Černý příkop represent a current problem, as the organics can be highly inhibited by bacteria occurrence, or a high concentration of particular POPs as the case may be. Biodegradation of these hazardous pollutants in the environment counts for significant prospective methods which by means of microorganisms decompose complicated pollutants that are harmful to the environment into simpler substances (harmless

ones). The principle of biodegradation technologies is an optimation of nutrient ratios (in order to support the growth of selected microorganisms capable of degradation of the target contaminants) and application of suitably selected isolated tribes of microorganisms with relevant degradation abilities.

For the laboratory check, pure bacterial cultures of *Rhodococcus sp.* and *Pseudomonas putida* have been used. *Pseudomonas putida* bacteria are gram-negative, chemoorganotrophic, aerobe obligate, and aerobically respiratory metabolisms. They are straight or curved rods. They move by one or more polar-located flagella. They are arranged mainly individually or in small clusters or chains. *Rhodococcus sp.* bacterie are gram-negative, chemoorganotrophic, aerobe obligate, and aerobically respiratory metabolisms. The cells are of a spheroidal shape. They appear individually or two and more cells aggregate into irregular clusters, sometimes tetrads or bundles.

In this locality, many samples of sediments were sampled. In the frame of this paper, the exemplary sample labelled as the Šverma sample has been described herein.

In total, the laboratory experiment took four weeks, individual experiments were provided concurrently. 100 g of soil, 100 ml of bacterial solution and 500 ml of substrate were inserted into 1-litre glass containers (reactor) which were following closed. Aeration (aerobic conditions) was secured by means of aquarium pumps. The required volume was gradually filled with distilled water. Samples for analyses were taken after one and four weeks.

The mentioned values of PAHs, PCBs a PHC were set before the experiment itself; afterwards they were analyzed after the 1st and 4th week of biodegradation. With respect to the fact that there is involved the sediment with its organic composition considerably differentiating from other soils with the concentrations of which dramatically exceeding the limits, the obtained results should reach the levels specified in the Enclosure N°10 (requirements related to contents of harmful substances in wastes used on the surface) of the Act N°294/2005 Coll. The values for ∑ PAHs (antracene, benzo(a)antracene, benzo(b)phluorathene, benzo(k)phluorathene, benzo(a)pyrene, benzo(ghi)perylene, phenanthrene, phluorathene, chrysene, indeno(1,2,3-cd)pyrene, naphthalene, pyrene) shouldn't exceed the limit values 6 mg/kg dry matter, as to the sum of individual PCBs congeners (congeners 28, 52, 101, 118, 138, 153, 180), it shouldn't exceed the limit value of 0,2 mg/kg dry matter.

The results of bacterial leaching applying a pure bacterial culture of *Rhodococcus sp.* imply that after one-month leaching it is possible to remove 96 % of PHC, 90 % of PAHs and 50 % of PCBs from the sample Šverma. The results of bacterial leaching applying a pure bacterial culture of *Pseudomonas putida* imply that after one-month leaching it is possible to remove 51 % of PHC, 77 % of PAHs and 57 % of PCBs from the sample Šverma.

In this phase of the research, a biodegradation proved effective by applying a pure bacterial cultures *Pseudomonas putida* and *Rhodococcus sp*. as some organic polutants were eliminated even of 100 % (especially phenanthrene by bacteria *Rhodococcus sp.*). The acquired results imply that the bacterial culture of *Pseudomonas putida* is more convenient for degradation PCBs and the bacterial culture *Rhodococcus sp.* is more convenient for degradation PAHs and PHC.

It results from the laboratory results that degradation of particular PAH was different, as any hydrocarbon requires specific degradation condition. As to the major representation at Šverma sample, the fluoranthen degradation efficiency was the highest (99 %) by means of bacteria *Pseudomonas putida*.

In conclusion, it is necessary to say that even despite a possible biodegradation at Šverma sample, no ∑PAH limit value was reached. It is obvious from the obtained results of samples, their analysis and subsequent biodegradation that the only problem indicator is ∑PAH in particular which exceeds the limit value 6 mg/kg cca twenty times (the values are

from 70,2 up to 167,4 mg/kg in the dry matter). As to the ∑PCB indicator, the limit value of 0,2 mg/kg was reached at the Šverma sample by means of the bacteria *Rhodococcus sp.* and *Pseudomonas putida*.

Better results could be reached by prolonging the biodegradation time or by application of an adapted bacterial culture, or eventually by the modification of the optimal conditions during the biodegradation.

REFERENCES

1. *Kužílek V.*: Polycyklické aromatické uhlovodíky v hydrosféře, Výzkumný ústav vodohospodářský T. G. Masaryka v Praze, Praha, 1994.

2. *Raclavská H.*: Znečištění zemin a metody jejich dekontaminace, VŠB-TU Ostrava, 1998.

3. *Raclavská H.*: Polyaromatické uhlovodíky (PAU) v sedimentech z OKR. In: Iniciace přirozených ekosystémů poddolované krajiny pro proces obnovy území Karvinska, VŠB-TU Ostrava, dílčí úkol 3, 2003.