

Investigation of inhibitory effect of molybdenum and cobalt in the isolated microorganism consortia which is used in bioremediation

Tanja Jednak^{1,2}, Miroslav M. Vrvic², Srđan B. Miletić³, Jelena Avdalović³, Mila Ilić³, Jelena Milić³, Vladimir Beškoski¹

¹ Faculty of chemistry, University of Belgrade, Serbia

² BREM GROUP Ltd, Belgrade, Serbia

³ Institute for Chemistry, Technology and Metallurgy, University of Belgrade, Serbia

INTRODUCTION

Contamination of soil, groundwater, sediment, surface water and air with hazardous waste such as oil and by-products arising during processing of crude oil, pose a major problem the world faces today.

Catalysts used in the process of oil desulphurisation can be a source of pollution with heavy metals and therefore we tested their chemical properties, as well as their impact on the growth of microbial consortium in the process of bioremediation, which was isolated from the waste of fuel oil from the Belgrade power plants and from waste motor oil. We examined five different catalysts that are derived from the Oil Refinery. We focused our attention on two metals: Mo (molybdenum) and Co (cobalt) because of their abundance in those catalysts.

The efficiency of bacterial cells in concentrating metal has enabled their high ratio of surface area to volume and high charge density on the cell surface. Entire bacterial cell is negatively charged due to the presence of different anions. Therefore, the bacterial cell walls have a strong affinity for metal cations. Intact bacterial cells, regardless of whether they are alive or dead, as their products are also very effective in accumulating metals.

EXPERIMENTAL

- Tests for chemical properties of the catalysts
- Radiographic analysis of testing catalysts
- For the preparation of microbial consortium the following materials were used: waste motor oil and soil contaminated with waste fuel oil originated from Belgrade Power Plant.
- Chemical and microbiological analysis of waste motor oil and soil contaminated with waste fuel oil was made.
- Determination of minimum inhibitory concentrations of metals from catalysts in various consortia of microorganisms.

CONCLUSION

- Aqueous extract of the catalyst number 3 doesn't have inhibitory effect on consortium at investigated concentration of metals and could be safely used in the bioremediation process.
- The results of present study provide evidence that microbial consortium isolated from oil contaminated soil could also be used in the bioremediation process with the presence of wasted catalysts.

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RESULTS

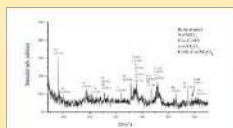
Tests for chemical properties of the catalysts

Determination of chemical parameters	Units	Catalyst 1	Catalyst 2	Catalyst 3
Moisture	%	9,8	28	17,5
Ash	%	84,59	7,69	94
pH		3,54	9,95	2,8
Carbonates	%	1,16	-	-
CO ₂	%	0,51	-	-
Hexane extractable substances (HES)	g/kg d.m.	1,20	-	-
Total petroleum hydrocarbons (TPH)	g/kg d.m.	0,43	-	-
Elemental organic analysis (EOA)				
C	%	0,64	83,38	<0,12
H	%	0,90	2,16	0,54
S	%	3,19	-	0,87
Metal content	mg/g d.m.			
As		0,31	0,001	2,77
Fe		9,12	2,26	2,56
Co		17,12	0,033	18,65
Mo		52,15	0,095	56,68

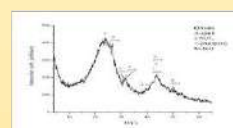
Legend:

HES – Hexane extractable substances
TPH – Total petroleum hydrocarbons
EOA – Elemental organic analysis

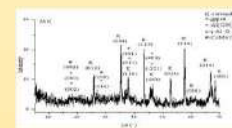
X-ray diffraction analysis of testing catalysts



In the analyzed sample showed the presence of crystalline phases following: SiO₂, corundum (α-Al₂O₃), γ-Al₂O₃, CoO and CoAl₂O₄.



In the analyzed sample can be the presence of the following crystalline phases: quartz, γ-Al₂O₃, apatite (Ca₅(PO₄)₃(F, Cl, OH)), but in very small quantity.



Determined the presence of the following crystalline phases: corundum (α-Al₂O₃), gibbsite (Al(OH)₃), γ-Al₂O₃, Al(OH)₃, CoMoO₄, Al(OH)₃. It is different from the crystal structure of gibbsite.

Chemical and microbiological analysis of waste fuel oil and waste motor oil

Motor oil							
HES [g/kg _{d.m.}]	TPH [g/kg _{d.m.}]	Ash [%]	EOA (%)				Moisture [%]
			N	C	H	S	
925	875	0.43	0.55	84.90	11.41	1.87	0.50
Microbiological analysis							
Total chaemoorganotrophs, aerobic and optional anaerobic bacteria		Yeast and mold spores		Microorganisms, which as the only source of hydrocarbons use diesel D2			
7 × 10 ³		4 × 10 ³		4 × 10 ³			

Waste fuel oil							
HES [g/kg _{d.m.}]	TPH [g/kg _{d.m.}]	Ash [%]	EOA (%)				Moisture [%]
			N	C	H	S	
834	465	0.45	0.55	84.90	11.41	1.87	0.16
Microbiological analysis							
Total chaemoorganotrophs, aerobic and optional anaerobic bacteria		Yeast and mold spores		Microorganisms, which as the only source of hydrocarbons use diesel D2			
5 × 10 ³		3 × 10 ³		2 × 10 ³			

Toxicity of Mo and Co in consortia K1 and K2

The Inhibitory effect of tested catalysts on growth of microbial consortium in nutrient medium was studied using catalyst aqueous extract in concentration range of 250-6000 ppm for molybdenum, and 64-1540 ppm for cobalt.

AKNOWLEDGEMENT

This research is a part of project III 43004 funded by the Ministry of Education, Science and Technological Development of Republic of Serbia.