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MICROORGAMISMS FROM BIOREMEDIATION TO ELECTRONIC WASTE: SOME OF OUR EXAMPLES

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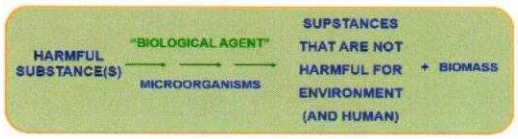
INTRODUCTION

Chemical and biochemical activities of microorganisms are obvious in industrial biotechnology. They are becoming even more important in environmental biotechnology and circular economy.

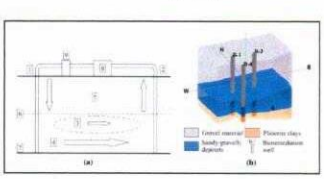
The application of microorganisms in remediation, environmental protection and management have proven that they are "biological agents" of choice. In bioremediation processes they may be used for the treatment of waste water as well as for polluted surface and underground waters, polluted soil and process gases, i.e. indirectly, even for polluted air. Essence of bioremediation is shown bellow:

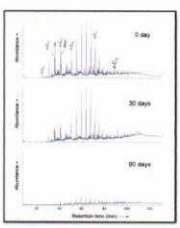


REAL "GREEN" AND "ZERO WASTE" TECHNOLOGY!!!

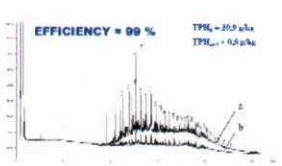
OUR EXAMPLES
In situ and *Ex situ* bioremediation

In situ and ex situ bioremediation procedures for the treatment of soil and underground water contaminated by oil derivatives with the application of zymogenous active microbial consortia on the industrial level have shown in our multi-year practice to be very effective and applicable in all aspects. During biodegradation of oil pollutants, the soilification of the substrate has occurred through the process of humification. [1,2]





In situ bioremediation and its efficiency



Ex situ bioremediation and its efficiency

LABORATORY EXPERIMENTS WITH ELECTRONIC WASTE (EW)

Laboratory experiments dealing with the recovery of a number of elements from electronic waste (printed circuit boards) with the application of the bacterial species *Acidithiobacillus ferrooxidans* that generates/regenerates iron(III)-ion as an active reagent for the solution of metals have proven that biohydrometallurgical procedures have potential application in the recycling and reuse of technically important metals such as are rare earth elements-REE (critical materials).

We have investigated the bioleaching of metals (Cu, Sn, Ni, Zn and Ag) from printed circuit boards using *At. ferrooxidans* isolated from copper mine dump Bor.

Experimental flasks contained 9K medium (9 gFe^{2+}/L) inoculated with *At. ferrooxidans*, and compared with abiotic control meddium. In all solutions shredded electronic waste were added with pulpe density 1:100 (m:v). The experiments were run in rotary shaker, for 14 days at 28 °C.

At the end of experiment, in test solution in which Fe(III)-ion has been produced microbiologicaly, high concentrations of metal in solution indicated the oxitation role of Fe(III)-ions and in acid environment, which is confirmed by 10 fold lower metals concentration in abiotic control. [3]

CONCLUSION

It may be concluded that microorganisms are undoubtfully the most useful "green" agents in the area of environmental protection and in the future, in circular economy of some of critical elements. Microorganisms are inseparable from the green chemistry and engineering and they are an important link in the sustainable development.

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