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Humic acids generation during bioremediation of petroleum pollution in soil substrates

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[Introduction]

The advance of technology and industry in the last hundred years, population growth and the development of big cities have led to the production of waste materials in quantities which exceed self-purification capacity of nature. The accumulation of waste materials of various origin causes increased pollution of the environment, including soil. Nondegradable waste materials degrade soil and disrupt normal soil processes, which has negative effects on the ecosystem and human health.

Petroleum and its derivatives are one of the major and most dangerous pollutants of soil. Pollution by petroleum and petroleum derivatives is caused by its exploitation, processing, transport, storage and use, but also by accidental spills. Bioremediation is a method of reducing petroleum pollution which has been widely used in the last years.

Bioremediation is a process which is based on the natural capacity of microorganisms to degrade or transform toxic substances from the environment into harmless products. Bioremediation technologies are in harmony with the principles of sustainable development since waste materials are not generated, and the treated soil can recover its natural biological activity.

[Methods]

The aim of this paper is to study the use of different microorganisms as “biological agents” through processe which are of crucial importance for soil formation. The processe includes the study of an active consortium of zymogenous microorganisms for *ex situ* bioremediation of a complex petroleum contaminant in soil substrate, along with simultaneous monitoring of the humification process.

[Results and discussion]

In the studies based on simultaneous bioremediation and humification, which lasted for 6 months, 150 m^3 of soil contaminated by various petroleum derivatives was treated by *ex situ* bioremediation. Results are shown in the following tables.

Sample	Ambiental temperature [ºC]	Ground temperature, 15 cm depth [ºC]	pH (*s:l=1:2.5*)	Humidity at 105 ºC [%(m/m)]	TPH [g/kg]
HP1 (Day 0)	18,0	53,4	7,9	19,9	29,99 ± 1,88
HP2 (Day 33)	23,4	34,6	7,7	13,8	23,08 ± 3,32
HP3 (Day 63)	37,5	38,2	7,5	33,7	13,73 ± 1,31
HP4 (Day112)	14,5	31,4	7,5	35,6	7,74 ± 2,88
HP5 (Day 147)	28,9	37,2	7,6	37,0	5,42 ± 1,76
HP6 (Day 184)	15,6	36,8	7,3	23,8	2,17 ± 1,32

Sample	Alkyl C 0-45 ppm (%)	O/N Alkyl C 45-105 ppm (%)	Aromatic C 105-160 ppm (%)	Content of humic acids (%)	Degree of aromaticity
HP1-HA	42,90	26,73	23,15	1,92	24,9 %
HP2-HA	42,53	26,99	23,56	2,08	25,3 %
HP3-HA	40,75	26,17	24,18	2,30	26,6 %
HP4-HA	42,55	26,45	25,16	2,62	26,7 %
HP5-HA	41,22	26,71	25,50	2,72	27,3 %
HP6-HA	37,72	26,56	26,10	2,83	28,9 %

[Conclusion]

The total petroleum hydrocarbons (TPH) content was reduced from the initial 30 to 2,2 g/kg, while the content of humic acids increased by 47%. The analysis of humic acids from the studied samples showed that the structure of humic acids changed during bioremediation.

[Acknowledgement]

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