

SOIL CHEMICAL AND MICROBIOLOGICAL PROPERTIES VARIATION AS A CONSEQUENCE OF OIL POLLUTED SOILS ELECTRO REMEDIATION

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Abstract

Electro remediation technologies have been applied on a former Petroleum Park, at Sfinții Voievozi, Dâmbovița County. The evolution of the soil chemical and microbiological properties has been studied, by sampling and laboratory analyses carried out at different time intervals. Organic carbon and nutritional macro elements contents varied in time. An organic carbon depletion tendency has been noticed, implying the oil residues contents depletion, which is the purpose of the experiment. The variations of the plant nutritional elements contents (nitrogen, phosphorus, and potassium) were low, meaning that these elements do not migrate with the oil residues, which is very important for this land's re-cultivation. The soil reaction and the total soluble salts content registered small variations, statistically not ensured. As for the microbiological properties, a modification phenomenon was noticed, of the number, communities' structure, and physiologic activities of the soil micro flora. The obtained results will be used to develop a computing system for petroleum products pollution risk management and to apply electro kinetic and bio-remediation techniques in situ.

INTRODUCTION

The oil contaminated fields problems are getting more important lately, from the practical, scientific, and political point of view, at a national and international scale, and constitute a major concern of the European Union. The inherited contamination represents, in the last few years, a critical soil pollution category, because of the pollutant persistence in soil and groundwater on one hand, and because it is more difficult to manage or to solve than a new pollution on the other hand. The present paper was elaborated in the frame of a project which aims to develop management tools of the health estate of certain areas and assist strategic and tactical decisions taking depending on it.

MATERIAL AND METHODS

The research field is placed near Târgoviște, in the Sfinții Voievozi area, on a former Petroleum Park. A 2 by 2 m lot was delimited and electrodes were inserted in its corners (cathodes, F1-F4) and middle (anode, F5), in ceramic tubes, down to 2 m depth. A potential difference was applied between the electrodes, as part of the remediation technology. The lot was sampled at the electrodes 7 times, at several days intervals.

The soil samples were chemically analysed in the laboratory, by standardized methods [1-5], in order to determine the reaction, organic carbon, total nitrogen, nitrates, mobile phosphorus and potassium, and soluble salts contents. Microbiological analyses were also performed, as microbiologic activity is very important for the oil polluted soils remediation. All these soil properties' variation in time was studied, in order to develop decontamination technologies, along with a risk assessment system for such terrains.

RESULTS AND DISCUSSION

The evolution in time of organic carbon and nutritional macro elements contents under the influence of remediation electro kinetic treatment

The organic carbon contents around the electrodes have a depleting tendency with the electro remediation time (Figure 1). It is more accentuated at the cathodes, but not here or at the anode is it statistically ensured.

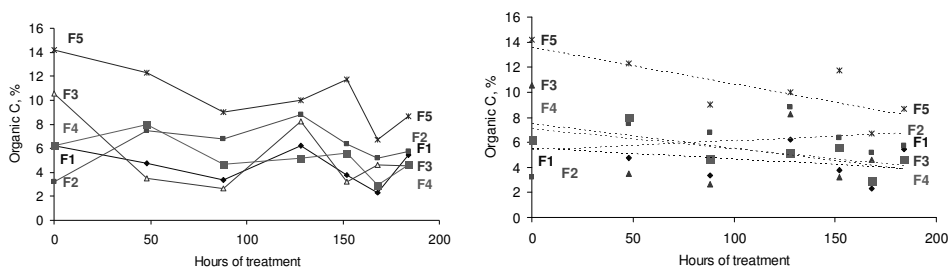


Fig. 1. Evolution in time of organic carbon contents of samples taken from the electrodes in experimental lot; right: linear tendencies

The total nitrogen contents have a depleting tendency (Figure 2) during the remediation process, more stressed for the F3 cathode and almost inexistent at the anode, not statistically ensured.

The carbon:nitrogen ratio tendency is symmetrical with that of the total nitrogen content: the latter increasing tendency is reflected by the former depleting tendency (Figure 3). Again symmetrically, the most accentuated depleting tendency is registered at the F3 cathode, and weakest at the anode. These tendencies are not statistically ensured.

The nitrates contents vary irregularly, especially at the F4 cathode (Figure 4). The fact must be considered that nitrates are easily leached into the soil depth due to their high water solubility and the experimenting period was a rainy one. A slight increasing tendency can be noticed though at the F2 cathode and a depleting tendency at the anode, not statistically ensured.

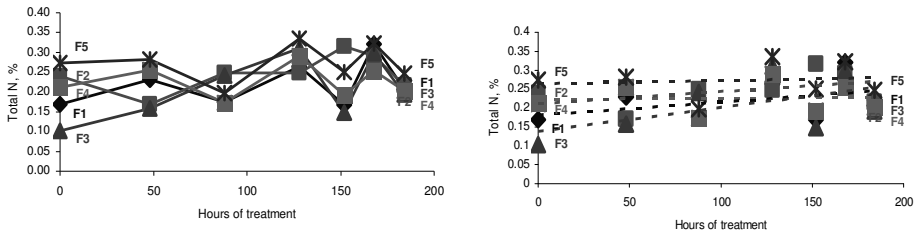


Fig. 2. Evolution in time of total nitrogen contents of samples taken from the electrodes in experimental lot; right: linear tendencies

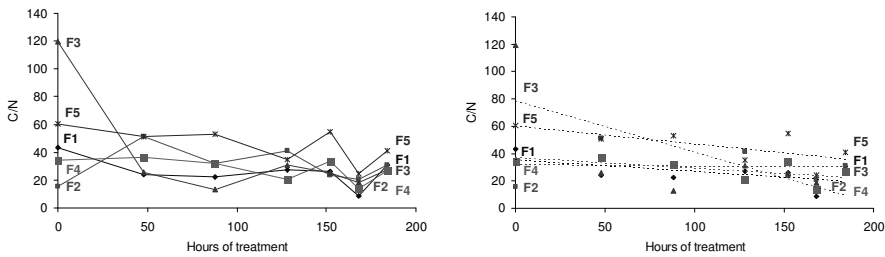


Fig. 3. Evolution in time of C/N ratio of samples taken from the electrodes in the experimental lot; right: linear tendencies

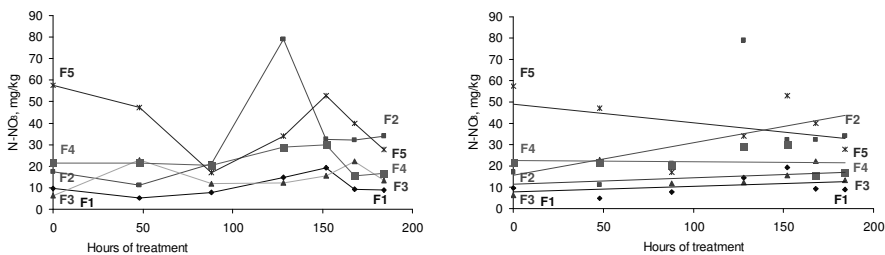


Fig. 4. Evolution in time of nitrogen contents of samples taken from the electrodes in the experimental lot; right: linear tendencies

The mobile phosphorus contents variation is also irregular (Figure 5). The increasing tendency at the F2 and F3 cathodes and the depleting one at the anode are not statistically ensured.

The mobile potassium contents tend to increase at the F2 cathode and to deplete at the anode (Figure 6) but the tendencies are not statistically ensured. Almost no difference can be noticed at the other cathodes.

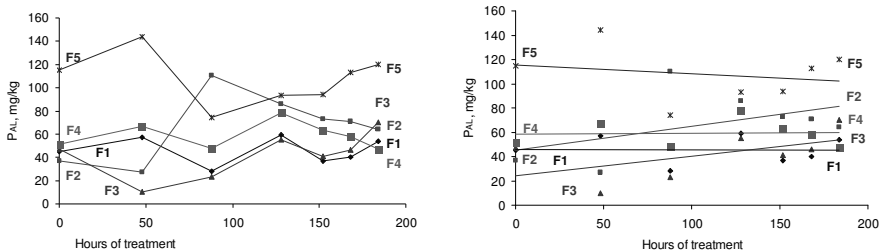


Fig. 5. Evolution in time of mobile phosphorus contents of samples taken from the electrodes in experimental lot; right: linear tendencies

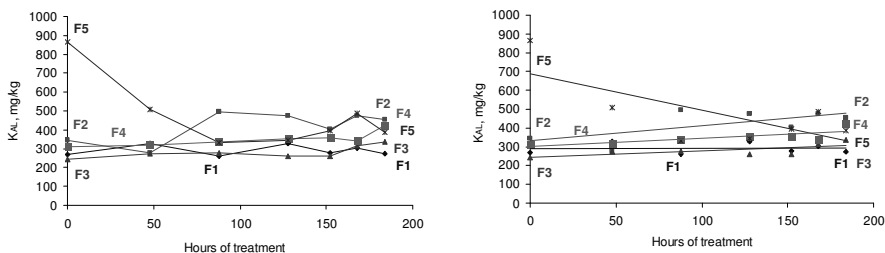


Fig. 6. Evolution in time of mobile potassium contents of samples taken from the electrodes in experimental lot; right: linear tendencies

The variation in time of soil reaction and soluble salts content

The soil reaction is slightly alkaline, with a little higher values at the F1 cathode and lower at the F2 ONE and has a slightly increasing tendency in these points (Figure 7).

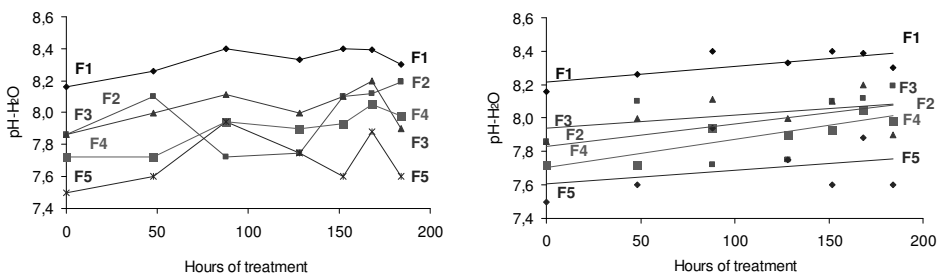


Fig. 7. Evolution in time of reaction of soil samples from the experimental field electrodes; right: linear tendencies

The total soluble salts (determined by conductimetry, Figure 8) dynamics indicate a slight increase at the F3 cathode and a bigger one at the F2 one and a slight diminution at the F1 cathode and bigger at the F4 cathode and the anode.

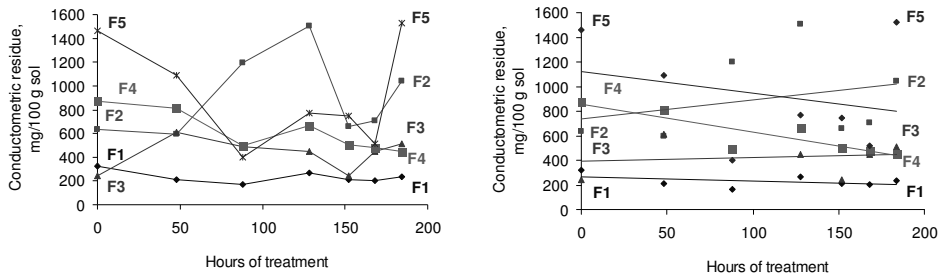


Fig. 8. Evolution in time of total soluble salts contents, determined by conductimetry, in soil samples from the experimental field electrodes

Microbiological soil properties variation along the remediation treatment

A modification phenomenon takes place, under the influence of the remediation treatment, of the communities' numbers and structures and of the physiologic activities of the oil polluted soil micro flora which is very important from the oil polluted soils remediation technologies point of view. As compared to the initial moment, an increasing sinuous tendency is noticed of the bacteria and fungi populations, with maximums at different moments. Very high values were registered at the cathodes in the samples taken after 152 hours and at the anode in the samples taken after 168 hours.

The most important fungi numbers increases as compared to the initial moment, and also as compared to the cathodes, were registered at the anode, after 168 and 184 hours. The general tendency is of microbial population increase in time both for the cathodes and for the anode. The phenomenon is more accented with the bacteria, with up to 3 orders of magnitude, than with the fungi (only 1 order of magnitude).

As regards the microbial community structure, fluorescent *Pseudomonadaceae* settle as dominant bacteria species after 88 hours, both at the cathodes as at the anode, and the *Bacillaceae* share diminishes. For the fungi the potentially pathogenic species belonging to the *Fusarium* genre are dominant regardless of the sampling moment, both at the cathodes and at the anode.

The soil respiration values have an increasing tendency at the cathodes, with different maximums at F1 and F3 after 168 hours, F2 after 152 hours, and F4 after 88 hours. At the anode, where higher values than at the cathodes were registered, a maximum was noticed 88 hours from the initial moment after which the tendency was of diminution.

CONCLUSIONS

1. The organic carbon and macro elements contents in the experimental field vary in time under the influence of the electro kinetic remediation treatment. The organic carbon contents depletion tendency is to be noticed, as it means diminution of hydrocarbons' contents, the very goal of the remediation treatment. The variation of the contents of plant nutrition elements are much too weak meaning that these elements are not exported from the soil along with the hydrocarbons, which is very important for the re-cultivation of the terrain.
2. The soil reaction and total soluble salts contents do not significantly vary. The slight increasing tendency is due to their accumulation at the electrodes under the influence of the potential difference. It is possible that the contents depletes between electrodes, so these spaces should be sampled too.
3. The microbiologic soil properties vary in time, in numbers, in structure, and in physiologic activity, which is very important from the oil polluted soils remediation technologies point of view. The increasing tendencies are sinuous.
4. The experimental time was short so clear tendencies, especially for the organic carbon contents, could not be highlighted. A longer experimenting period and sampling at larger periods could clarify the described tendencies. The weather conditions in the experimenting period must be recorded because rain, fog, drought, for example, significantly influence the elements' contents of soils. The rainy period of the experimentation affected the elements' contents variation in soil.

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