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THE INFLUENCE OF THE APPLICATION OF ELECTRICAL DESORPTION ON SOIL NUTRIENT CONTENT

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ABSTRACT

Checking the nutrient content of the soil after applying a depollution method has a significant impact on the environment. Of the macroelements present in the soil structure, those of particular interest are nitrogen, phosphorus and potassium. The presence of each element in the soil structure is important for plant growth on depolluted soils. Nitrogen absorbed from the soil is transformed through various chemical reactions into assimilable amino acids that ensure the growth of leaves, stems and the development of the plant root system. Phosphorus, assimilated by plants in the form of phosphoric acid or phosphoric anhydride, is involved in the functioning of the immune system, increasing the plant's resistance to crop conditions, atmospheric conditions, pest attack and insecticide administration. Potassium is converted during chemical reactions into potassium hydroxide and assimilated in this form by the plant. It increases the plant's ability to store nutrients in its reserve organs. Electrical desorption remediation is recommended as a remediation method for soils contaminated with volatile or semi-volatile compounds. The extraction yield of pollutants from soil is around 95%, lower values are only obtained if the mass content of pollutants in the soil is higher than 10%.

Following the application of desorption depollution, the only element that does not undergo transformation is potassium, which makes this method of depollution preferred, despite being expensive.

Keywords: soil, depollution method, desorption, nutrients

INTRODUCTION

The soil, one of the environmental factors responsible for the health of humans and the planet, is constantly challenging scientists. In its soil structure, soil contains nutrients that have been classified into macroelements (C, H, O, N, P, K, Ca, Mg, S) and microelements (Fe, Mn, Cu, Zn, B, Mo, Cl). Soil nutrients are found either as assimilable substances: as free ions in the soil solution, absorbed in the colloidal complex, as soluble salts in the soil water, or as substances inaccessible to plants, as hardly soluble salts [1].

When harmful substances are accidentally dumped on the soil, these nutrients can be affected and, consequently, the soil structure can be altered. For a soil to be subjected to

remediation methods, when this is required, the choice of method is the hardest choice for specialists.

The specialists around the world are interested in the presence of nutrients in the soil, so there are concerns about the reduction of chemical fertilizers, completely harmful to soils, the importance of irrigation for various crops so that the nutrient content is not affected.

The application of soil remediation methods must be in close accordance with the qualities and properties of the soil [2-8].

Since there are frequent situations of soil pollution with liquid petroleum products, in this paper a study is presented on how the application of a depollution method can influence the NPK content of the soil structure.

MATERIALS AND METHODS

The study was carried out on a garden soil sample for which the nutrient content was first determined. Then the sample was polluted in a controlled way (7%) at laboratory level with a liquid petroleum product, characterised by physical properties analysis (density and viscosity). This polluted sample was subjected to depollution by electrical desorption.

This paper is part of an extensive study on the application of depollution methods and various comparisons between them. All experiments were carried out at laboratory level and physical, chemical, electrical and thermal decontamination methods were applied. These determinations are still continuing [9].

The nutrient content has been highlighted based on the oxides of these elements, delivered with the kit from Hanna Instruments [10].

The tests were performed using the Hanna Instruments HI3896 kit shown in Figure 1.

To achieve thermal desorption, which ensures high temperatures by means of electrical heating and provides an electronic temperature display, the apparatus OFITE shown in Figure 2 was used.

Figure 1. *Nutrient analysis kit* [10]

Figure 2. *Electrically heated thermal desorption apparatus* [11]

The apparatus used for thermal desorption (Figure 2 and Figure 3) contains [11]: sample cup, condenser, a heating element, one thermostat and one liquid receiver.

The equipment allowed to set the working temperature. A temperature of 400 ^{0}C (752 ^{0}F) was set and was continuously monitored on the electronic display of the apparatus (Figure 4). The experiment was terminated when no more liquid flowed into the collecting vessel.

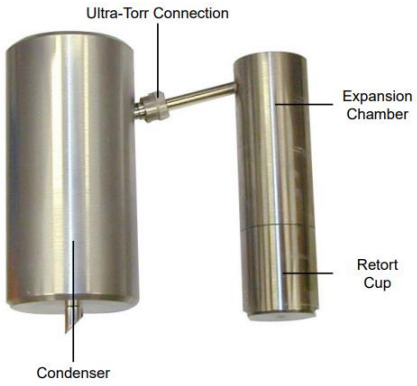

***Figure 3**. Thermal desorption assembly* [9]

***Figure 4**. Electronic display of the equipment*

The soil sample was weighed and placed in the special retort (retort cup) so that the lid was placed tightly over the sample and the sample exited through the hole in the lid according to the manufacturer's instructions [11].

The remediation of soils contaminated with hydrocarbons by the thermal desorption method is based on the property of liquid hydrocarbons to vaporize at atmospheric pressure at temperatures below 400 °C.

If molecular species with a higher normal boiling temperature are present in the liquid petroleum pollutant, there is a possibility that they will decompose before vaporizing into compounds with a lower molecular mass and a lower normal boiling temperature.

In principle, the thermal desorption remediation process has two distinct steps: the first step consists of volatilizing the pollutants by heating the contaminated soil, and the second step involves treating the resulting gases in order to separate and concentrate the pollutants.

Typically, the volatilization of pollutants from the soil takes place at temperatures between 200 and 450 ^{0}C.

RESULTS

Before being polluted, the nutrient content of the garden soil was qualitatively determined. As can be seen from Figure 5, the nitrogen and potassium contents are high and the phosphorus content is low.

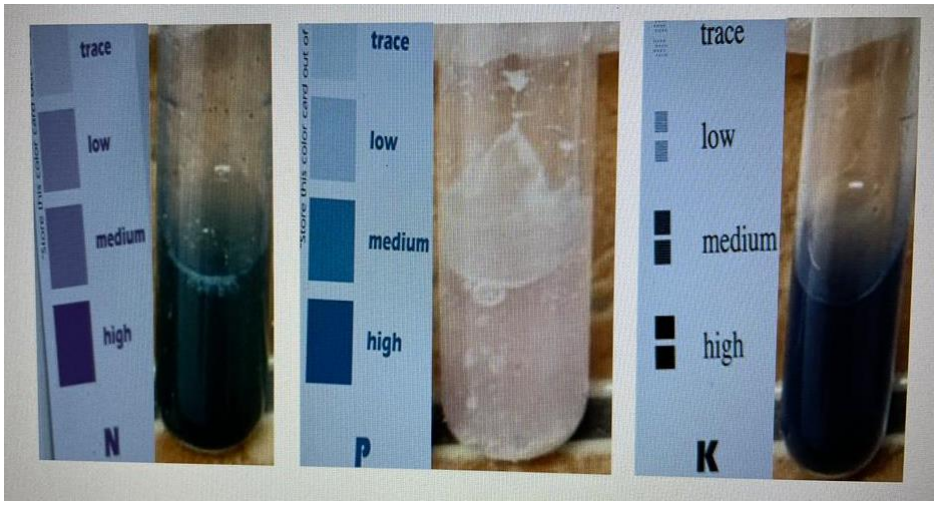

***Figure 5**. NPK nutrient content in the unpolluted sample*

Next, the soil sample was polluted in a controlled laboratory with a liquid petroleum product (7%) simulating real situations of accidental soil pollution.

Soil samples (unpolluted and polluted with 7% liquid petroleum product) were subjected to thermal desorption, which was achieved by electrical heating. The experiment was conducted until the required temperature of 752 °F (400 °C) was reached and no more liquid flowed out of the condenser. The collected sample is shown in Figure 6.

***Figure 6**. Sample collected after desorption*

The results obtained from the application of thermal desorption are shown in Table 1.

***Table 1**. Results obtained after desorption*

Products obtained	**Control sample analysed**	**Soil sample with 7% liquid petroleum product (4,3 ml)**
Water, ml	8,5	8,5
Petroleum product, ml	-	4
Degree of depollution, %	93	

After applying the depollution method, the change in nutrient content was monitored. The results obtained for the thermally depolluted soil sample are shown in Figure 7.

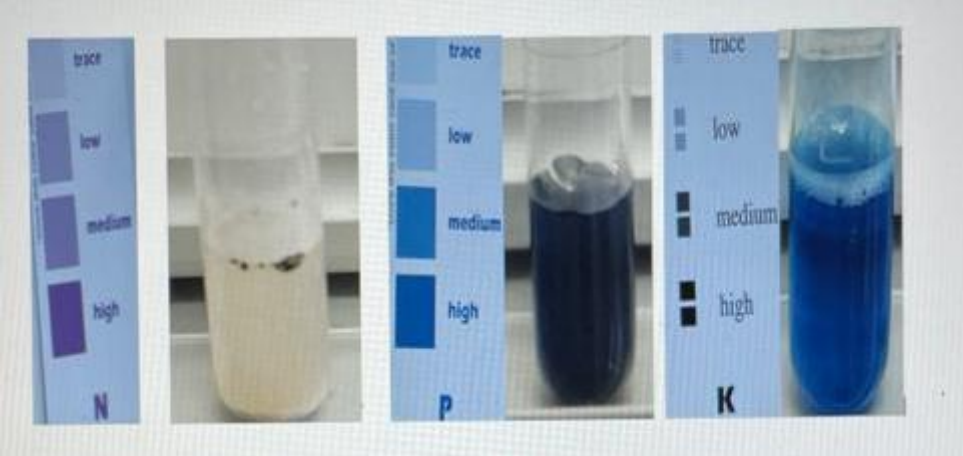

***Figure 7**. NPK nutrient content in thermally depolluted sample*

CONCLUSIONS

As has been specified, choosing a remediation method for soil polluted with liquid petroleum products is a difficult task for specialists. On the one hand, the presence of the pollutant in the soil poses great problems for soil scientists. On the other hand, it is very important that the pollutant can be recovered. Between these two problems lies the nutrient content of the soil. NPK plays a significant role when the soil is cleaned up and often returned to agricultural use.

This paper presents the study carried out in thermal desorption depollution, carried out by electric heating. What is important is the recovery of the polluting oil product. A depollution degree of 93 % was achieved.

By its structure, soil is a component of the environment that also contains water and air. The soil solution as a whole is a nutrient medium because it contains Ca, Mg, K, Na. Knowing the role of the soil solution in regulating the regime of certain elements in the soil helps to make rational use of chemical fertilisers, even after depollution, when soils can be returned to the agricultural circuit. Soil air plays an important role in soil dynamics. The air content differs in different types, depending on the presence of organic matter and on microbiological activity.

Regarding nutrient content, when electrical desorption was applied to the garden soil analysed, nitrogen and phosphorus changed, only potassium content remained the same. So, the temperature of 400 °C caused nitrogen to decrease and phosphorus to increase. These results lead to the conclusion that the study of nutrients in soil, before and after any applied depollution method, is still looking for answers.

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