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ANALYZE OF THE PHYSICAL-CHEMICAL PROPERTIES OF THE SOIL IN THE AREA POSTA RAT / TURDA

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ABSTRACT. The most important contaminated areas from Cluj County are the uncontrolled HCH scrap deposits from Turda city, which appeared as a result of the industrial activity of the former Chemical Plant Turda. Over the years, were identified 4 locations in the area. The four contaminated locations situated in the area of Turda city Sum up to 60000 tons of HCH polluted soil are. One of these zones is the Posta Rat area (40000 m^2) which is situated on the left bank of Aries River. The objective of this paper is to carry out experimental researches in order to establish the physical-chemical properties of the soil from Posta Rat area, soil contaminated with HCH (hexachlorocyclohexane). The texture, structure, humidity and pH are the main analysis performed in order to determine the optimum cleaning technologies for the deteriorated soil as a result of the activity of the Chemical Plant in Turda. The results of the physical-chemical analysis can point out the most suitable cleaning soil solution, because as a result of the study, the characteristics of the soil are known, being much easier to identify the applicability limits of the cleaning solutions.

Key words: *humidity, Posta Rat, pH, structure, texture*.

INTRODUCTION

The environment decay and pollution comprises changes in the quality of the environment. Any material or substance introduced artificially into the biosphere or that exists in natural conditions and induces negative modifications of the quality of the environment represents a pollutant (Munteanu et al., 2011).

The most important contaminated areas from Cluj County are the uncontrolled HCH scrap deposits from Turda city, which appeared as a result of the industrial activity of the former Chemical Plant Turda (Prodan, 2012).

At the Chemical Plant from Turda, founded in 1911, was produced starting with 1950 an insecticide called hexachlorocyclohexane (HCH) and after 1960 a liquid insecticide dichlorodiphenyltrichloroethane (DDT) – 400 tons/year. In 1979 the production of HCH was stopped but until that moment in Turda was created several chemical residues deposits as a result of the production process of this insecticide (Prodan, 2012).

Over the years, were identified 4 locations in the area (RPM, 2010). The four contaminated locations situated in the area of Turda city (approximatively 7 ha) sum up to 60.000 tons of HCH polluted soil are (Prodan, 2012):

1. Right bank of Aries river (4000 m^2);
2. Right bank of Aries river – construction site SC Constructorul Turda (24000 m^2);
3. Left bank of Aries river – Posta Rat area (40000 m^2);
4. National Road DN 1 km 440/700 – Mihai Viteazu village (5000 m^2).

The HCH production of Turda Chemical Plant resulted in obtaining significant quantities of dangerous waste built from other isomers of this substance.

From the technological production process of HCH results waste in a ratio of approximately 3 times bigger than the active part. As a percentage, approximately 25 % was obtained gamma active isomer and the rest of 75 % inactive isomers which were deposited in an uncontrolled way. So, as a result of the technological process, resulted a quantity much bigger of inactive product dumped uncontrolled, thus significantly deteriorating the environment (RPM, 2010).

The problem of these contaminated areas is difficult to handle due to the fact that Turda Chemical Plant seized completely its activity, and the goal of cleaning them is left in the responsibility of the local public administration (Gabrian, 2013).

The scope of this paper is to analyze the physical-chemical properties of the soil in order to investigate the optimum cleaning technology of the deteriorated soil as a result of the activity of Turda Chemical Plant.

MATERIALS AND METHODS

From Posta Rat area were taken 3 soil samples (figure 1) from different depths, according with table 1.

Gathering of the soil samples assigned to physical-chemical analysis was made according with the methodological norms mentioned in STAS 7184/1-84 and processed further on according with SR ISO 10381-6:1997 standard and respectively SR ISO 11464:1998 (STAS 7184/1, SR ISO 10381-6, SR ISO 11464).

Sampling point 1 is located in the north-west part, towards the limit of the studied area, near a local residence (46,566718N; 23,814856E). In the depth of the soil profile was observed the existence of the same soil type, cement looking, and the presence of HCH could be seen clearly (white-grey color).

Sampling point 2 is located in the central part of the area towards the south (46,565711N; 23,814951E). Nearby were found coniferous threes among which well delimited zones which were not covered by any type of vegetation. The aspect of the soil from this point is very similar with point 1, cement looking and with visible traces of HCH.

Sampling point 3 is located in the central area towards east (46,566165N; 23,815801E). In this point the vegetation is much denser, but the traces of HCH are similarly visible.

The soil samples taken were analyzed from physical-chemical point of view in order to establish the main characteristics which will influence the choice of most suitable cleaning method of Posta Rat area. The analyzed characteristics are: humidity, pH, structure and texture.

The analysis of the samples was made in the Laboratory of soil cleaning methods and equipment from the *Department Environmental Engineering and Sustainable Development Entrepreneurship* of the Faculty of Material and Environment Engineering, Technical University of Cluj-Napoca.

Fig. 1. *Sampling points*

Table 1. *Soil samples from different depths*

Depth [cm]	Point 1	Point 2	Point 3
0 – 10	P1	P2	P3
30 – 40	P1'	P2'	P3'
60 – 70	P1"	P2"	P3"

The analysis of the samples was made in the Laboratory of soil cleaning methods and equipment from the *Department Environmental Engineering and Sustainable Development Entrepreneurship* of the Faculty of Material and Environment Engineering, Technical University of Cluj-Napoca.

Humidity determination was made using gravimetric method accordingly with the methodological norms from STAS 7184/9-79 and processed accordingly with SR ISO 11465 norms (STAS 7184/9, SR ISO 11465).

pH determination was made using potentiometric method accordingly with the methodological norms from STAS 7184/13-88 and processed accordingly with SR ISO 10390 norms (STAS 7184/13, SR ISO 10390).

Soil structure determination from Posta Rat area was made using Sekera method. The method consists in dispersing in water soil aggregates and comparing the results with the models presented in an auxiliary board (Micle and Berar, 2012).

Texture determination was expressed through the ratio of mass content of the main components: clay, dust, sand, ballast and boulder using RETSCH AS 200 bolter equipment (Micle and Sur, 2012).

EXPERIMENTAL

Soil humidity determination

In order to determine the actual humidity was used the gravimetric method which consisted in weighing with analytic KERN scale 100g of each soil sample. The samples were introduced in Binder FD 53 stove, at 105 °C temperature and maintained up to complete evaporation of the physical bonded water (4 hours).

pH determination

For this analysis was weighted 5g of soil/sample over which was added 100 ml of distilled water and stirred in order to homogenize. pH measurements were made with WTW MULTILINE IDS multiparameter.

Soil structure determination

From each soil sample were selected 10 soil aggregates with the diameter of about 1 cm. These soil samples were put in a Petri basin/bowl on a filter paper previously moisten in distilled water. The soil samples were allowed for 3 minutes to absorb the water from the filter paper. After the 3 minutes have passed, distilled water was added up to a certain level above the aggregates. The samples prepared using this method were rested for 10 minutes, after that were rotated in the table plan three times without being lifted from the table in the clockwise sense. Next step was to gentle drain the water surplus, after which each sample was extracted on a white sheet of paper and the result is compared with the models from the auxiliary board.

Texture determination

In order to determine the texture of the soil, were weighted 500 g of soil/sample using the analytic scale. The weighted soil was introduced in the RETSCH bolter equipment, which has 11 bolters with the diameter of: 0,8; 0,6; 0,44; 0,32; 0,20; 0,16; 0,15; 0,071; 0,063; 0,056; 0,040 [mm], and the soil which remained of each bolter was weighted. Based on the soil mass remained on each bolter were determined the structural mass fractions found in the studied soil.

RESULTS AND DISCUSSIONS

Soil humidity

According with the results obtained (figure 2) it can be seen that the soil from the studied area contains a high quantity of physical bonded water in its mass. This thing is clearly observed due to the fact that the majority of the samples have a humidity percent of over 80 %. Sampling point 3 registered lower values (60 – 80 %).

pH

The results of the pH determination process show that the soil in the investigated area has a strong basic behavior/composition (much higher that limit value of 7), and its basic composition grows constantly with respect to the depth of the soil (figure 3).

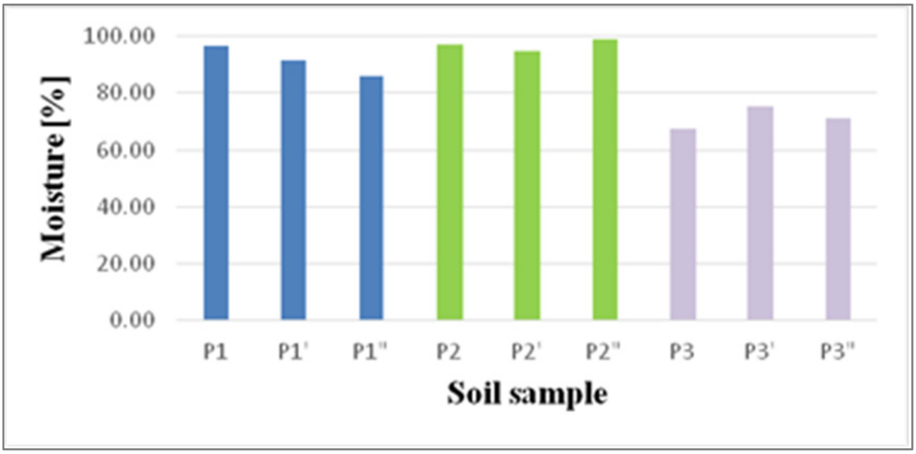

Fig. 2. *Soil humidity from Poşta Rât area*

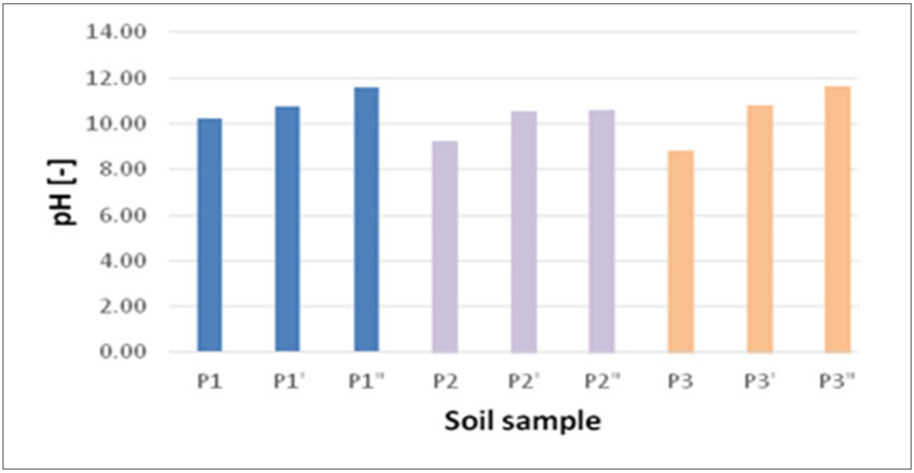

Fig. 3. *pH variation in the soil profile*

Structure

On all three sampling points was noticed the same behavior of the soil in depth plan. The results obtained in the samples of sampling point 1 are shown in figure 4.

Analyzing each sample was observed the variation on depth of the structure type, thus the samples taken from the same depth had the same structure, no matter the sampling point. As a conclusion it can be said that the soil situated at 0 – 10 cm depth is partially structured, the one at 30 – 40 cm is relatively well structured and the soil from 60 – 70 cm depth is very well structured.

a) b) c)

Fig. 4. *Structure determination –sampling point 1: a) 0 – 10 cm; b) 30 – 40 cm; c) 60 – 70 cm.*

Texture

The results of the texture analysis show the fact that coarse sand fraction are found predominantly, followed by middle sand and a small proportion of fine sand (figure 5).

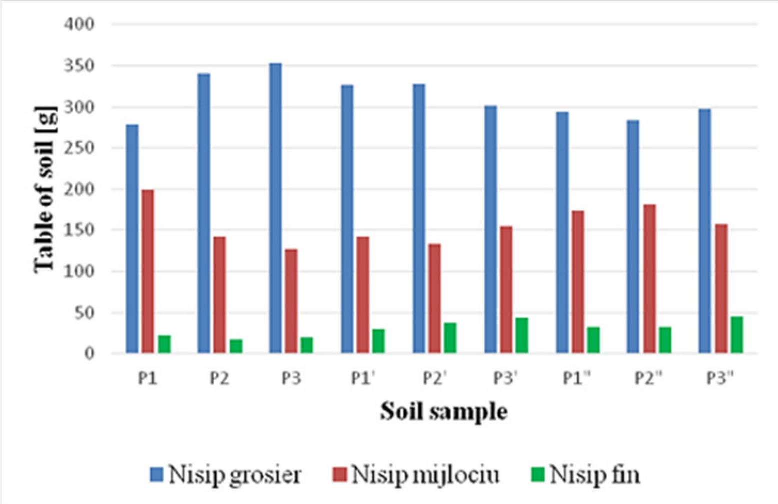

Fig. 5. *Structural fractions of the analyzed soil*

The texture of the soil has a direct influence in the soil permeability and this property is important in determining the cleaning method. Function the component type were determined the following permeability classes (table 2) (Micle, 2009).

According with the bibliography, correlated with the textural specialty results, the soil from the analyzed area has a relative high permeability being formed mainly from coarse sand and middle sand.

Table 2. *Depending on the state of permeability of the soil in the textural (Micle, 2009)*

Nr. crt.	Component type	Permeability [m/s]	Permeability class
1	Clay	$<10^{-9}$	Impermeable soil
2	Dust	$<10^{-7}$	Slightly permeable soil
3	Fine sand	$<10^{-4}$	Permeable soil
4	Middle sand	$<10^{-3}$	Soil with satisfactory permeability
5	Coarse sand	$<10^{-2}$	Permeable soil
6	Ballast	<1	Soil with good permeability
7	Bolder	<10	Very permeable soil

CONCLUSIONS

The insertion in the natural environment of some anthropic made substances or even natural ones has a direct influence in the bio-physical and chemical balance of the respective habitat. The danger is bigger when the inserted substances have hazardous properties like HCH. Inactive HCH has its origin in the production of HCH pesticide in Turda Chemical Plant, but were also produced significant quantities of waste which contain other isomers of this substance. The waste thus obtained was deposited wrongly on different areas in the vicinity of Turda city.

It was noticed the fact that on the entire contaminated area surface exist traces of soil mixed with HCH, due to the direct unloading of waste resulted from the technological production process of HCH at Turda Chemical Plant.

It is obvious that the emplacement nests a significant quantity of waste present in this area for a long time due to the fact that the soil has cemented and absorbed HCH and a relatively high depth (over 70 cm).

It was noticed also the presence of HCH in the soil profile, both at the surface and also in depth, the soil having the same color, texture, structure and behavior during the study in all sampling points.

The analyzed soil indicates that coarse sand is predominant, followed by middle sand and a small proportion of fine sand, having a basic pH.

The results of the physical-chemical analysis can point out the most suitable cleaning soil solution, because as a result of the study, the characteristics of the soil are known, being much easier to identify the applicability limits of the cleaning solutions.

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*** STAS 7184/13-88 *Soluri. Determinarea pH-ului.*

*** SR ISO 10390/1999 *Calitatea solului. Determinarea pH-ului.*