Review on Agriculture and Rural Development 2014. vol. 3 (1) ISSN 2063-4803

INFLUENCE OF THE TEXTURE ON THE EFFICIENCY OF THERMAL DESORPTION PROCESS OF SOILS CONTAMINATED WITH CRUDE OIL

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ABSTRACT
The hereby paper presents the experimental research on the influence of three types of soil texture on the efficiency of decontamination performed using the technology of thermal desorption. The concentrations of crude oil of the soil samples, the initial ones as well as those following the depollution process were determined using the Soxhlet method. The decontamination process with thermal desorption on soil samples was performed using the electric oven with chamber, and with silicon carbide bars. Experimental researches were performed on the following types of soils: loamy sand, loam and loamy clay. The main parameters established for the process of thermal desorption were the temperature 350 °C and the amount of time for keeping the soil samples in the oven, of 5, 10 and 15 minutes. The results of the experiments indicated that the type of texture has influenced the efficiency of the thermal desorption, and the highest efficiency was obtained for the sample of loamy sand, treated for 15 minutes.

Keywords: crude oil, pollution, soil texture, technology, thermal desorption.

INTRODUCTION

The development of the oil industry, both the extractive one as well as the exploitation industry, including transport of crude oil and petroleum products is sometimes accompanied by accidental phenomena leading to environment contamination with crude oil, residues and petroleum products. The impact on ecosystems, due to pollution with crude oil residues and used waters exceeds the intensity of other anthropogenic actions (PÂRVAN, 2012).
Due to these phenomena, the implementation of certain remediation methodologies is absolutely necessary, considering that crude oil pollution affects even the capacity of soils to maintain life.
In the researches of ARARUNA, J.T. ET AL. (2004) experiments were performed in an ex situ small thermal desorption system. The system was used to evaluate two parameters: the temperature between 100 – 500 °C and the amount of exposure time, from two to eight hours. Tests were made for 50 g soil samples polluted with petroleum residues. The unit was set up inside a chamber with controlled temperature. Researches indicated that the highest efficiency of thermal desorption was obtained by exposing the samples to temperatures over 450 °C.
FALCIGLIA ET AL. (2011) have made research on the influence of temperature and soil texture in the kinetic elimination of contaminants using thermal desorption at low temperatures, for soil polluted with diesel. The experimental researches were performed on soil of five granulometric fractions: coarse sand (500 – 840 μm), medium sand (200 – 350 μm), fine sand (75 – 200 μm), silt (10 – 75 μm) and clay (> 4 μm), where they have been artificially contaminated with diesel and thermally treated using a machine inside the laboratory. The results have shown that the desorption efficiency was affected by the soil texture and that the temperature and the amount of time for treatment have been the key factors of the remediation process (FALCIGLIA ET AL. 2011).

After the treatment using thermal desorption, it is possible to reuse the soil, depending on the temperatures used and the concentration of contaminants (WOOD P., 2001).
The purpose of the hereby study is the lab research on the decontamination of various types of soil (loamy sand, loam and clay loam) polluted with crude oil, using the thermal desorption technology.

MATERIAL AND METHOD

In order to implement the experimental researches on the depollution of the three types of soil (loamy sand, loam and clay loam), contaminated with a quantity of 6,1 ml crude oil per 100 g of soil, we have prepared the scheme of the research plan, presented in *Figure 1*.

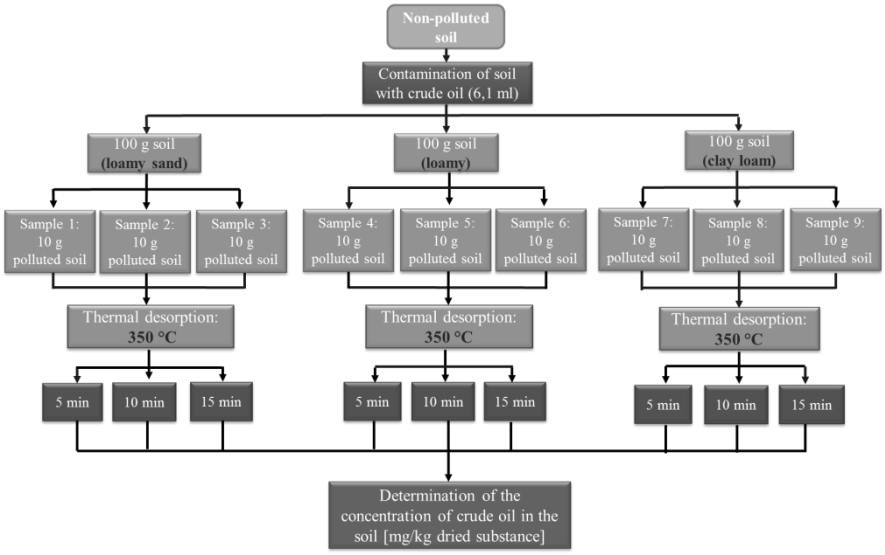

Figure 1. Scheme of the research plan

The soil samples were extracted in the area of Cluj County, Romania, at a depth of 0 – 20 cm according to STAS 7184/1-75 (state standards). The soil samples of loamy sand texture (P1) and loamy texture (P2) were extracted in the commune of Bonţida, and the third type of soil – clay loam (P3) in the Commune of Căianu.
The elaboration of experiments regarding the process of decontamination using thermal desorption was performed with the electric oven with chamber and silicon carbide bars, owned by the Technical University of Cluj – Napoca.

The main parameters established for thermal desorption were the temperature of 350 °C and three different treating amounts of time (5, 10 and 15 minutes), then we determined the quantity of crude oil in the soil in order to establish the efficiency of the decontamination. The content of crude oil from the soil samples, both the initial and the one remaining after decontamination, were determined according to STAS SR 13511/2007 (state standards) using the Soxhlet method (*Figure 2*).

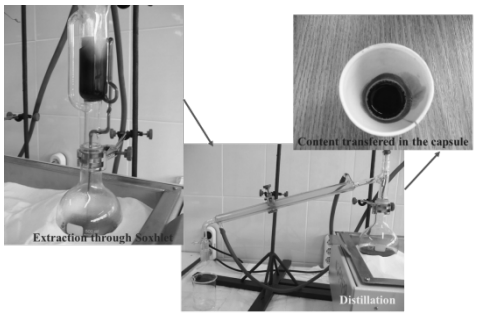

Figure 2. Extraction of crude oil using the

Soxhlet method The concentrations of crude oil in the samples tested in the lab were related to the values of the alert threshold and intervention threshold established by ORDER NO. 756 of 11/03/1997, (*Table 1*).

Table 1. Reference values for the total amount of hydrocarbons in the petroleum (mg/kg dried substance)

Traces of elements – Hydrocarbons in petroleum	Normal values	Alert threshold / Types of uses		Intervention threshold / Types of uses	
		sensible	less sensible	sensible	less sensible
Total Hydrocarbons in petroleum	< 100	200	**1000**	500	**2000**

RESULTS

The results obtained after having determined the initial content of crude oil in the control samples are shown in *Figure 3*.
By analyzing these results, it can be observed that the standardized values as per ORDER NO. 756 of 11/03/1997 are highly exceeded.

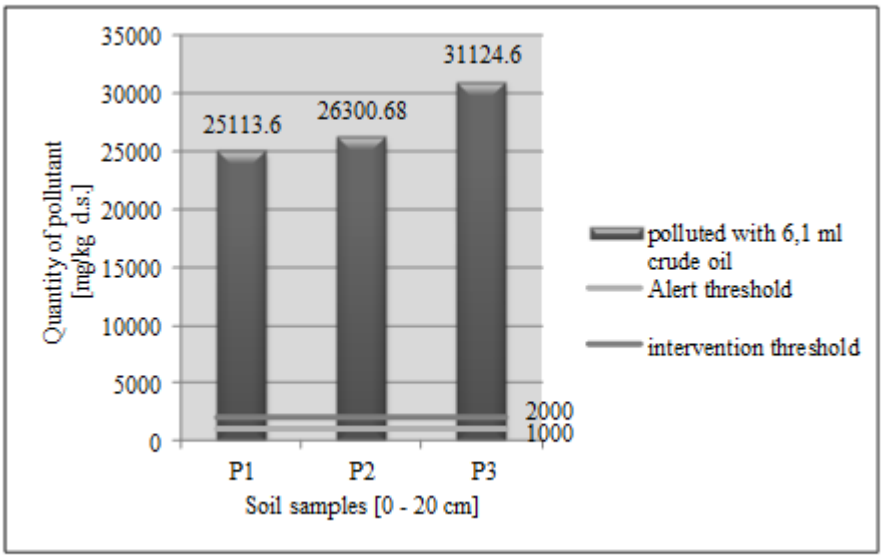

Figure 3. Initial content of crude oil in the soil samples

Variation of the quantity of crude oil in the soil following the thermal desorption

Following the experimental researches on the process of decontamination using thermal desorption, it can be observed that the amount of crude oil contained in the soil is under the alert threshold only for samples P1 treated for 10 and 15 minutes and for sample P2 exposed for 15 minutes at a temperature of 350 °C (*Figure 4*). In addition, it can be observed that the amount of pollutant after the treatment, for all soil types, decreased while the amount of time for exposure in the oven increases, and the highest value is obtained for the samples with clay loam texture.

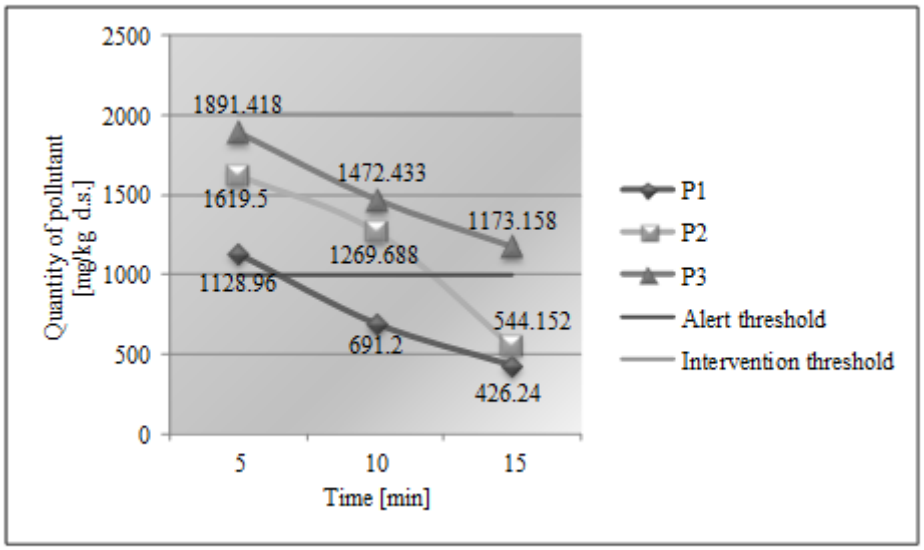

Figure 4. Variation of the quantity of crude oil in the soil samples after the thermal desorption at a temperature of 350 °C

Variation of the quantity of crude oil eliminated through thermal desorption

Looking at the variation of crude oil eliminated through thermal desorption (*Figure 5*), it can be observed that the value is increasing as the time for exposing the samples in the oven increases. The highest level of pollutant is for sample P3.

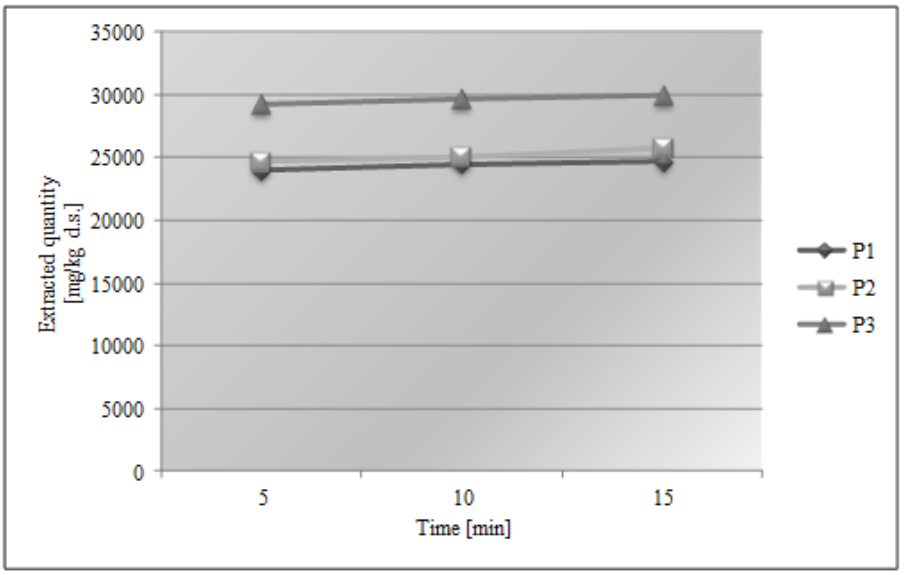

Figure 5. Variation of the quantity of crude oil eliminated through the thermal desorption technology

Efficiency of thermal desorption at 350 °C

The final step in the experimental researches was to calculate the efficiency of the desorption process of the crude oil from the soil, for the three types of soil, depending on the main parameters of the decontamination process. The values of the thermal desorption efficiency ranged between 93,84 – 98,30 % (*Figure 6*).

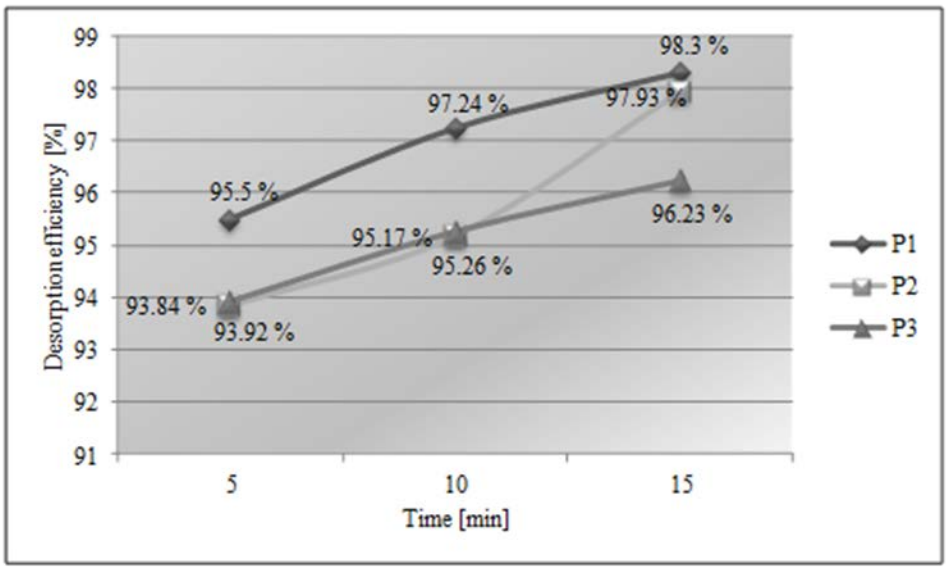

Figure 6. Variation of the efficiency values depending on the soil texture and the amount of time for exposure of samples in the oven, at 350 °C

By comparing the results obtained, it can be observed that the highest efficiency was reached for sample P1 (loamy sand texture) for an amount of exposure time of 15 minutes in the oven, while the lowest efficiency was obtained for sample P2 (loamy texture) for treated for 5 minutes.

CONCLUSIONS

After determining the pollutant concentration in the control samples, it can be observed that the alert threshold and the intervention threshold as per the standardized norms, are highly exceeded.

The results of the experiments performed indicate that the temperature, the exposure time in the thermal desorption unit and the soil texture are the main parameters influencing the process of eliminating pollutants through thermal desorption.

Efficiencies obtained during the experiments range between 93,84 – 98,30 %. By analyzing the efficiencies depending on the soil texture, it results that the highest efficiency of thermal desorption was obtained for the loamy sand for an exposure period of 15 minutes, and the lowest value was obtained for the loamy texture, for the soil treated for 5 minutes.

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