

COMPARATIVE STUDIES ON REMEDIATION TECHNIQUES IN LABORATORY OF SOILS CONTAMINATED WITH LIQUID PETROLEUM PRODUCTS

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Abstract

Soil pollution by oil products is one of the most obvious environmental problems that Romania has been facing in recent years. Given the alert pace of use of petroleum products and for meeting energy needs, it is noted that both in Romania and abroad there are reported accidental oil spills to soil or water, which causes economic, social and environmental issues. In this paper we propose a review of the particularities of soil pollution with liquid petroleum products and opportunities for remediation. The analysis of remediation processes of soils contaminated with liquid petroleum products highlights the advantages and disadvantages of each method. The analyzed samples were subjected to thermal remediation methods: combustion and thermal desorption and one of the chemical processes, successive extraction with solvents.

The results of these experimental data allow us to conclude that the used method is efficient and can be applied at industrial level with high efficiency.

Keywords: *liquid petroleum products, pollution, remediation*

1. Introduction

The paper aims to emphasize the particularities of remediation of soils that were contaminated with liquid petroleum products in the laboratory.

Several studies show the ways of choosing a method of remediation of soils that were contaminated with liquid petroleum products. For the areas polluted with these kinds of substances, measures should be taken right after the incident. Depending on the physical properties of the soil and of the other products that pollute the soil, remediation depends on the time the pollutant is on and in the soil. The analysis of remediation processes of soils that were contaminated with liquid petroleum products shows the advantages and disadvantages of each method itself.

In the present paper there were applied thermal methods of remediation in the laboratory: combustion and thermal desorption and successive extraction with solvents using petroleum ether and benzene. These authors are concerned about testing multiple types of soils [1-4].

2. Experimental part

For the analysis, there were chosen samples from an area with liquid petroleum products that have been discharged on the soil for a longer period of time. There were taken samples of contaminated soil that were homogenized and analyzed using three methods. There were also taken samples of uncontaminated, fresh soil from the surroundings of the polluted area, that were called witness samples and that were also subject to decontamination methods.

The results represent an average of all of the determinations that were made. The remediation of soils that were contaminated with petroleum products through combustion method means burning the pollutant with the oxygen from the air and this method is recommended for the soils that were polluted with heavy petroleum products. By burning the mixture of soil and petroleum products, it is done not only the full elimination of the pollutant, but also the organic material from the soil structure. The installation in which the experimental determinations were done, regarding the remediation of soils samples through combustion method is shown in figure 1[5].

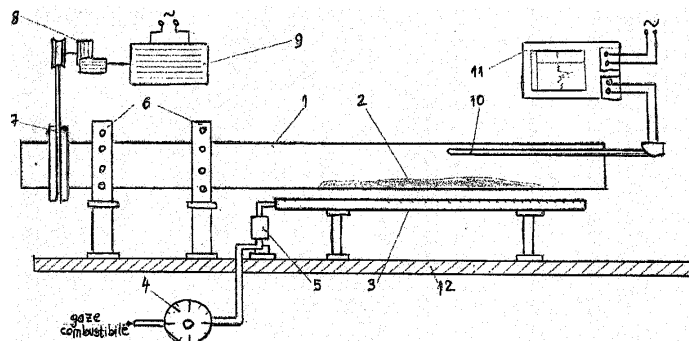


Figure 1. Decontamination by combustion installation scheme
1- combustion tube; 2 - soil sample subjected to combustion; 3 - burner gas; 4 - combustible gas meter; 5 - fuel-air mixing system; 6 - supporting bearings; 7 - drive system combustion tube; 8 - speed reducer; 9 - electric motor drive; 10 - sheathed thermocouple, 11 - meter and recording; 12 - support system

Thermal desorption is recommended for soils contaminated with volatile or semi-volatile compounds. The remediation process through thermal desorption has two different stages. The first stages means volatilization of pollutants by heating the contaminated soils, while the second stage means treatment of the resulted gases, in order to separate and concentrate the pollutants.

The installation for decontamination method through thermal desorption is presented in figure 2 [5].

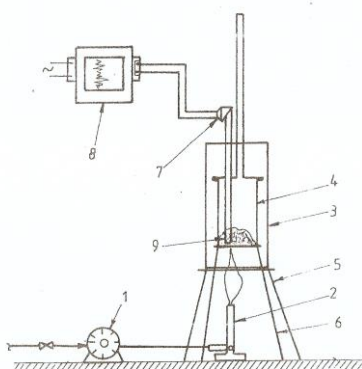


Figure 2. Decontamination by thermal desorption installation scheme
1 - gas meter; 2 - gas lamp; 3 - heating jacket; 4 - metal crucible; 5 - heating mantle support; 6 - support crucible; 7 - thermocouple; 8 - temperature recorder; 9 - soil sample subjected to thermal desorption.

The extraction of petroleum product through the contaminated soils was done with the Soxhlet apparatus. There were used two solvents, petroleum ether and benzene and there was a successive extraction with those solvents. In figure 3 it is presented the Soxhlet apparatus in which the extractions were made [5].

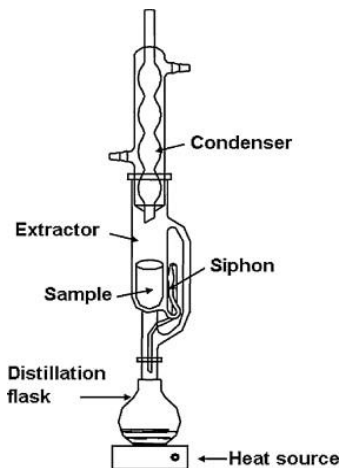


Figure 3. Soxhlet apparatus

3. Results and Discussion

In Tables 1-3 are the results obtained after the application of the three methods for decontamination.

Table 1. Results after combustion

No.	Specified size	Clean soil sample	Polluted soil sample
1.	Quantity of polluted soil, g	-	100
2.	Quantity of clean soil for combustion, g	100	-
3.	Quantity of soil after combustion,g	98	81
4.	Quantity of organic material,g	2	2
5.	Quantity of petroleum products+organic material,g		19
6.	Quantity of petroleum product, g	-	19 – 2 = 17
7.	Petroleum product, % mass	-	17
8.	Degree of remediation,%	-	100

Table 2. Results after thermal desorption

No.	Specified size	Clean soil sample	Polluted soil sample
1.	Concentration pollutant, c_o , %	0	17
2.	Temperature, °C	300 - 400	300 - 400
3.	Desorption time, minute	30	30
4.	Quantity of sample, g	100	100
5.	Quantity of sample after desorption, g	98	86
6.	Organic material lost, %	2	2
7.	Organic material lost + petroleum product lost, after desorption, %	-	14
8.	Quantity of petroleum product, %	-	14-2=12
9.	Degree of remediation,%	-	70.6

Table 3. Results after successive extraction

No.	Specified size	Clean soil sample	Polluted soil sample
1.	Quantity of sample, g	10	10
2.	Quantity obtained with petroleum ether, g	0.019	0.35
3.	Quantity obtained with benzene, g	0.036	0.48
4.	Total quantity after extraction,g	0.055	0.83
5.	Organic material lost after extraction, % mass	0.55	0.55
6.	Petroleum product lost after extraction, % mass	-	8.3-0.55=7.75
7.	Degree of remediation,%	-	45.6

All results are presented in Table 4 for comparison.

Table 4. The results obtained through the three methods

Organic material lost, % mass		Petroleum product lost, % mass	Degree of remediation, % mass
Extraction	0.55	7.75	45.6
Combustion	2	17	100
Thermal desorption	2	12	70.6

4. Conclusions

The soils that were decontaminated through thermal methods have their structure and composition affected because of the high temperatures they were exposed to.

By fully eliminating the organic part because of the combustion remediation and by the major transformation that the soil suffers because of thermal desorption, the germinative potential of the specific soil is reduced.

For the analyzed samples, without knowing the pollutant concentrations, it was considered that the combustion method is 100% efficient and it was possible to establish a pollutant concentration in the initial samples (17%). The reduced remediation degree for thermal desorption (70.6%) can be explained because without knowing the nature of the pollutant (structure, physical properties) it is possible that the maximum applied temperature of 400 °C to be too low (compared with the 800 °C temperature applied for combustion) for getting rid of the heavier products that exist.

By subjecting the same sample to remediation through successive extractions with solvents, it was found that a smaller concentration of pollutant is obtained, compared to the results that were obtained through thermal methods. This thing can be explained through the fact that it may be possible the usage of a third or even fourth solvent.

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