Methods of Detection and Analysis of Total Petroleum Hydrocarbons (C10-C40) in Soil

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Keywords: Soil, Total Petroleum Hydrocarbons, Dichloromethane, Ultrasonic Extraction, Rapid Solvent Extraction Right

Abstract: With the rapid development of industrialization nowadays, especially the rapid development of petroleum industry, the petroleum industry will bring some environmental and ecological pollution problems in the process of production, processing and transportation, especially in recent years, the problem of oil pollution is becoming more and more serious, and oil incidents are common and more and more concerned by people. Oil pollution will not only cause irreparable harm to the soil, but also make it more serious that the contaminated soil is difficult to repair, and the PAHs in the pollutants will go deep into the rain atmosphere and organisms, destroy the environment, and pose a serious threat to the safety of human life. Therefore, it is of great significance for the detection of total petroleum hydrocarbons in contaminated soil.

1. Introduction

Oil and its by-products have been widely used in human life, in the process of application will inevitably produce a variety of hydrocarbons or non-hydrocarbons, hydrocarbon pollution, also known as petroleum hydrocarbons, has a high toxicity and shadow on water. In this case, it is important to study the determination method of hydrocarbon in soil.

comparing the efficiency of extraction of total petroleum hydrocarbons from n-hexane, n-hexane/dichloromethane (1:1) and dichloromethane, it was found that the recovery of extraction of dichloromethane was higher than that of n-hexane ($p < 0.05$), and the ultrasonic extraction recovery of dichloromethane was higher than 89 in 0.5%,1.0% oil-contaminated soil. by comparing the efficiency of ultrasonic extraction and rapid solvent extraction instrument for the extraction of total petroleum hydrocarbons in soil, it was found that the extraction efficiency of rapid solvent extraction instrument for two cycles of extraction was significantly higher than that of ultrasonic twice extraction ($p < 0.05$), and the recovery increased by 7% and 6% in 0.5% and 1.0% of oil-contaminated soil, respectively. Meanwhile, the relative standard deviation (rsp) is obviously reduced, and the accuracy and precision of the measurement are raised. determine 0.5% to 2.0% of the total petroleum hydrocarbon content of contaminated soil, the recovery rate of the method can reach more than 96%,(rsd) is 2.8% to 3.6%, and the detection limit can be as low as 0.2μg/k. the rapid solvent extractor is more superior to the traditional ultrasonic extraction for the analysis of total petroleum hydrocarbons in the soil.

Nowadays, there are many methods for the determination of total petroleum hydrocarbons in contaminated soil, including fluorescence spectrophotometry, gravimetric method and gas chromatography. These methods are usually widely used, and the methods of extraction are various nowadays. A device and technology for quick extraction of petroleum hydrocarbons are very important. As a kind of rapid solvent extractor, the extraction efficiency is greatly improved, and the analysis time is shortened. Therefore, this study used this kind of equipment to change different conditions, and compared the traditional ultrasonic extraction method with the rapid solvent extraction method to establish a rapid extraction of petroleum hydrocarbons in contaminated soil.

  DOI: 10.25236/wccbm.2020.038

2. Experiment Section

2.1. Instruments and Medicines

KQ500DB CNC ultrasonic cleaner (Nanjing Hayuan Precision Instrument Co., Ltd.), XZ-16 high-speed centrifuge (Changsha Xiangzhi Centrifuge Instrument Co., Ltd.), SP-100QSE automatic fast solvent extractor (Shanghai Spectrometer Co., Ltd.), UV1700 UV-Vis spectrophotometry (Nanjing Kejie Analytical Instrument Co., Ltd.); reagents: PE, CH2C12, Hexane are all analytical grade.

In the preparation of contaminated soil, the non-polluted soil came from farmland in Jiangning District of Nanjing City, and 0.5 g ,1.0 g and 2.0 g crude oil were accurately dissolved in petroleum ether and mixed with the above non-polluted soil. 2.0%, over 40 mesh sieve, set aside.

Figure 1 Instruments and medicines

2.2. Experimental Methods

n-hexane, n-hexane/dichloromethane (1:1), dichloromethane different extractants were used for the extraction analysis of 0.5%,1.0% oil-contaminated soil to compare the extraction efficiency. and ultrasonic extraction to determine the appropriate extraction conditions.

2.3. Data Processing

processed using the statistical software SPSS (20.0).

3. Results and Discussions

3.1. Comparison of Extraction Solvents

The recovery of different extraction solvents was calculated by comparing the experimental results of different extractants.

Total Petroleum Hydrocarbon Content in Soil = C Total Petroleum Hydrocarbon × V Extraction Solvent Volume/M Soil the results showed that the extraction effect of dichloromethane was better than that of hexane. the yield of dichloromethane to 0.5% and 1.0% contaminated soil was over 89%, which was 18 and 27 percentage points higher than that of hexane, respectively. however, there was little difference in the recovery of different pollution levels by ultrasonic extraction.

3.2. Comparison of Rapid Solvent Extraction and Ultrasonic Extraction

It can be seen that the extraction effect is not. The efficiency of ultrasonic extraction was significantly higher than that of rapid solvent extraction treatment I, but more obvious than that of treatment II. the extraction effect is better than the traditional ultrasonic extraction by the rapid solvent extraction instrument for circulating extraction twice.

3.3. Determination Limit, Recovery Rate and Precision of Rapid Solvent Extractor

The detection limits were prepared in advance for different concentrations of dichloromethane petroleum solution with concentrations of 0,8,16,24,32,40 mg/l. the uv absorbance of different

concentrations of the solution was tested three times each time, and the standard curve equation y =0.0171x +0.0312,(where y was the uv absorbance and x was the concentration of the test sample), r2=0.998. the 30 times blank dichloromethane absorbance was measured, and the detection limit formula lod =3 s/k (lod is the detection limit, s is the standard deviation, and k is the slope) was used to calculate the detection limit (lod) at 0.2μg/kg.

The recovery rate and precision were determined with reference to the method of rapid solvent extraction instrument for the determination of total petroleum hydrocarbons in contaminated soil. the recovery rate of the method was 96% to 98% and (rsd) was 2.8% to 3.6%.

The actual sample determination repeated three times to determine the artificially prepared 1.70% oil contaminated soil, the side result was 1.64% and the standard deviation was 6.3%. And for the three oil pollution samples collected in the field, the total petroleum hydrocarbon content was 1.3%, 0.7% and 1.8%, respectively.

4. Sources and Hazards of Petroleum Hydrocarbons

The so-called petroleum hydrocarbon refers to the hydrocarbon compounds in the oil, and the hydrocarbon refers to the hydrocarbon in the oil, which occupies a considerable proportion in the oil, and can be divided into tens of thousands according to the type, without obvious overall characteristics, which is completely different from the hydrocarbon.

4.1. Sources of Petroleum Hydrocarbons

As far as the composition of petroleum is concerned, its structure is very complex, especially the petroleum ecology is mainly composed of saturated hydrocarbon, unsaturated hydrocarbon, asphalt, aromatic compound, resin and so on. Given the significant impact on natural ecology of hazardous waste emissions and other pollution from oil extraction processes, oil extraction, melting, transportation and use are prone to some pollution and leakage;

Nowadays, oil pollution has become a global problem, especially in recent years, with oil pollution accidents occurring from time to time, including the 2007 oil spill from russian oil tankers, the 2010 oil rig explosion in the gulf of mexico and the 2011 oil spill from penglai 19-3. The damage to the whole ecological environment, when oil pollution occurs, if not handled properly, will cause pollution and damage to the surrounding soil, rivers and even groundwater. Thus endangering their health and even their lives, studies have shown that if oil causes serious pollution to soil, rivers, groundwater and air, and some parts of petroleum hydrocarbons accumulate in certain organisms; when these organisms pass through the food chain, they cause great harm to humans and animals, whose specific effects are cancer-causing, teratogenic and animal variants.

in addition, the second major source of hydrocarbons is municipal wastewater and waste. with the process of urbanization, more and more people live in cities, and people living in cities produce a lot of living every day. If it can be well treated, direct discharge into the river will cause more serious environmental pollution, when the polluted river flows into the sea, it will directly cause great pollution and damage to the coastal waters, and the East China Sea and the South China Sea are polluted by hydrocarbons to varying degrees.

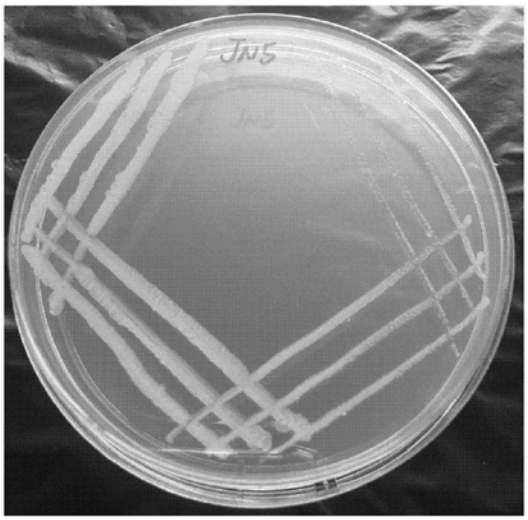

Figure 2 Petroleum hydrocarbons

4.2. Hazards of Petroleum Hydrocarbons

The harm degree of petroleum hydrocarbon is different, the harm degree is also very serious, its main component is hydrocarbon, the general characteristic is not obvious, at present, the serious threat of hydrocarbon to nature and ecology is mainly divided into two categories: one is alkane, the other is aromatic. hydrocarbons and polycyclic aromatics. Because of the different components of hydrocarbons, the effects of hydrocarbons in these components on humans are also different, phytochemicals. In general, petroleum hydrocarbons can be divided into low boiling point saturated hydrocarbons and high boiling point saturation according to their components. When the concentration is high, it will destroy animal cells and cause death, the latter is mainly harmful to plants, easy to adhere to the surface of plant roots, form mucous membrane, inhibit the normal respiration and nutrient absorption of plant roots, in addition, the reactive groups in petroleum hydrocarbons will also lead to the loss of soil components, affect the normal growth of crops, polycyclic aromatic hydrocarbons (Polycyclic aromatic hydrocarbons) are particularly toxic, which can lead to fish death in water and seriously affect human health.

Figure 3 Drug stabilization test box

5. Conclusions

Oil is an important fossil fuel in modern society. In the normal operation of oil field, the leakage and spillover of crude oil will cause soil pollution, change the basic characteristics of soil, increase soil toxicity, reduce the potential risk of soil pollution, limit the stable content of oil in soil to study the determination method of petroleum hydrocarbon content in soil, and standardize the indoor test.

Ultrasonic extraction, constant temperature change, Soxhlet extraction method is effective, easy to operate, constant temperature vibration method is commonly used in classical extraction. According to the extraction time and efficiency of petroleum oil hydrocarbon in petroleum contaminated soil, the fastest and most effective petroleum hydrocarbon extraction method is determined to adapt to the rapid development of oil field production. the extraction of petroleum hydrocarbons requires the selection of solvents. the traditional methods usually use petroleum gauges, halogenated alkanes, low-chain alkanes, or aromatics as a single extraction solvent.

Total petroleum hydrocarbons (TPH), also known as mineral oil, are ubiquitous organic pollutants in the environment. The treatment of petroleum hydrocarbon contaminated soil has always been the research heat. At present, the determination methods of petroleum hydrocarbon content mainly include gravimetric method, infrared photometric method, chromatographic method. However, no matter what specific testing methods are used, the key lies in the pretreatment of soil samples, and then the determination methods that meet the requirements are selected.

This study shows that dichloromethane has a good effect on extracting total petroleum hydrocarbons in soil, and the recovery rate of twice extraction is more than 89%, which can be used for actual fraction. the rapid solvent extractor has higher efficiency, simple operation and good reproducibility than the traditional ultrasonic extraction instrument, and the recovery rate of dichloromethane extractant can reach more than 80%, which can be popularized and studied.

Acknowledgements

This research has been financed by GDAS' Project of Science and Technology Development “Optimization and application of determination method of total petroleum hydrocarbon in soil” (2019GDASYL-0105011).

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