

Research on the Application of Analytical Chemistry in Soil Environmental Monitoring

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Abstract

With the increasingly severe soil pollution problem, in order to improve the sustainability and economic value of the soil environment, it is necessary to do a good job in soil environmental monitoring. As an effective means of soil environmental monitoring, analytical chemistry can accurately monitor the types, contents and pollution degrees of pollutants, and is an important basis for controlling and treating soil environmental pollution. Firstly, it briefly analyzes the current situation of soil environmental pollution in China and the advantages of analytical chemistry methods in monitoring activities. Subsequently, it expounds the main methods and applications of analytical chemistry in the soil monitoring environment, and puts forward application suggestions such as optimizing the monitoring plan, strengthening the innovation of monitoring technology and instrument quality control, creating a soil environmental monitoring information platform and controlling the quality of soil environmental monitoring, hoping to provide a basis and innovation direction for the application of analytical chemistry in soil environmental monitoring.

Keywords

Soil Monitoring; Analytical Chemistry; Application.

1. Introduction

Soil, as a key component of the Earth's ecosystem, undertakes important functions such as nutrient cycling, waste filtration, water regulation and support for biodiversity. With the increase in industrialization, agricultural activities and urbanization, the soil environment has been polluted by a large number of harmful chemicals. These pollutants include, but are not limited to, heavy metals, persistent organic pollutants (POPs), pesticides and so on. The residues of harmful chemicals not only affect the quality and functions of the soil but also may cause long-term harm to human health and the ecosystem through the food chain. Therefore, monitoring and detecting the residues and contents of harmful chemicals in the soil has become an important area of environmental science research. Analytical chemistry is a measurement science that studies the composition and structure of substances and determines the interactions among chemical components, contents, and spatio-temporal distributions of

substances in different states and evolutionary processes, and it has guiding value for establishing monitoring networks.

2. Current Situation of Soil Environmental Pollution

The "Bulletin of the National Soil Pollution Status Survey" in 2014 pointed out that eight kinds of inorganic pollutants in China's soil environment, namely lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), copper (Cu), chromium (Cr), zinc (Zn) and nickel (Ni), seriously exceeded the standards. The spraying of pesticides at excessive concentrations by farmers in daily farming activities may lead to soil pollution. As soil pollution is becoming increasingly severe, the monitoring and treatment of soil heavy metal pollution are urgent tasks. Among them, Cd pollution is the most serious, and the overall environmental quality is not optimistic. According to statistics, the area of heavy metal-polluted soil in China is as high as 3.33 million hectares. Different regional soil ecological structure types have significant differences in the mobility of heavy metal pollutants and soil water permeability. And analytical chemistry, as an effective control tool for pollution problems, has become a necessary means to be applied to soil environmental monitoring work.

3. Characteristics of Analytical Chemistry Methods in Soil Environmental Monitoring

As we all know, analytical chemistry is an important part of the discipline of chemistry.

Firstly, analytical chemistry has high compatibility. It can identify the components and contents of chemical substances and clarify the relationships among substance forms, structures and properties.

Secondly, analytical chemistry has high reliability and accuracy. It has a single monitoring and technical standard, and the instrumental analysis method is very effective for detecting trace components with a content of less than 1%.

Thirdly, analytical chemistry has high compatibility. Besides soil, there are also polluted wastewater, waste gas and so on in the samples for environmental monitoring. For different monitoring objects, only by organically combining analytical chemistry methods can the monitoring effect be maximized. For example, the iodometric method can be used to measure the content of dissolved oxygen in water, and the flame atomic absorption spectrophotometry can be used to measure the contents of elements such as Cr and As in soil.

Fourthly, the instruments and equipment of analytical chemistry have high convenience and operability. Automatic monitoring can be achieved both in the qualitative and quantitative analysis of soil elements, which is very in line with the monitoring requirements of the domestic soil environment.

4. Applications of Analytical Chemistry in Soil Environmental Monitoring

4.1. Main Analytical Chemistry Methods in Soil Environmental Monitoring

In the soil environment, the commonly used analytical chemistry methods include spectral analysis methods, chromatography methods, mass spectrometry methods, electrochemical analysis methods and thermal analysis methods.

Firstly, spectral analysis methods can be specifically divided into four methods.

Thirdly, mass spectrometry (MS). When used in combination with gas chromatography or liquid chromatography (such as GC - MS, LC - MS), it provides mass information of pollutants and is used for qualitative and quantitative analysis of complex organic substances.

Fourthly, electrochemical analysis methods. Among them, the voltammetry method is mainly used for the analysis of heavy metals in soil. The conductivity method can reflect the conductivity of the soil solution and indirectly judge the salt content in the soil and so on.

Fifthly, thermal analysis methods. Thermogravimetric analysis can evaluate the thermal stability of substances in the soil. Differential scanning calorimetry can measure the content of substances in the soil.

Applications of Analytical Chemistry in Soil Environmental Monitoring

Analytical chemistry has been widely used in soil environmental monitoring. The following are eight important application areas.

Firstly, soil pollution monitoring and assessment. For example, the content of heavy metals in the soil is detected by the atomic absorption method. If the measurement results show anomalies, it indicates that the soil may be contaminated by heavy metals.

Secondly, soil fertility analysis. By detecting the contents of elements such as N, P, K and the pH value and other soil physical and chemical properties in the soil, the soil fertility status is evaluated, and scientific fertilizer - use suggestions for agricultural planting are provided. For example, Xing Jia elaborated in detail on the detection methods of pH and other physical - chemical characteristics in the research topic of the remediation of heavy - metal - contaminated soil.

Thirdly, soil remediation effect assessment. After the contaminated soil remediation treatment, the analytical chemistry method is used to detect the residue of pollutants in the soil to evaluate the effectiveness and efficiency of the remediation project. For example, under different types of passivators, the content of heavy metals Pb and Cr in the tested soil is detected by the analytical chemistry method to judge the experimental effects of different passivators.

Fourthly, soil environmental background value investigation. The natural chemical composition of the soil in a certain area is analyzed to determine the background value of the soil environment so that there can be a benchmark comparison for later environmental changes.

Fifthly, pollutant migration and transformation research. Through the periodic sampling and analysis of soil samples, the migration law and transformation process of pollutants in the soil can be studied, which plays an important role in environmental governance and preventing the spread of pollution.

Sixthly, environmental supervision and policy - making. The application results of analytical chemistry provide a scientific basis for government supervision and help formulate relevant policy standards for soil protection and pollution prevention.

Seventhly, environmental risk assessment. The soil environmental monitoring data combined with the risk assessment model can predict the possible harm of pollution to human health and the ecosystem, which is used for land - use decision - making and planning. Scholars such as Hu Xiuyan monitored the contents of eight heavy - metal elements such as Ni and Hg in the soil environment, and combined with risk assessment, it was concluded that the farmland soil was at a moderate ecological risk, and the main contributing factor was Hg, which provided an important basis for subsequent soil planning and treatment.

Eighthly, scientific research and development. Analytical chemistry methods provide important support for understanding soil chemical behaviors, developing new - type soil amendments and environmentally - friendly agricultural technologies.

In practical applications, it is necessary to select suitable analytical chemistry methods for soil environment sampling, treatment and analysis work according to national or regional standards and regulations and in combination with specific monitoring purposes and conditions. With the improvement of environmental protection awareness and technological progress, these applications are still in continuous development and improvement.

5. Improvement Measures for the Application of Analytical Chemistry under Soil Environmental Monitoring

5.1. Optimize the Soil Environmental Monitoring Plan

Formulating a soil environmental monitoring plan requires a multi-directional understanding of the soil environment, such as the chemical components, types and characteristics of soil pollutants; secondly, improve the effectiveness of the improved analytical chemistry methods, such as optimizing sample collection, pretreatment and preservation; finally, the formulated soil environmental monitoring methods need to comply with relevant systems to ensure the implementation of the monitoring plan.

5.2. Strengthen the Innovation of Soil Environmental Monitoring Technology

Innovation is the core driving force for the continuous optimization of monitoring technology and provides a greater possibility for improving the accuracy of monitoring results. For example, scholars such as Chu Yuting innovatively combined the conditional Latin hypercube method to improve the overall distribution characteristics of soil properties in the monitoring area and obtain soil sample information more accurately.

5.3. Strengthen Instrument Quality Control in Analytical Chemistry Methods

Strengthening the quality control of various instruments can reduce the occurrence of errors, improve the accuracy of monitoring data, extend the service life of instruments, and improve monitoring efficiency. Therefore, in actual monitoring work, monitoring personnel need to carry out periodic calibration and maintenance of instruments and equipment.

5.4. Create a Scientific Soil Environmental Monitoring Information Platform

The establishment of an Internet + soil environmental monitoring platform based on computer network technology can collect and analyze monitoring data. Through the effective use of these data, the government's soil environmental monitoring capacity can be enhanced. However, attention should be paid to the problem of duplicate collection in the data collection work.

5.5. Control the Quality of Soil Environmental Monitoring

By continuously improving the professional skills of monitoring personnel and formulating a reasonable and scientific monitoring plan, the quality of soil environmental monitoring can be better controlled.

6. Conclusion

With the continuous progress of science and technology and the continuous improvement of the degree of industrialization, the problem of soil environmental pollution has become more serious. This has led to an increase in the types of substances to be monitored in the soil environment and a more complex monitoring environment, which requires more accurate soil environmental monitoring information. Therefore, exploring and strengthening the research and application of analytical chemistry methods in the soil environment has become an inevitable requirement for soil environmental monitoring. It is necessary to select appropriate analytical chemistry methods and instruments and equipment, innovate monitoring work plans and schemes, and strive to accurately measure data such as the types, contents and pollution degrees of pollutants in the soil environment, so as to provide a theoretical basis and data support for further improving the effectiveness of soil environment control and pollution treatment.

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