Application of Solid-Phase Microextraction Technology in Environmental Chemical Analysis

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Abstract: Solid phase extraction is a commonly used sample analysis method in China, which is widely used in environmental chemical analysis in China, such as air chemical analysis, water quality, poison detection, etc. The application of this sample analysis technique provides accurate and sensitive reference data to solve and improve the important work benefiting the country and the people. The significance, application and development direction of solid-phase extraction technology are analyzed in detail.

Keywords: Environmental Chemistry; Chemical Analysis; Solid Phase Extraction

Introduction

With the improvement of social economy, technology and the quality of people's life, many environmental problems have also emerged. With the continuous improvement of economy and quality of life, many factors such as chemical industry and automobile exhaust have greatly polluted the natural environment. Environmental issues are the major issues related to the survival of thousands of generations. Effective and time-saving analytical and technical means are essential to solving environmental problems. Solid phase extraction is a time-saving, accurate and efficient analysis method, which provides a powerful basic analysis data for environmental chemical analysis in China.

1. Principles and advantages of solid-phase extraction

1.1 Principles of solid-phase extraction

The principle of solid phase extraction is to expose the extracted phase to the sample matrix to be analyzed and calculate the adsorption equilibrium combined with the adsorption equilibrium theory

$$n = \frac{K_{fs} V_f V_s c_o}{K_{fs} V_f + V_s} \quad (1)$$

In the formula: n is the amount of the extracted analyte, c0 is the initial concentration of the target analyte in the sample, Vs is the sample volume, Vf is the coating volume, and Kf s is the partition coefficient between the coating and the analyte between the samples.

Advantages of solid phase extraction: Solid phase extraction technology has the advantages of ① simple, fast and shortened pretreatment time.② high-accuracy.③ The recovery rate of the analytes is relatively high.④ Reduced cost and pollution.⑤ The obtained samples were pure and not easy to emulsify.⑥ Easy to use with other devices to achieve automatic analysis.[1]

1.2 Selection of the SPME extraction head

The extraction head, the type and thickness of the coating on the core part of the SPME, is most critical for sensitivity. Therefore, its choice should be made with great care. The choice of the extraction head mainly depends on the properties of the coated [2]. According on the principle of the analyte can be easily extracted by the solid phase with similar polarity. Currently, the coating fixation phase of commercial extraction heads worldwide can be divided into four types: non-bonded, bonded, partial cross-linking and cross-linking. The nonbonded stationary phase is stable relative to some water-soluble organic solvents, but it causes a slight swelling when nonpolar organic solvents are used.[3] The bond-fixed phase was stable for all organic solvents, except for some nonpolar solvents. The partially cross-linked stationary phase is stable in most water-soluble organic solvents and some nonpolar organic solvents. The highly cross-linked stationary phase is similar to the uniformly cross-linked one, only generating multiple crosslinks in the same cross-linking center. The most commonly used and earliest used polymer coating materials are polydimethylsiloxane and polymethylmethacrylate.[4]

2. Specific application of solid-phase extraction technology in environmental chemical analysis in China

2.1 Application of solid-phase extraction in the analysis of air pollutants

Table 1 Application of solid phase microextraction technique in environmental atmosphere sampling

Sample type	Analyzing substances	Extraction mode	Fiber coating / tube	test method
air	Monocyclic aromatic hydrocarbons	Direct immersion	Carbon molecular sieve / polydimethylsiloxane	Gaschromatography-mass spectrum
Factory air	volatile sulfur compounds	Direct immersion	Carbon molecular sieve / polydimethylsiloxane	Gaschromatography-pulse-typeflameluminositydetection
Livingroomambentair	Top empty type	Top empty type	Carbon molecular sieve / polydimethylsiloxane	Gaschromatography-mass spectrum
RA	Volatile organic matter	Direct immersion	Carbon molecular sieve / polydimethylsiloxane	Gas chromatography-mass spectrum
automobile exhaust	Benzene,toluene,ethylbenzene,o-xylee	Direct immersion	Carbon molecular sieve / polydimethylsiloxane	gas phase chromatography
room air	amine substance	Top empty type	Polydimethylsiloxane/divinylbenzene,andfiberderivatizatin	Gas chromatography-mass spectrum
air	chlorobenzene	Top empty type	PEG / polydimethylsiloxane, polydimethylsilicon oxygen Alkyl / divinyl benzene	Gaschromatography--electroncaptureDetection, GC-MS
Underground mine air	Sulphurhexafluoride,perfluoromethylcyclohexane	Direct immersion	PDMS	Gaschromatography--electron-capture detection

gas sample	Adipose alcohol, benzene series, petroleum products	Top empty type	Oxide anode aluminum wire	Gaschromatography--flame ionization detection
atmosphere	carbon dichloride	Direct immersion	carbon nano-tube	Gas chromatography-mass spectrum

Air pollution is an important part of China's current environmental problems. The analysis of pollutants in the air is the key to solve the air problem. Analysis of air samples requires high sensitivity and accuracy. Previous solvent adsorption methods are insensitive, inaccurate, and easily affected by water vapor condensation. The mode of solid extraction technology is simple, and the detection results are very accurate, suitable for application.[5]

2.2 Polychlorinated organic compounds were analyzed by the solid-phase extraction method

Traditional water sample analysis requires separation, enrichment, purification and other steps, which often consumes a lot of time, resulting in different experimental time errors. Solid phase extraction can be combined with other techniques to separate different samples in terms of simple equipment, low cost and few solvents.

2.3 Solid-phase extraction analysis of pesticide carbamate

Following organophosphorus pesticides came a rapidly developing pesticide and herbicide, the carbamate. The number of patients living with this poison has increased year by year. This is mainly due to suicide, abuse, or poisoning.[6] The diagnosis and rescue of these poisoned patients requires references for carbamate. Solid-phase extraction and HPLC can isolate and detect carbamate pesticides in the body fluids of poisoned patients and eliminate the interference of proteins.

2.4 Diameter analysis of PAH by solid phase extraction

Polycyclic aromatic particle size is an organic pollutant widely found in nature. Some of these compounds have strong effects in causing malformations, cancers, and mutations, and they are very low abundant, even in many types, even in water. Solid phase extraction can be rapid, accurate, qualitative and quantitative chemical analysis, saving short time, less solvents, not easy to emulsification. For example, since the 1980s, the solid-phase extraction technology has been widely used in the water quality detection of the Songhua River and the Huangpu River in China.[7]

3. Development trend of solid-phase extraction process

With the progress of science and technology, the development of solid phase extraction technology tends to be small. Formation of solid phase extraction disk and solid phase microextraction technology. The SDS extractor is relatively robust and does not require support because it is a PTFE plate containing the filler or a glass fiber sheet containing the filler.[10] Solid phase extraction disks allow a large number of liquid samples, but the disadvantage is the high cost and small range of application.[7]Solid phase microextraction technology is simple to operate and is not easy to consume solvents, but its disadvantage is that the conditions for quantitative analysis are not mature and need further improvement. Automation of solid phase extraction is one of the goals that people have been trying to achieve.[8]

4. Conclusion

The key to the development of solid-phase extraction technology is the coating on the extraction head. The nature of the

coating determines the scope of the method and the range of concentrations that can be detected in the analysis. With the emergence of some inorganic adsorbents and the improvement of this technique, solid-phase microextraction will be used for inorganic material analysis and biomolecular analysis. Therefore, the development of some high-performance coatings with special properties will become an important direction for the development of solid-phase microextraction technology in the future.

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