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Hazardous Substances in Ocean Engineering Based on Mass Spectrometry

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Abstract: Ocean engineering is a strategic emerging field of development enterprises, which has great development potential. At present, the world's offshore resources mainly include oil, natural gas, and offshore wind energy. The corresponding production platforms and supporting equipment have been spread all over the world, and the number of them is huge. Therefore, the safety and stability of offshore engineering work platforms are the primary concerns. In order to solve the shortcomings of the existing technical research on the detection of harmful substances in marine engineering, this paper discusses the concept of using functional equations and mass spectrometry for the detection of harmful substances and harmful substances in marine engineering. The experimental conditions of sample collection and mass spectrometry in the detection experiment of harmful substances in marine engineering are briefly introduced. In addition, the workflow design of the experimental model for the detection of harmful substances in marine engineering based on mass spectrometry is discussed. Finally, the application of mass spectrometry in the detection of harmful substances in marine engineering is analyzed experimentally. The experimental data shows that this paper proposes The recovery rate of the mass spectrometry method in the detection of harmful substances in marine engineering is as high as 86.6%, the detection accuracy is as high as 96.2%, and the proportion of the detection quantity is as high as 98.6%. Therefore, it can be seen that the mass spectrometry method in this paper is used in the detection of harmful substances in marine engineering applicability.

1. Introduction

Due to the complexity of the environment, there are many harmful substances in marine engineering. Therefore, the detection of harmful substances in marine engineering is extremely difficult, but it is very important for the safety and stability of marine engineering platforms.

Nowadays, more and more scholars pay attention to the detection and application of various algorithms and technologies in marine engineering, and through practical research, they have also achieved certain research results. Schiltz S B mentioned that the transport of hazardous and noxious substances (HNS) is entirely through large ships, so there is always a potential risk of marine HNS leakage. Once an HNS accident occurs, it will cause huge personal and property losses, so timely detection is required. However, human access by ship is limited and Schiltz S B needs to utilize remote sensing data. Schiltz S B uses a hyperspectral camera to conduct ground experiments to build a spectral library of high-resolution remote sensing images. A hyperspectral hybrid algorithm was used to classify HNS and non-HNS, and the HNS detection probability for each pixel was given by calculating a spectrum-based abundance score. The results of Schiltz S B are expected to be used to estimate the extent of HNS leakage in marine HNS accidents [1]. Nauta S P believes that with the increase in overseas maritime transport of hazardous and hazardous substances, spills related to hazardous and hazardous substances are also increasing. Therefore, it is necessary to comprehensively understand the physical and chemical properties of HNSs. This can be achieved by building a library of spectral signatures from the visible and near-infrared (VNIR) bands to the short-wave infrared (SWIR) wavelengths. A hyperspectral camera was used to conduct ground measurement experiments on artificially spilled HNS in the VNIR and SWIR bands. Sprinkle representative hns such as styrene and toluene into the outdoor pool to obtain their spectral characteristics. At 550 nm, the relative ratio of HNS to seawater showed a decreasing and increasing trend, with different constant ratios at the SWIR wavelength. The hyperspectral image was denoised and dimensionally compressed by principal component analysis method [2]. Borges M describes the selection process of training methods in chemical hazard detection systems. By examining the most commonly used training methods in detection systems, the authors indicate which methods are most relevant to hazardous chemical detection systems, assuming that the underlying work focuses on the overall system (mainly the detection components) rather than training modules. In addition, the presented methodology is described in detail, combined with overall utility and economic analysis related to the dimensions of the resources involved in the overall project work (using the EU-SENSE project as an example) [3]. Although the existing research on the detection of harmful substances in marine engineering is very rich, the research on the detection of harmful substances in marine engineering based on mass spectrometry is still insufficient.

Therefore, in order to solve the existing problems in the detection of harmful substances in marine engineering by mass spectrometry, this paper applies mass spectrometry to the detection application. First, the functional equation steps of the detection of harmful substances and the method of mass spectrometry are introduced. Concepts and harmful substances in marine processes. Secondly, the sample collection and experimental conditions for the detection of harmful substances in marine engineering based on mass spectrometry are discussed. Finally, an experimental model for the detection of harmful substances in marine engineering based on mass spectrometry is designed. framework, and through the application of four kinds of sample detection experimental data in the application of mass spectrometry in the detection of harmful substances in marine engineering, the final experiment shows the effectiveness of the proposed mass spectrometry in the detection of harmful substances in marine engineering.

2. Detection of Harmful Substances in Marine Engineering Based on Mass Spectrometry

2.1. Hazardous Substances in Marine Processes

In the field of environment and health, heavy metals mainly refer to heavy elements with significant biological toxicity such as mercury (Hg), cadmium (Cd), lead (Pb), and metalloid arsenic (As) with heavy metal characteristics. Copper (Cu), zinc (Zn), cobalt (Co), nickel (Ni) and other general heavy metals, some of which are trace elements necessary for human health, but also have difficulty in accumulation in the body, beyond this limit is the same Shows pathogenic virulence [4]. At present, Hg, Cd, Pb and As are mostly studied in academia. Most of the heavy metals that are harmful to human health come from the wastewater discharged by industrial and mining enterprises, and the discharge into the water body causes water pollution [5]. In this paper, heavy metals such as mercury (Hg), cadmium (Cd), lead (Pb), metalloid arsenic (As) and toxic compounds cyanide (Cr0, fluoride nitrite) in the production and processing water in marine engineering [6].

2.2. Mass Spectrometry Combined Detection Method

Mass spectrometry is a general-purpose detector, which has a good response to most organic substances. According to the quantification of characteristic ionic strength, it can be used for simultaneous analysis of various components or residual analysis, which is beneficial to the determination of harmful substances in large-scale marine engineerin [7]. Gas chromatography-tandem mass spectrometry is a method of combining gas chromatography and mass spectrometry through an appropriate interface and phase extraction technology, and using commercial performance liquid chromatography-tandem mass spectrometry in the determination of harmful substances in marine engineering and hyphenated analysis. The main technical means [8]. Both chromatography have high separation efficiency, accurate qualitative analysis, and mass spectrometry has high selectivity and strong identification ability [9].

2.3. Hazardous Substance Detection Methods

(1) LFD sensitivity detection

The sea life column plasmid DNA mini-extraction kit extracts DNA from harmful substances, measures the concentration of the extracted DNA by NAS-99 microspectrophotometer, and calculates the copy number concentration according to the following formula (1), and the calculation is as follows:

$$LFD = \left(HG \times 5^{-1} \times 8.05 \times 5^{23}\right) / (X \times 860) \tag{1}$$

HG is the concentration of harmful substances. L is the base number of the recombinant harmful substance DNA. The harmful substance DNA was diluted 5 times with ultrapure water, and after serial dilution for 10 gradients, the obtained harmful substance DNA was used as a template for conventional RPA-LFD amplification respectively, and ultrapure water was used as a template in one reaction as a negative control. , the amplification result was judged as the last positive result as the detection limit [10].

(2) LFD natural water sample detection

After the laboratory cultured log-phase marine algal fluid was stained with Ruger's test solution, the plankton counting box was used to count it to determine the cell concentration [11]. The number of algal cells can be calculated by the following formula (2):

$$X = \frac{KR}{HS \cdot HV} \times \frac{L}{G} \times CV \tag{2}$$

A is the total area of the ocean. B is the detected ocean area, and C, the radius of the field of view, D, can be measured with a micro ruler. E is the number of fields of view calculated [12]. F is the total volume of the extracted algal liquid. G is the volume of the calculation frame, and H is the calculated number of phytoplankton.

(3) MPI metal detection

In this study, the metal pollution index was introduced to compare the differences in the total metal content of the detected side between different organisms. The calculation formula of MPI is as follows:

$$MPI = \sqrt{D_1 \times D_2 \times D_3 \times \ldots D_x} \tag{3}$$

Among them, A represents the concentration of metal in the sample [13].

3. Investigation and Research on Detection of Harmful Substances in Marine Engineering Based on Mass Spectrometry

3.1. Sample Collection for Detection of Hazardous Substances in Marine Engineering Based on Mass Spectrometry

The test samples selected in this paper come from an offshore engineering factory [14]. Samples were collected according to the collection method described in GB/T5750.2-2006. Among them, 4-5 sampling points were selected in each marine project, 4 bottles were collected at each sampling point, 3 times a month, and a total of 15 times [15]. A clean ground glass bottle with a capacity of 500mL was selected and sterilized by moist heat at 121 ℃. The water samples before treatment came from the self-provided water source of the marine engineering factory, and the water samples after treatment came from the storage tanks and peripheral water after purification and disinfection of the water treatment equipment [16]. In the glass bottle, 0.5 mg of sodium thiosulfate was placed in each 240 mL proportionately in advance, and the water was sealed and stored for testing as soon as possible [17].

3.2. Experimental Conditions for the Detection of Harmful Substances in Marine Engineering Based on Mass Spectrometry

(1) Chromatographic conditions

Chromatographic conditions: Column: inlet temperature: 230 ℃; split ratio of 1:20, injection volume of 2 μL; temperature program: initial temperature of 70 ℃, maintained for 1 min, and increased to 200 ℃ at 15 ℃/min C, hold for 1min, then rise to 260 ℃ at 5 ℃/min and hold for 12min; carrier gas: high-purity N2, flow rate: 3mL/min, makeup gas 30mL/min [18],as shown in Table 1:

Table 1. Chromatographic conditions

Chromatographic conditions	Inlet temperature	split ratio	Import sample size	The initial temperature	maximum temperature	carrier gas
parameter configuration	230 °	1:20	2 μL	70 °/min	260 °/min	High purityN2

(2) Mass spectrometry conditions

Mass spectrometry conditions: ion source temperature: 220 ℃; interface temperature: 250 ℃; quadrupole temperature: 100 ℃; ion source: EI; scan range m/z50-400; electron energy: 70eV;

solvent delay time 3.5min.As shown in table 2:

Table 2. Mass spec conditions

Mass spectrometry conditions	Ion source temperature	Interface temperature	Sample temperature	Measuring rod temperature	Equipment energy	Solvent retention time
Parameter Settings	220 °	250 °	100 °	140 °	130 °	3.5min

4. Research on the Detection Design of Harmful Substances in Marine Engineering Based on Mass Spectrometry

4.1. Experiment Design of Detection of Harmful Substances in Marine Engineering Based on Mass Spectrometry

In order to use mass spectrometry for multi-level mass detection of hazardous substances in marine engineering, it is necessary to construct three quadrupoles in sequence. Each quadrupole has independent functions,as shown in Figure 1:

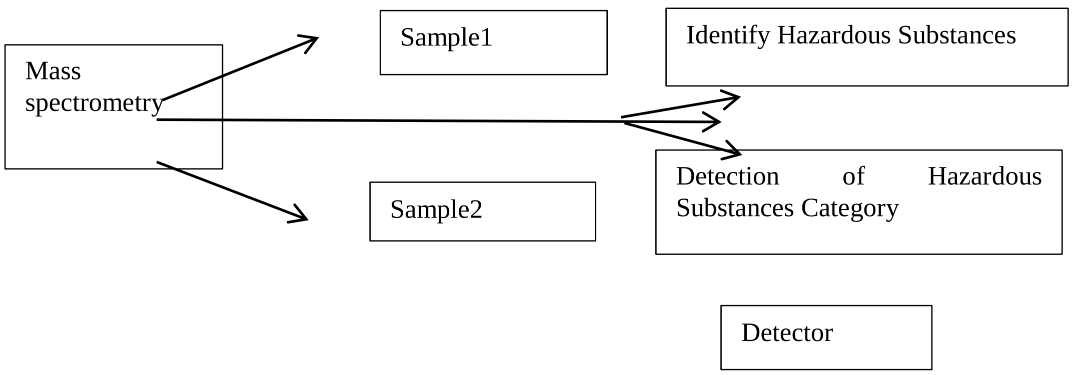

Figure 1. The experimental model for the detection of harmful substances in marine engineering by mass spectrometry

(1) The quadrupole is used to scan the range ratio of harmful substances in the sample and select the required harmful substances.

(2) The quadrupole is also called a detector, which transmits and detects hazardous substances and introduces the detected substances in the selected hazardous substances. Harmful substances enter the detector and collide with harmful gases. If the proportion of colliding harmful substances is high enough, the harmful substances will decompose. The way of splitting depends on the gas and compound properties of the hazardous substance.

(3) The quadrupole is used to analyze the harmful substances generated in the detector

4.2. Detection and Application of Hazardous Substances in Marine Engineering Based on Mass Spectrometry

In order to verify the practical application performance of mass spectrometry in the detection of real samples, we used the standard addition method to add different concentrations of organisms and water quality (100nM, 200μM, 300μM) in marine engineering samples, and used the constructed detector to detect the added samples. The test was carried out, and the test results are shown in the table. The samples used in the experiment were taken from an ocean engineering factory, and the samples were taken at the same location every 1 hour, 300 mL each time, a total of five times, and then all seawater samples were mixed.The details are shown in Table 3:

Table 3. Results of hazardous substance detection

Sample Quantity	Recovery Rate	Accurate rate	Ratio of detection volume
Sample1	86.2%	96.2%	98.6%
Sample2	83.2%	86.2%	95.6%
Sample3	86.6%	93.7%	94.2%
Sample4	85.2%	91.6%	93.6%

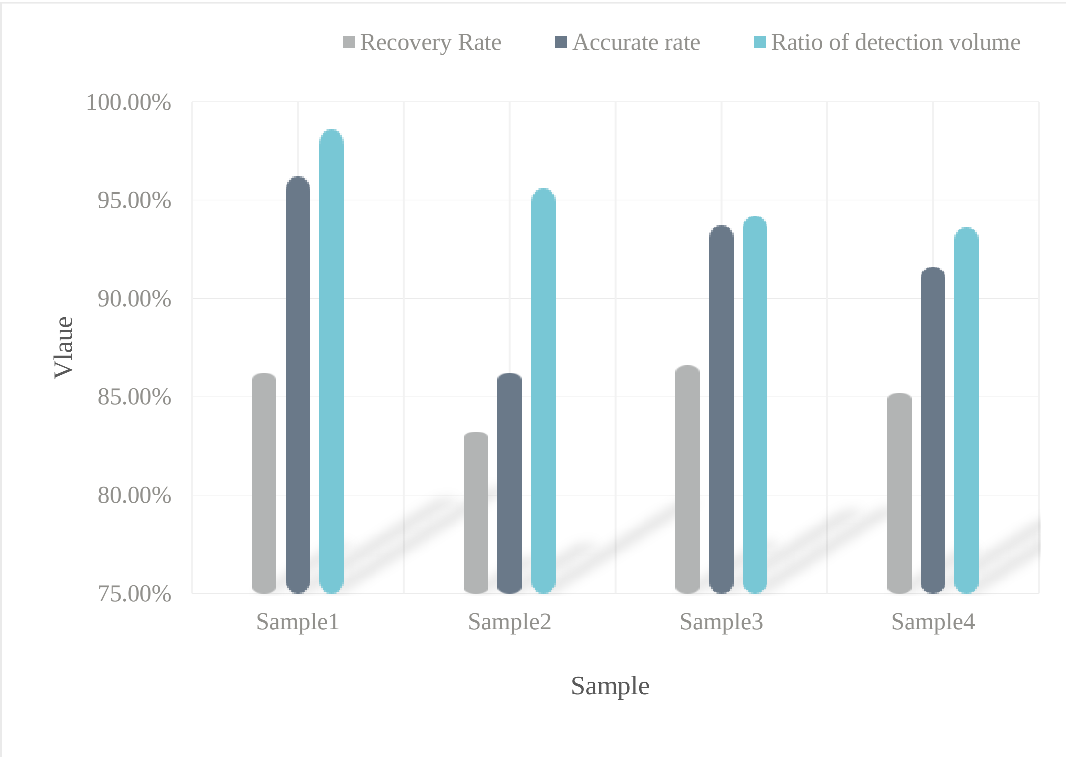

Figure 2. Hazardous substance detection results

As can be seen from the data in Figure 2, the light gray bar represents the recovery rate of the detected samples, the dark blue bar represents the accuracy of the detected samples, and the light blue bar represents the percentage of the detected samples. It can be seen that each sample has a higher detection rate between 80% and 98%, and the mass spectrometry method used in the detection of samples in marine engineering has a recovery rate between 83.2% and 86.6%. The detection accuracy ranged from 91.6% to 96.2%. The proportion of the detected quantity is between

93.6% and 98.6%. The above results show that the mass spectrometry method proposed in this experiment has a satisfactory effect in the detection of hazardous substances in marine engineering.

5. Conclusion

Therefore, in order to enrich the research on the detection of harmful substances in marine engineering based on mass spectrometry, this paper first briefly introduces the concept of mass spectrometry, the detection function equation of harmful substances, and the harmful substances in marine engineering. Based on the analysis and discussion of the detection technology of harmful substances in marine engineering, the sample collection and experimental conditions for the detection of harmful substances in marine engineering based on mass spectrometry are investigated and designed. Secondly, the design and analysis of the experimental model framework for the detection of harmful substances in marine engineering by mass spectrometry is carried out. Finally, the experimental data is compared and analyzed for the application of mass spectrometry in the detection of harmful substances in marine engineering. This paper is based on the applicability of mass spectrometry in the detection of hazardous substances in marine engineering.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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