Determination and Analysis of polycyclic aromatic hydrocarbons (PAHs) in Building Dust Fine particles (PM2.5)

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Abstract. Based on construction of dust particles extraction of polycyclic aromatic hydrocarbons in the optimized analysis, to determine the optimal experimental conditions of ultrasonic extraction of polycyclic aromatic hydrocarbons; Determination of polycyclic aromatic hydrocarbons are normalized concentration analysis, Phenanthrene (PhA) was the highest, accounting for 29.1% of the total PAHs, followed by Naphthalene (NaP) 18.9%, Benzo[b] fluorathene (BbF) 13.1%, Pyrene (Pyr) 8.2%; building the dust PM2.5 fine particles of polycyclic aromatic hydrocarbons the source component spectrum, provide analysis data for the control and management of pollution sources.

1. Introduction
With the rapid development of modern industry, people pay more and more attention to the environment, and the research on the treatment of environmental pollution, especially the treatment of fine particles, is becoming more and more mature. A large number of suspended dusts will be produced in the operation process of modern construction, and the toxic and harmful substances accumulated in the dust will cause great harm to the human body. It is of great significance to determine the types and contents of toxic and harmful substances in dust by using modern analytical technology for the prevention and control of construction dust. Research on the model design of managing haze by using the whole process of PPP.

2. Experimental part
2.1. Sample collection and treatment
Take the construction area of the CBD of Jinan as the main research object, and select the 15 construction sites near the 10-way, the industrial South Road, the Otian Middle Road, the Huayang Road, the Industrial North Road, the Huilong Road and the Garden Road to collect construction dust in the 150-meter range from the construction site as sampling points. The sample is collected for more than 5 kg at each sampling point.

2.2. Sample pretreatment
The building dust source samples of each sampling point are mixed, then dried, and finally packaged and preserved. The specific treatment procedures are as follows:
(1) The samples are naturally dried in the laboratory, and then the dust particles below 300 μm are obtained through 50 mesh nylon screen (300 μm) screen leakage.

(2) The fine particles (PM2.5) in building dust were collected by re-suspension sampler [5]. The procedure is as follows: the quartz inorganic filter membrane was burned in a 450 °C muffle furnace for 2 hours, and the filter membrane burned for 2 hours was put into the dryer to dry and balance the weighing filter membrane for 3 days. The reading was accurate enough that the filter membrane was placed in the resuspension sampler by 0.01mg, and the PM2.5 particles were collected by PM2.5 sampling head.

2.3. Optimization of sample extraction conditions

(1) Optimization of extraction time

Using 300ml dichloromethane as polycyclic aromatic hydrocarbons (PAHs) extractant, the extraction time was set at 8, 12, 16, 20, 24, 28, 36, 48 hours, and the reflux rate was accurately controlled at 2:4 times per hour. The extraction rate of the polycyclic aromatic hydrocarbons increased with the increase of the extraction time, and the extraction rate decreased between 24 and 48 hours. This is because, in the case where the reflux speed is constant, the longer the reflux time, the more the reflux times, and the amount of the solvent is increased, so that the organic matter adsorbed on the particulate matter is desorbed and dissolved in the solvent. However, with the extension of the reflux time, the organic matter on the particulate matter has been completely eluted, and at this time, the extraction time is prolonged, that is, the amount of the solvent is increased, the dissolution of the organic substance is hardly increased, and the extraction efficiency is no longer increased. On the other hand, the increase in the extraction time also results in an increase in the volatilization loss of the methylene chloride and the decomposition or volatilization loss of the organic contaminant in which the thermal stability is poor or the boiling point is low. Therefore, the optimal extraction time of the dust material is selected for 24h.

(2) Optimization of the amount of dichloromethane solvent

The dust samples were evenly divided into six parts, the amount of dichloromethane was set to 50100150200250300ml, the extraction time was 24 hours, and the reflux rate was controlled at 2 ≤ 4 times per hour. When the amount of solvent was between 50~250mL, the extraction efficiency increased significantly. However, the increase between 250~300mL/g is slow, which accords with the extraction principle [7], that is, under the condition of ensuring the minimum amount of solvent needed for reflux cycle and certain other conditions, the actual amount of solvent does not have much effect on the extraction efficiency. At the same time, from the point of view of economic value, under the premise of ensuring the extraction efficiency as much as possible, the solvent is used as little as possible, so the dosage of dichloromethane is 250 mL. The optimum experimental conditions were determined as follows: the extraction time was 24 h, the ultrasonic temperature was 50 degrees, and the selection of dichloromethane was 250 ml.

2.4. GC/MS Sample Analysis Conditions

In this experiment, weak polar TR-5MS capillary chromatography column and reasonable heating program can not only ensure the separation of polycyclic aromatic hydrocarbons (PAHs) with different boiling points, but also have a good peak shape and shorten the experimental time. At the same time, the selective ion detection method of mass spectrometry has strong selectivity for the determination of organic matter. In order to ensure that each polycyclic aromatic hydrocarbons (PAHs) can be above the detection limit and ensure the effectiveness of the experimental results, the sample is injected without shunt.

2.5. Quality assurance and quality control

In order to ensure the accuracy of the experimental quality, the measures taken are as follows:

(1) blank experiment: the blank filter membrane is taken and analyzed according to the same experimental steps as the sample, in order to test the pollution during the experimental operation.
(2) recovery experiment: the mixed reference material was quantitatively dripped on the blank filter membrane and analyzed according to the same experimental steps as the sample to determine the recovery of the target compound in order to correct the loss and pollution in the experimental process.

3. Experimental results and analysis

3.1. Qualitative experimental results analysis

The PPAHs standard samples of 10. μg/mL were measured to obtain the qualitative spectrum of the polycyclic aromatic hydrocarbons. The qualitative and quantitative ions of 16 kinds of PAHs in the samples were determined and their retention time was determined. The sample volume is 1. μL, the mass spectrum scanning mode is selected as the ion current (SIR) scanning mode, the scanning range is between 150 and 350 amu, and the characteristic nuclear mass ratio and the retention time [9] are shown in Table 2. By comparing the retention time of the peak with the standard substance and the standard mass spectrum in the NIST (National Bureau of National Standards), the quantitative determination of the sample to be measured was performed using the external standard method.

3.2. Analysis of experimental results of recovery rate

The recovery rates for 16 reference substances are shown in Table 1.

| name  | percent recovery | name  | percent recovery | name  | percent recovery | name  | percent recovery |
|-------|------------------|-------|------------------|-------|------------------|-------|------------------|
| AcP   | 78.28%           | NaP   | 87.81%           | BaA   | 81.98%           | Chr   | 86.87%           |
| AcPA  | 93.65%           | Flu   | 104.54%          | BbF   | 82.70%           | BkF   | 101.4%           |
| PhA   | 102.7%           | AnT   | 83.48%           | BaP   | 95.49%           | InP   | 86.76%           |
| FluA  | 87.69%           | Pyr   | 84.74%           | DbA   | 88.62%           | BghiP | 84.65%           |

It can be seen from the table that the recovery rate of various polycyclic aromatic hydrocarbons is between 75% and 105%, and the ratio of EPA to PAHs detection recovery rate is 75% -115%.

3.3. Analysis of determination results of 16 kinds of polycyclic aromatic hydrocarbons

The measurement data of 16 polycyclic aromatic hydrocarbons is shown in Table 2.

| name  | Content (ng/g) | name  | Content (ng/g) | name  | Content (ng/g) | name  | Content (ng/g) |
|-------|----------------|-------|----------------|-------|----------------|-------|----------------|
| AcP   | 234.57         | NaP   | 2737.77        | BaA   | 556.85         | Chr   | 614.96         |
| AcPA  | 789.21         | Flu   | 585.93         | BbF   | 1892.30        | BkF   | 997.21         |
| PhA   | 4209.04        | AnT   | —              | BaP   | 654.38         | InP   | —              |
| FluA  | —              | Pyr   | 1188.45        | DbA   | —              | BghiP | —              |

It can be seen from the table that the content of polycyclic aromatic hydrocarbons (PAHs) in 16 is higher than that in polycyclic aromatic hydrocarbons (PAHs). Among them, AnT, FluA, InP, DbA, BghiP was not detected. The carcinogenicity of BaP in 16 kinds of polycyclic aromatic hydrocarbons (PAHs) was strong, and the content of BaP in building dust should not exceed 10 ng / m3, and the content of BaP in building dust had greatly exceeded the limit stipulated by the state, so it was very harmful to human body.

The formula for calculating BaPE is as follows: \[ \text{BaPE} = \text{BaA}\times 0.06 + (\text{BkF} + \text{BbF})\times 0.07 + \text{BaP}\times 0.6 + \text{InP}\times 0.08. \]
According to the calculation formula, it can be concluded that the equivalent carcinogenic concentration (BaPE) of benzo (a) pyrene in fine particulate matter PM2.5 of building dust is: 890.06 ng/g, has seriously exceeded the limit value stipulated by the state, and the carcinogenicity is strong. The main reason for the strong carcinogenicity of building dust is that there are many kinds of building materials, such as metal, plastic, composite and sand cement, etc., and all kinds of materials are mixed to form the mixed source of building dust. the different construction technology will also lead to different organic compounds on the dust source, which can enhance the carcinogenicity of building dust.

4. Composition Spectrum of PM2.5 polycyclic aromatic hydrocarbon Source in Building Dust Fine particles
Dividing the concentration of the polycyclic aromatic hydrocarbon in the sample by the mass concentration of 16 polycyclic aromatic hydrocarbons in the sample and carrying out the normalization treatment to convert the mass concentration of each substance into a dimensionless percentage (i.e., the normalized concentration) to highlight the characteristics of the pollution source. The average value of the calculated results is the component spectrum of the polycyclic aromatic hydrocarbon source of the PM2.5 pollution source in the fine particulate matter of the building. The normalized results are shown in Table 3.

| name | Normalization concentration (%) | name | Normalization concentration (%) | name | Normalization concentration (%) | name | Normalization concentration (%) |
|------|--------------------------------|------|--------------------------------|------|--------------------------------|------|--------------------------------|
| AcP  | 0.016                          | NaP  | 0.189                          | BaA  | 0.038                          | Chr  | 0.043                          |
| AcPA | 0.055                          | Flu  | 0.041                          | BbF  | 0.131                          | BkF  | 0.069                          |
| PhA  | 0.291                          | AnT  | 0.041                          | BaP  | 0.045                          | InP  | —                              |
| FluA | —                              | Pyr  | 0.082                          | DbA  | —                              | BghiP| —                              |

The content of 16 kinds of polycyclic aromatic hydrocarbons (PAHs) can be clearly seen from the normalization concentration diagram of 16 kinds of polycyclic aromatic hydrocarbons (PAHs). It can be seen from the data diagram that the content of phenanthrene (PhA) is the highest, accounting for 29.1% of the total polycyclic aromatic hydrocarbons (PAHs), followed by Naphthalene (NaP) 18.9%, benzo (b) fluoranthene (BbF) 13.1%, pyrene (Pyr) 8.2%, benzo (k) fluoranthene (BkF) 6.9%, acenaphthene 5.5%, benzo (a) pyrene (BaP) 4.5%, flexion (Chr) 4.3%, fluorene (Flu) 4.1%. Benzo (a) anthracene (BaA) 3.8%, acenaphthene (A cP) 1.6%.

5. Conclusion

5.1. Experimental conclusion
(1) Using dichloromethane as extractant, polycyclic aromatic hydrocarbons (PAHs) from dust were extracted by ultrasonic extraction. The optimum experimental conditions were determined by orthogonal analysis software as follows: extraction time 24 h, ultrasonic temperature 50 degrees, dichloromethane dosage 250 ml.
(2) Determination of 10 μg/mL PAHs standard samples, qualitative spectra and qualitative analysis of 16 kinds of PAHs. The qualitative and quantitative ions of 16 kinds of PAHs in the sample were determined, and the specific nuclear ratio and retention time were determined.
(3) The equivalent carcinogenic concentration (BaPE) of the benzene in the fine particulate matter PM2.5 of the building dust is 890.06 ng/g, and the carcinogenicity is strong;
(4) Carrying out normalized concentration analysis on the content of 16 polycyclic aromatic hydrocarbons, and determining that the content of the phenanthrene (PhA) in the 16 polycyclic aromatic
hydrocarbons is the highest, accounting for 29.1 percent of the total amount of the polycyclic aromatic hydrocarbon. The second is (NaP) 18.9%, benzene and (b) 13.1%, Pyr 8.2%, benzo (k) fluorin (BkF) 6.9%, APA 5.5%, benzo (a)% (BaP) 4.5%, Qu (Chr) 4.3%, benzo (Flu) 4.1%, benzo (a)% (BaA) 3.8%, and allyl (AcP) 1.6%. While the dibenzo (a, h) antigen (DbA), the antigen (AnT), the fluorin (FluA), the dibenzo (1,2,3-cd), (InP), the benzo (ghip) are not detected.

5.2. Look into the distance
Monitoring of building dust pollutants is a long-term work. Due to the influence of weather and sudden factors on the construction site, short-term monitoring data is difficult to reflect the actual pollution status of pollution sources. Even so, the experimental results can clearly explain the particulate pollution status of building dust pollution sources, and provide analytical data for the analysis of building dust sources, which is also the significance of this experiment. In the future work, on the basis of this determination and analysis, the following measures will be taken to further improve the composition spectrum of fine particulate PM2.5 polycyclic aromatic hydrocarbon source:

(1) the temporal and spatial distribution analysis of building dust, and the emission characteristics of pollution sources will be further analyzed from the aspect of time and space.

(2) to further analyze the pollution degree of polycyclic aromatic hydrocarbons (PAHs) in other pollution sources, to establish the composition spectrum of various emission sources in an all-round way, and to strengthen the analysis of receptor model, and to carry out the study of migration and transformation of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs), so as to lay a foundation for environmental pollution control and control. 3) the contribution rate of dust content to haze and the linear correlation analysis with haze.

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