Source Spectrum Construction of Open Source Fine Parates (PM2.5) in Air Pollution

Yuanyuan Liu *
Shandong Xiehe University, Jinan, China

*Corresponding author e-mail: liuyuan0906@sdxiehe.edu.cn

Abstract. Taking Jinan, provincial capital of Shandong Province, as the research area, three types of open source sampling and chemical component analysis provide scientific reference and decision basis for urban environmental dye control measures in Shandong Province, determine open source source analysis, and provide data support for the source control measures of environmental pollution in Shandong Province.

1. Introduction

In recent years, our scientific community has increased the development and application of air fine particulate matter (PM2.5) source analysis technology. The National Key Laboratory of Urban Air particulate Pollution Prevention and Control under Urban Environmental Protection of Nankai University put forward the "dual source analysis" technology in 2000. Ji Yikang adopted emission factor method, combined with the energy consumption of different industries in 2013, and established the emission list of air pollution sources in Beijing. Using AERMOD diffusion model simulated the diffusion of pollutant emissions of motor vehicles and fire power plants within the scope of Beijing area, and combined with the monitoring results of Beijing monitoring points in 2014, conducted preliminary research on the haze weather. Bai Zhipeng and other people studied and analyzed the PM2.5 pollution characteristics and haze level evaluation in Tianjin, took into account the pollutants and meteorological factors affecting the formation and development of haze, and applied the gray clustering method to build the level evaluation method of haze to comprehensively reflect the pollution degree of haze. Song Shaohua collected samples of soil dust, road dust, construction dust and storage yard dust in Guilin, analyzed a variety of inorganic elements and water-soluble ion content, constructed the open source spectrum of Guilin, and revealed the characteristics of open source components in the atmosphere of Guilin. Throughout the current situation of research at home and abroad, although domestic and foreign researchers have conducted many studies on fine particulate matter (PM2.5) and made certain progress, there are also some deficiencies in this field, mainly reflected in:

1. Monitoring and analysis of atmospheric pollutants Although more studies have been carried out in China, the investigation of open source pollutants and their harm assessment and the composite pollution and health effects of air pollutants are not in-depth enough;

2. Although the sample collection, pre-treatment, and analysis methods of PAHs in fine particulate matter (PM2.5) have been studied, but overall, the systematic research is not in-depth enough. In addition, due to the differences in sampling methods, the source composition spectrum may be different, which will bring errors to the source analysis results;
(3) There is no comparability between the sampling methods and analysis methods of various fine particulate matter (PM2.5) and the basic data obtained, and the mechanism of PM2.5, emission characteristics and the degree of analysis components.

2. Experimental scheme design

2.1. Experimental content

Sample collection:
(1) Use gas chromatography-mass spectrometry (GC/MS) to determine and analyze the content of 16 PAH in three open source samples, construct PAH component spectrum and conduct toxicity assessment.

(2) An ion chromatograph was used to analyze the soluble ion (NH4+, F-, Cl-, NO2-, SO42-, NO3-, Na+, K+, Mg2+, Ca2+) content in the three open source samples, construct the open source source spectrum of Jinan City, and conduct the source analysis.

2.2. Experimental steps

Sample collection:
(1) Construction dust:
According to the investigation of pollution sources, Jinan, in recent years after the relocation of two major cement plants in the city and the closure of small cement plants, there are no cement factories in the city, but there are many construction sites, reaching 1300, and the cement sales of 1.3 million tons. Therefore, the construction dust in Jinan is mainly caused by the construction of the construction site. Three construction sites under construction are selected, and the waste from the construction site is collected around about 100 meters to represent the construction dust in Jinan.

(2) Demolition and waste:
Three construction sites being demolished in Jinan are selected, and three demolition wastes were collected at the three buildings, and more than 2kg samples were collected at each sampling point.

(3) Road dust:
Three different roads of large, medium and small in Jinan are selected for sampling. 2-3 sampling points are set on each road, with a total of 35 sampling points. Each sampling point is mixed with a vacuum cleaner to get the road dust.

Sample treatment:
(1) Solar extraction: Take dichloromethane as the extraction agent, and the orthogonal method is selected to optimize the experimental conditions, and determine the best extraction time, the temperature of the water bath pot, and the amount of solvent addition. There are multiple methods for extracting PAHs in material samples, and the extraction method is considered the classic extraction method and is used by many countries as the legal standard method for the extraction of organic matter in atmospheric particles or aerosols. This paper uses Sos extraction method to process the experimental materials. Firstly, we optimize the factors affecting the extraction efficiency of the experiment material.

(2) Rotary evaporation: place the extraction liquid on the rotary evaporator for distillation and enrichment;

(3) Silica column chromatography: to separate and purify the polycyclic aromatic hydrocarbons in the extracted liquid by using the silicone column chromatography. Install 10g activated silicone (Qingdao sea wave desiccant plant, 100–200 visual column chromatography, 2 hours and about-grade) in wet column with 1 cm long inner diameter of 20cm,. The concentrated extraction liquid was moved to the top of the silica column, remove the silica column with 40mL n-hexanane (pure, 69-70 °C) and 1: 1 volume ratio, discard the n-hexane eluting component (A1), and collect n-hexane / benzene eluting component (A2). The elution component A2 is concentrated on the rotating evaporator at a constant temperature of 50 °C at distillation. When the eluting liquid is concentrated to about 1mL, transferred to the core bottle, concentrated to 1 mL with N2 airflow, sealed in the core bottle and stored at low temperature for testing.
(4) Fixed capacity: concentrated 1 mL capacity with N2 airflow, sealed in sample bottle and stored at low temperature for testing.

3. Experimental data analysis

3.1. Construction of component spectrum of polyPAH source

16 kinds of polycyclic aromatic hydrocarbons were determined by gas chromatography-mass spectroscopy (American thermoelectric). Chromatographic conditions: inlet temperature of 290 °C; transmission line temperature of 290 °C; column type: TR-5MS(30m × 0.32mm × 0.25um); carrying gas: helium, flow velocity of 1.0ml/min, pressure 65.2kPa; sample inlet mode: no shunt inlet sample (splitless); mass spectrometric condition: ion source temperature of 200 °C, voltage of electron multiplier of 1.0kv;

See Table 3.1 for determination results of 16

### Table 1. Determination Results of 16 PACs

| Name   | Content(ng/g) | Name   | Content(ng/g) |
|--------|---------------|--------|---------------|
| AcP    | 227.57        | NaP    | 2537.77       |
| AcPA   | 723.21        | Flu    | 523.93        |
| PhA    | 3209.04       | AnT    | —             |
| FluA   | —             | Pyr    | 1098.45       |
| BaA    | 532.85        | Chr    | 514.96        |
| BbF    | 1234.30       | BkF    | 607.21        |
| BaP    | 554.38        | InP    | —             |
| DbA    | —             | BghiP  | —             |

![Figure 1. Measurement results of the 16 polycyclic aromatic hydrocarbons](image)

Combined with the icon analysis, FluA, DbA, AnT, InP, BghiP were not detected, with the highest PhA content, followed by NaP, binding toxicity assessment, which shows strong carcinogenicity.
3.2. Determination of the anion

The NH$_4^+$, F$^-$, Cl$^-$, NO$_2^-$, NO$_3^-$, Na$^+$, K$^+$, Mg$^{2+}$, Ca$^{2+}$-was quantitatively analyzed in this sample using the DX—100 type ion chromatograph. See Table 2.2 for the measurement results.

| Ion   | Demolition and removal dust | Road dust | Building dust |
|-------|-----------------------------|-----------|---------------|
|       | Content% | Deviation | Content% | Deviation | Content% | Deviation |
| NH$_4^+$ | 0.0450   | 0.0855    | 0.6123 | 0.3014 | 0.0654 | 0.1235 |
| F$^-$   | 1.3409   | 2.6896    | 0.1243 | 0.7810 | 1.2342 | 0.2231 |
| Cl$^-$  | 0.0287   | 0.0755    | 0.3125 | 0.2914 | 0.0737 | 0.1115 |
| NO$_2^+$| 0.1408   | 0.0306    | 0.1064 | 0.0872 | 0.1486 | 0.0777 |
| SO$_4^{2-}$ | 2.5409 | 3.8576    | 1.1243 | 0.7420 | 1.7688 | 0.2381 |
| NO$_3^+$| 0.3508   | 0.0507    | 0.0764 | 0.0923 | 0.1284 | 0.0378 |
| Na$^+$  | 3.4309   | 5.7890    | 1.5678 | 0.8790 | 1.8990 | 0.3321 |
| K$^+$   | 2.3409   | 4.5620    | 1.3245 | 0.4568 | 1.3450 | 0.2231 |
| Mg$^{2+}$ | 0.1308  | 0.0356    | 0.1764 | 0.0923 | 0.2486 | 0.0977 |
| Ca$^{2+}$ | 0.0387  | 0.0955    | 0.3425 | 0.3314 | 0.0987 | 0.1145 |

Combined with the icon analysis: the anion content, the higher is Na$^+$, SO$_4^{2-}$, K$^+$, the anion composition contained in various material particles are higher than coarse particles, especially the road dust particles anion content is greatly different, because these anions are mostly secondary ions, after physical and chemical changes, the thinner the particles, the easier the particles reunite, the more adsorbed substances; the relatively high SO$_4^{2-}$content of the three anion components.

4. Conclusion

The Conclusion:

(1) According to the main source of air inhalable particulate matter in Jinan and combined with the source analysis results of inhalable particulate matter in Jinan, three powdery materials of construction dust, demolition dust and road dust were selected as experimental materials to study the production mechanism and control technology of inhalable particulate matter in the free whereabouts of the main open sources of air pollution in Jinan.

(2) NH$_4^+$, F$^-$, Cl$^-$, NO$_2^-$, SO$_4^{2-}$, NO$_3^-$, Na$^+$, K$^+$, Mg$^{2+}$, Ca$^{2+}$-was quantitatively analyzed by ion chromatography- the anion composition contained in various material particles are higher than coarse
particles, especially the anion content of road dust particles, because most of these anions are secondary ions, through physical and chemical transformation, the thinner the particles, the more likely the particles reunite, the more adsorption substances; the SO42-content of the three anion components is relatively high.

3) The control technology of inhalable particulate emission during material falling is mainly considered from three aspects and can control the emission by changing the influence factors of inhalable particulate matter to a certain extent; in order to reduce dust, reduce water evaporation and reduce water consumption, dust inhibitor can control the production and emission of inhalable particulate matter in water.

Acknowledgments
This work was financially supported by Shandong Province Scientific research plan project of colleges and universities. The project name’s Study on source spectrum construction of open source fine particulate matter (PM2.5) Item no. J18KA084

References
[1] Jiang Wei, Dong Haiyan, Chen Kui, Bian Wei. Characteristics of water-soluble ion components in PM2.5, Tianjin. Environmental Monitoring in China, 2013, 29(03): 39-43
[2] Wu Hong, Zhang Caiyan, Wang Jing, Xuan Zhaofei, Chu Cuijuan, Feng Silver Factory, Xu Hong. Qingdao Environmental Air PM10 and PM2.5 Pollution Features. Environmental Science Research, 2013, 26 (06): 583-589
[3] Liu Guirong, Shi Guoliang, Zhang Pu, Zhou Lidong, Wu Jianhui, Feng Silver Factory. Source Identification and toxicity Assessment in PM10, Chengdu. China Environmental Science, 2014, 34 (10): 2479-2484
[4] Xu Hong, Lin Fengmei, Bi Xiaohui, Jiao Li, Feng Silver Factory, Hong Shengmao, Liu Wengao. Research on the Chemical Composition Characteristics of Atmospheric Dust Reduction and PM10 in Hangzhou. China Environmental Science, 2011, 31 (01): 1-7
[5] Yu Yangchun. Study on Particle Size Distribution of Water-soluble Inorganic Ions in Atmospheric Particulates in Jinan [D]. Shandong University 2011
[6] Yan Chao. Study on indoor atmospheric particle matter concentration and particle size distribution characteristics in Jinan [D]. Shandong University 2012
[7] Chen Nan. Research on emission List of Pollution Source in Chengdu Economic Circle (Urban Agglomeration) [D]. Southwest Jiaotong University 2011