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Pollution Characteristics and Sources of $PM_{2.5}$ and PAHs in a Traffic Intersection in Beijing

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KEYWORD: Beijing; haze; $PM_{2.5}$; PAHs

ABSTRACT: We chose a traffic intersection that were heavily polluted in Haidian District of Beijing as the representative monitoring point to collect of atmospheric particulate samples within four seasons, respectively, and analysis of the $PM_{2.5}$ and PAHs levels and their contribution to haze in Beijing atmosphere. The results showed that the concentration of $PM_{2.5}$ and seasonal characteristics of PAHs follow this order: winter> autumn> spring> summer in Haidian District of Beijing, and the composition of PAHs are mainly four and five membered ring derivatives. In addition, by using the ratio calculation method, it was concluded that the combustion contributes the most for PAHs in $PM_{2.5}$ contamination in Beijing.

1 RESEARCH METHODS, SAMPLING AREA AND TIME

Atmospheric aerosol sample collection was performed by collecting $PM_{2.5}$ particulate matter samples using Thermo2025i instrument (the United States). The key points are Chegong zhuang Road and Baishi Bridge South, on behalf of the typical traffic pollution areas in urban. Sampling time was selected from designated days in spring, summer, autumn and winter in 2014, and Spring Festival's Eve of 2015.

2 $PM_{2.5}$ LEVELS IN DIFFERENT SEASONS IN A TRAFFIC INTERSECTION IN BEIJING

The aim of this study was to analyze the seasonal variation of $PM_{2.5}$ pollution in Beijing from January to December in 2014 and January to March in 2015.The seasonal concentrations of $PM_{2.5}$ were 78.3 μg / m³, 68.3 μg / m³, 89.6 μg / m³ and 98.7 μg / m³ in Spring, Summer, Autumn, and Winter respectively. It can be seen that the seasonal characteristics were as follows: winter> autumn> spring> summer. The level of $PM_{2.5}$ in spring was lower in Haidian District, because the strong wind in spring of Beijing could greatly dilute the concentration of $PM_{2.5}$. In summer, there was lots of rainy days in Beijing, which also plays negative roles for the level of $PM_{2.5}$.

3 VARIATION OF PAHS IN DIFFERENT SEASONS IN A TRAFFIC INTERSECTION IN BEIJING

The US Environmental Protection Agency published 16 kinds of priority PAHs, the study of these 16 kinds of PAHs as a research object was performed at an important traffic junction in Haidian district of Beijing, was selected as a monitoring point, the content of $PM_{2.5}$ and PAHs are shown in and Figure 1, respectively.

The results of monitoring and analyzing showed that there were some differences in the compositional characteristics of PAHs in different seasons. Overall, 4 and 5 membered rings are the main components of PAHs, accounting for about 80% of the total PAHs. the BaP content was the highest during the winter heating period, with an average concentration of 5.13 ng/m^3; the concentrations of PAHs in air $PM_{2.5}$ were obviously different in different seasons, partly due to the semi-volatility of the 4 membered-ring PAHs and the low volatility of the 6 membered-ring PAHs.

On the other hand,the PAHs in air particulates had obvious seasonal variation, PAHs in the air were significantly higher than those in the non-heating period. The main reasons were the differences of fuel structure, the changes of meteorological conditions, the physical properties of PAHs, and the change of PAHs in the air.

As shown in Figure 2,the seasonal characteristics of PAHs in $PM_{2.5}$ was follow the order: winter> autumn> spring> summer. The PAHs pollution was much severer in winter, mainly due to a large number of coal-fired heating period and exhaustly incomplete combustion of fuel that increased the concentration of PAHs in the atmosphere. As to summer, PAHs were mainly generated by burning for cooking. Meteorological conditions also affect the concentration of PAHs, such as static stable weather and temperature suitable for the formation of haze.

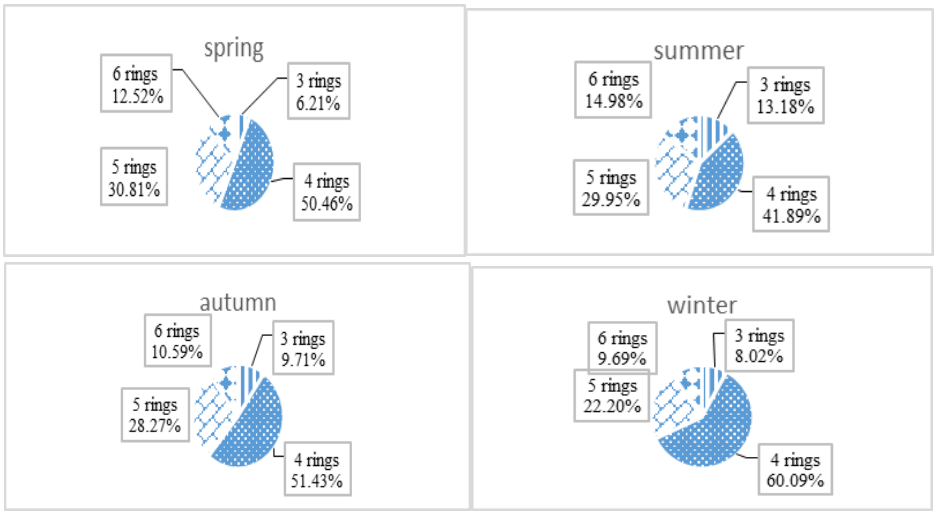

Figure 1. The proportion of PAHs in different seasons in a traffic intersection of Beijing

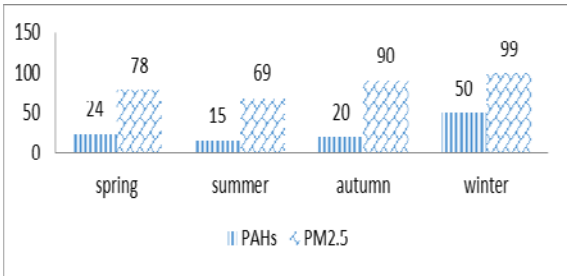

Figure 2. Concentration of PAHs and PM2.5 in different seasons (PAHs concentration ng / m³, particle concentration ug / m³)

4 SOURCES OF $PM_{2.5}$ AND PAHS IN A TRAFFIC INTERSECTION IN BEIJING

4.1 *Analysis of Sources of $PM_{2.5}$ in a Traffic Intersection in Beijing*

The main sources of $PM_{2.5}$ in Beijing are industrial emissions, motor vehicle exhaust emissions, coal and coal heating, dust and building dust, agricultural stalks combustion, which release secondary sulfates and nitrates and organic matters, according to the measured results of some sources of pollution in Beijing and many papers[1-3]. However, In different regions, the contribution rate of pollution sources changes little, some pollution sources, such as coal, dust, biomass burning, secondary sulfate and nitrate, are more obvious in different areas. Beijing has a high concentration of $PM_{2.5}$ in the winter. The contribution rate of dust in winter is much higher than that in summer. The winter vegetation cover in Beijing is low, and the winter vegetation aside the road has withered in winter. Biomass burning problems occurred in the fall, especially when the crop is ripe, straw burning makes the content of $PM_{2.5}$ sharply increased; secondary sulfate and nitrate content is the

highest in summer, because the strong summer sunshine, automobile exhaust and other atmosphere pollutants in the air and then produce secondary pollution.In summary, for Beijing, $PM_{2.5}$ concentration is caused by the synergies of many factors, including motor vehicle exhaust as the main factor.

4.2 *Analysis of PAHs Sources in a Traffic Intersection in Beijing*

In the present study, the ratio method, the characteristic compound method and the multivariate statistics method were used to analyze the sources of PAHs in the fine particles of the atmosphere. According to the measured data, the proportion of PAHs in the atmospheric fine particles in the main traffic port of Beijing was calculated by using the ratio method.

	spring	summer	autumn	winter	average
ρ (BaA)	2.76	1.25	2.45	6.49	2.76
ρ (Chr + BaA)	2.76	1.25	2.45	6.49	2.76
ρ (IcdP)	1.24	1.02	1.15	1.67	1.24
ρ(BghiP + IcdP)	2.88	1.92	2.18	4.88	2.88
ρ(BaP)	2.32	0.87	1.21	5.13	2.32
ρ(BghiP)	1.64	0.9	1.03	3.21	1.64
ρ (BaA) /ρ (Chr + BaA)	0.54	0.55	0.6	0.5	0.54
ρ (IcdP) /ρ(BghiP + IcdP)	0.43	0.53	0.53	0.34	0.43
ρ(BaP) /ρ(BghiP)	1.41	0.97	1.17	1.6	1.41
Bap/BeP+BkF+Bb	0.76	0.44	0.27	1.17	0.76

Table 1. concentration ratios of PAHs in atmosphere $PM_{2.5}$ in Haidian District,Beijing(ng/m^3)

From Table 1, it can be seen that the fours seasons characteristic value of ρ (BaA) / ρ (Chr + BaA) and the annual average value are more than 0.2, indicating that the combustion source is the main source of PAHs in the area; ρ (IcdP) / ρ (Ba) / ρ (BghiP) is 0.84in the summer and 0.85 in the autumn, and the mean value of the annual mean is more than 0.5, indicating that the coal is the main source of the PAHs, indicating that PAHs in $PM_{2.5}$ in summer and autumn were from mixed sources of motor vehicle exhaust and coal combustion. In spring and winter, the values were more than 0.90, indicating that Coal combustion is the main source of PAHs in $PM_{2.5}$ in spring and winter.
Because of the difference in the type of fuel and the combustion conditions, the composition and relative content of PAHs are different in different degrees [4]. Sawicki [5] suggested that the ratio of BaP / (BeP + BkF + BbF) can be used to determine the type of pollution,The ratio is 0.3 ~ 0.44 for traffic pollution, and the ratio of 0.9 ~ 6.6 for coal-fired pollution. The average value of Bap / BeP + BkF + BbF in the winter is 1.17, indicating that the main source of PAHs in winter is coal, and the ratio between summer and autumn is between 0.3-0.44, which indicates that the main sources of PAHs in summer and autumn are traffic, the sources of PAHs were mixed sources.
we can draw the following conclusion: the monitoring point of the intersection in Beijing Haidian of summer air pollution sources are mainly due to motor vehicle exhaust, especially this point for the traffic busy area, traffic pollution is particularly prominent. The sources of air pollution in spring and autumn are more complicated, and they are mixed sources of traffic pollution and coal pollution; But in winter, especially in the heating season, coal combustion of flue gas pollution is the main source of air pollution.

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