Study on the influence of vehicle flow and location on the concentration of air particulate matter

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Abstract. This article mainly studies the problem of particulate matter. PM2.5 and PM10.0 are the representatives of the pollution level. Comprehensive investigation was been conducted according to the location and the vehicle flow. The distance to the street was divided into three types: the point that near the street, the point with medium distance to the street and the point which is far from the street. In addition, the traffic lights are also representative places. This study used SPSS independent sample T test to study the difference between different conditions of the pollution result. This measurement analyzed the possible pollution sources as well as the ideal measures to solve the problem of the air particulate matter.

Introduction

In the modern time, the economy develops rapidly. PM2.5 and PM10.0 and other particulate matter can create huge disadvantages to human health. Meteorological and medical experts conducted a study about the haze weather. Haze weather is caused by air particles. It can have a worse influence to human health than the sandstorm. Long-term exposure to the polluted air would cause the morbidity and mortality's rise [1, 2]. The particles are inhaled into the human body. They can cause diseases such as bronchitis and cardiovascular [3]. The particles may have bad influence on cardiovascular system, reproductive system and blood system [4].

Pan found that during the period from 2004 to 2006, when the average daily concentration of PM2.5 increased, the number of patients with cardiovascular diseases in No.3 Hospital of Peking University increased. Although both PM10.0 and PM2.5 are risk factors, the effect of PM2.5 is more obvious. The World Health Organization also pointed out in 2005 edition of "air quality standards" that: PM2.5 has risen 20 milligrams per cubic meter, with about 340000 deaths annually in China and India.

Methodology and materials

Experiment instruments. The mass concentrations of PM2.5 and PM10.0 were measured by a smart dust detector (DUSTTRAK 8520). The number concentrations of the particles were measured by a laser particle counter (8220 AEROTRAK) and its measurement range is greater than 0.3μm. The experimental instruments were placed at 0.8 meters above the ground.

Experiment scheme. The experiment schemes of different vehicle flow are as follows:

(1) Measuring point: The measuring point is 3 meters away from the center line of the street, the instrument is 1 meter high from the ground.

(2) Sampling time: The time period from 3:30 to 4:30pm is the normal time and the time period from 5:30 to 6:30 pm is the peak time. It takes 10 minutes to measure a data.

(3) Sampling interval: 2minutes.

(4) Operation focus: In this measurement the local particulate concentration was recorded as well as the traffic flow.

The experiment schemes of different location are as follows:

(1) The measuring points were divided into 4 different locations, which were 3 meters, 10meters, 20meters away from the center line of the street and the traffic lights.

(2) Sampling time: This measure was conducted in the time period from 3:30 to 4:30pm, which was the normal time period. It takes 10 minutes to measure a data.

(3) Sampling interval: 2 minutes.

(4) Operation focus: In this measurement the location of the four sites was exact, and the figures were measured in the same time by different person.

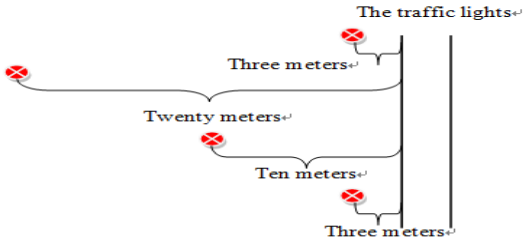

Fig. 1 The map of the four measure sites

Experimental method

(1) The method of controlling variable was used in this measurement. According to the vehicle flow and the location, the professional investigation was conducted in a street.

(2) The measure was based on the comparison of the quality concentration and the count concentration.

(3) The measure was based on two statistical software named ORIGIN and SPSS.

Results and Discussion

The effects of different vehicle flows on the concentration characteristics of air particulate matter

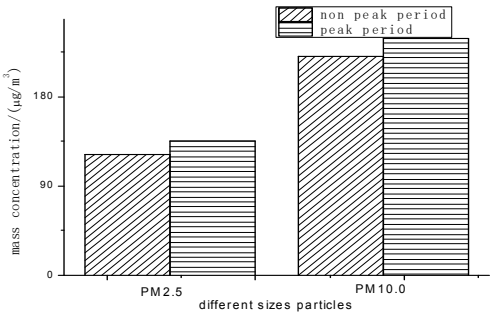

Fig. 2 The number concentration characteristics of air particles under different vehicle flow

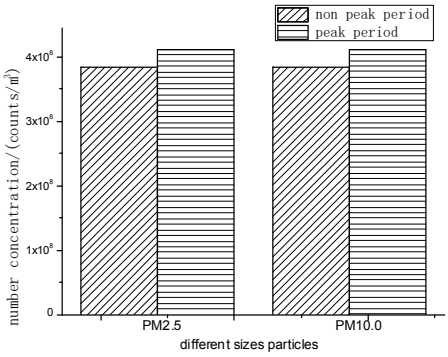

Fig. 3 The mass concentration characteristics of air particles under different vehicle flow

From the chart above, the concentrations of peak time are relatively higher than those of normal time whether in the aspect of the mass concentration or the number concentration. In terms of the street, the most important differences between the peak and normal period are the emissions of automobile tail gas and the diffusion mode of the particulate matter. The emission of automobile tail gas in the peak time is larger. The diffusion speed in the peak time is faster. The transmission range of the peak time is wider.

To further analyze whether different vehicle flows have a significant difference on the concentrations of the air particles, the independent sample test (by SPSS software) of the air particle mass concentrations in these two conditions was conducted. In order to reduce the effect of the initial values on the result, the independent sample test selected the concentration of PM2.5 and PM10.0 as the test variables. Table 1 and Table 2 show the output results.

Table 1 The average value and standard deviation of the T test

Whether or not the peak time		N	Average value	Standard deviation	Standard deviation of the average value
PM2.5	N	11	121.89	9.05	2.73
	Y	11	134.82	2.16	0.65
PM10.0	N	11	222.90	17.25	5.20
	Y	11	240.90	8.14	2.45

Table 2 The T test and the correlation analysis of the concentrations of PM2.5 and PM10

		Levene test		The T test of the mean equation		
		F	Sig	t	df	Sig
PM2.5	Assume the variances are equal	6.03	0.02	-4.61	20	0.00
	Assume the variances are unequal			-4.61	11.14	0.00
PM10.0	Assume the variances are equal	4.62	0.04	-3.13	20	0.01
	Assume the variances are unequal			-3.13	14.24	0.01

From the above results, we can see that the F test with the accompanying value of 0.023. It is obvious that 0.023<0.05. That results indicating an obvious difference between the figures of different vehicle flow. Therefore, according to results of the T test of the independent sample, it is not hard to draw a conclusion that the vehicle flow has a great impact on the degree of pollution of the air particles.

The effects of different locations on the concentration characteristics of air particulate matter

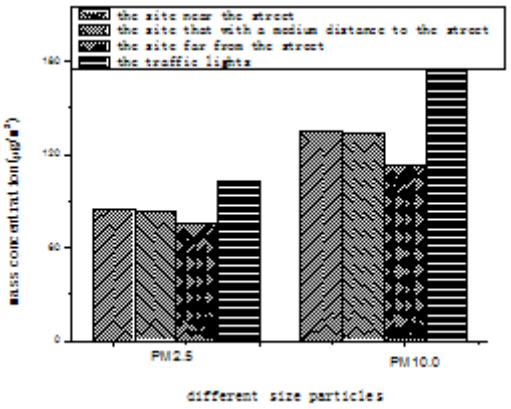

Fig. 4 The mass concentration of air particles in different locations

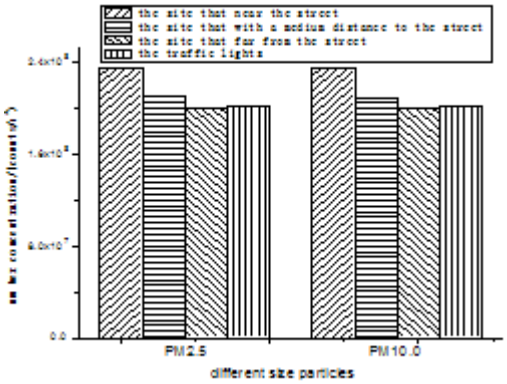

Fig. 5 The number concentration of air particles in different locations

Both the mass concentration and number concentration of PM10.0 in the four sites are about 50% higher than PM2.5. The concentration of the particles near the traffic lights has an absolute advantage to the other three sites. The air particulate concentrations of the other three points can be ranked from high to low. The particulate concentration of the site that near the street is the highest level, the site that is 10 meters away from the street is the second and the site that is 20 meters away from the street is the last.

To further study whether there are significant differences of the mass concentrations with different particle sizes in these four conditions, the mean process analysis (by SPSS software) of the air particle mass concentrations in these four conditions was conducted. The concentration of PM2.5 and PM10.0 were still considered as the test variables. Results are illustrated as follows. The 0, 1, 2 and 3 stand for the site that near the street, the site that with a medium distance to the street, the site that far from the street and the traffic lights respectively. The 1-0 stands for the significant relate value is between 1 and 0. The rest may be deduced by analogy.

Table 3 The multiple comparisons of the four sites

Dependent variable	Locations	Significant unique values
PM2.5	1-0	0.001
	1-2	0.749
	1-3	0.090
PM10.0	2-0	0.000
	2-1	0.910
	2-3	0.008

It can be seen from the chart that 0.749 and 0.910 are the two maximum values. Those two values appear respectively at the point 1and 2. Compared with other values of other points, those two values are far greater than 0.05. It is obvious that the slope of the points 1 and 2 is not sharp. It is not hard to draw a conclusion that the difference between the site 1and 2 is small and the differences of other points are larger.

Conclusion

In this study, the effects of different vehicle flow on the mass concentrations and number concentrations of the air particles were measured and analyzed. At the same time, the effects of different locations were measured and analyzed.

(1) As the distance to the street became small, the concentration of PM10.0 and PM2.5 increased significantly. The reason is the emission of automobile tail gas, which is not purified and which contains a lot of particulate matter. The most serious place is the traffic lights corner. The reasons can be the car's frequent starts and stops and the long time aggregation.

(2) The particulate pollution level of the peak time is significantly higher than those of the normal time. It can be inferred that the vehicle flow of the peak time is very large, resulting in a large amount of particulate matter diffusion. It is undeniable that the scope of the diffusion is wide.

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