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Study on the characteristics of air particulate from a petrochemical complex industrial site in the Southwestern Beijing

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Abstract At petrochemical complex industrial sites in the southwestern suburb of Beijing, oil has been the major energy source. The air particulate samples were collected separately for 3–4 consecutive days every month. The results showed that there are apparent correlations among monthly changes of weight of extracts, their mutagenicities and concentrations of PAHs. The weights for the day-time samples were higher than those for the night-time. Wights of extracts, revertant numbers, BαP concentration etc. were all lower for the petrochemical complex industrial site (PCIS) than for iron-steel complex site (ISCS). However, mutagenicities per unit weight of extracts were higher for PCIS than for ISCS.

Keywords: particulates; air pollution; mutagenicity; petrochemical industrial complex; PAH.

INTRODUCTION

As coal is the main fuel for both industrial and domestic uses in China, it constitutes more than 2/3 of the energy structure in Beijing area and should respond to air pollution in most parts of Beijing. However, at some petrochem-complex industrial sites (PCIS) in the southwestern suburb of Beijing, oil has been using to substitute for coal. The residents there use superfluous heat energy from the plant and also liquefied gas. It will be interesting to characterize this kind of atmospheric pollution and to compare it with that traditional fuel. This paper reports briefly the monthly change of mutagenicities and main carcinogen concentrations of the air particulates collected from a petrochemical industrial site in this area within a year.

EXPERIMENTAL

The particulate samples were collected for 3–4 consecutive days every month of 1984 by using Anderson H-Vol Sampler. Samples were distinguished into day-time and night-time ones which were collected from 8 a.m. to 8 p.m. and from 8 p.m. to 8 a.m, respectively, and then the extracts of particulates of day-time samples within one month were mixed, so as the night-time samples. The mutagenicities determination and chemical analyses of the extracts were done after concentrating. Protocol suggested by Ames with strains TA98 and TA100 was followed without change, with or without liver microsome (S9 mix). Shimadzu LC-3A HPLC was used to determine the concentrations of carcinogenic PAH (polynuclear aromatic hydrocarbons), such as benzo (a) pyrene (BaP), and 3-methylcholanthrene (3-MC) according to the procedure mentioned before.

RESULTS AND DISCUSSION

The weight of particulates and extracts per unit volume had been found to be in the range of 0.141 – 0.718 mg/m^3 and 3.96 – 24.4 g/m^3 with their average values as 0.352 mg/m^3 and 9.9 μg/m^3, respectively. Taking TA98 as an example, we found the data of Ames test based on the extracts per cubic meter are as follows: 2.7 – 35.6 Rev./m^3 with average as 13.8 Rev./m^3 (–S9) and 4.1 – 35.3 Rev./m^3 with average as 15.0 Rev./m^3 (+S9). The concentrations of BaP in the particulates were 0.12 – 3.9 ng/m^3 with average as 1.1 ng/m^3 while of 3-MC were 0.16 – 5.1 ng/m^3 with average as 0.58 ng/m^3.

Fig. 1 shows the monthly changes of weight of extracts, mutagenicities, and concentrations of different PAH. It seems that there are apparent correlations between these parameters. Although there are some differences among the data of different months, regular seasonal changes are not distinct. This is probably correlated to the fluctuation of industrial production.

In general, the data for the day-time samples are higher than those for the night-time samples as shown in Table 1. This difference may be resulted from reducing the fuel used in the night.

Table 1 The comparison of the day-time and night-time samples

Samples	Day-time	Night-time
Dust, mg/m^3 air	0.4227	0.282
Tar, μg/m^3 air	11.2	8.51
Revertants TA98 without S9 mix	15.87	11.66
Revertants TA98 with S9 mix	18.82	11.14
Benzo (a) pyrene, ng/m^3 air	1.368	0.789
3-Methylcholanthrene, ng/m^3 air	1.804	1.106

These results were compared with the data obtained from an iron-steel complex site (ISCS). It can be seen from Fig. 2 to Fig. 4 that weights of extracts, revertant numbers, BaP concentration etc. are all lower in the petrochemical site than in the iron-steel site. The annually average values shown in Table 2 also indicate the similar trend. Since in the iron-steel complex site coal is used as the main fuel and additional fuel is required for heating purposes in the winter, distinct seasonal variation in different parameters of air particulates here has been observed. Whereas in the petrochemical industrial site, the situation is totally different.

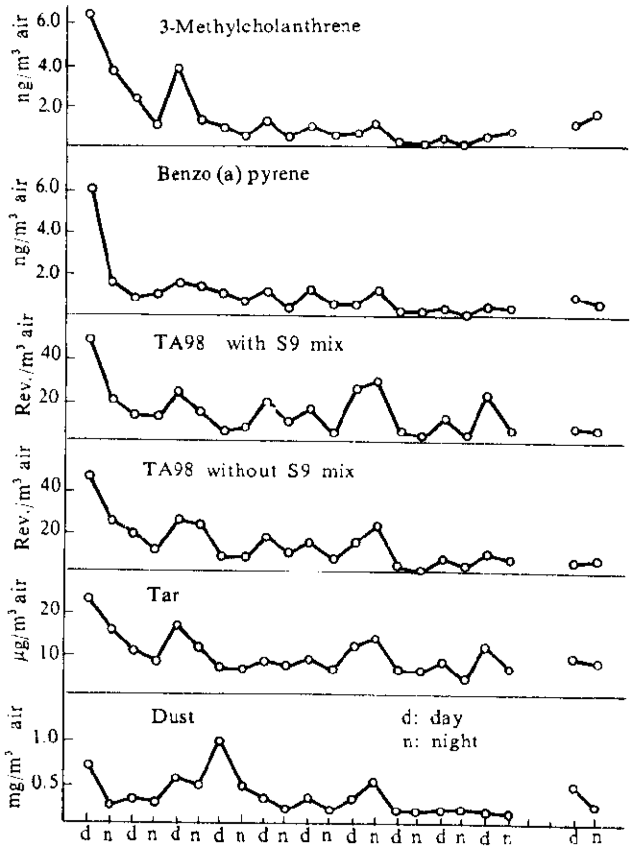

Fig. 1 The monthly changes of weight of extracts, mutagenicities, and concentrations of main carcinogenic PAH in the petrochemical complex industrial site, Beijing

Table 2 The means of weights and mutagenicities of the airborne particulates and their concentrations of BaP in the petrochemical complex site and the iron-steel complex site

Samples	Petrochemical complex site	Iron-steel complex site
Tar, $\mu g/m^3$ air	10.12	34.0
Revertants TA98 without S9 mix	13.76	44.15
Revertants TA98 with S9 mix	14.98	46.27
Benzo (a) pyrene, ng/m^3 air	1.079	50.72

The weights of extracts per unit volume of air collected are plotted against the corresponding BaP concentration in Fig. 5, from which it can be seen that BaP contents in iron-steel complex increase dramatically with the weights of extracts. This also indicates higher BaP emission from coal combustion. However, when weight of extracts verses corresponding mutagenicity data are plotted in Fig. 6, the slope of the curve for petrochem-site is higher than that for iron-steel site. This probably shows that there are more potent compounds in the air particulates needed to be studied.

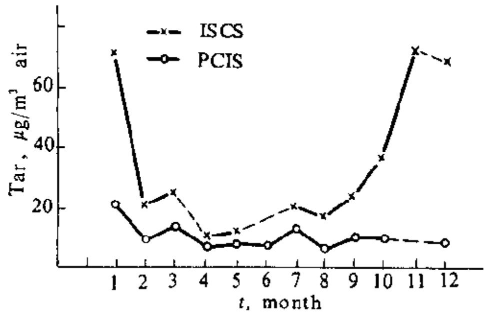

Fig. 2 The change of the weight of extracts collected from the petrochemical complex site and the iron-steel complex site

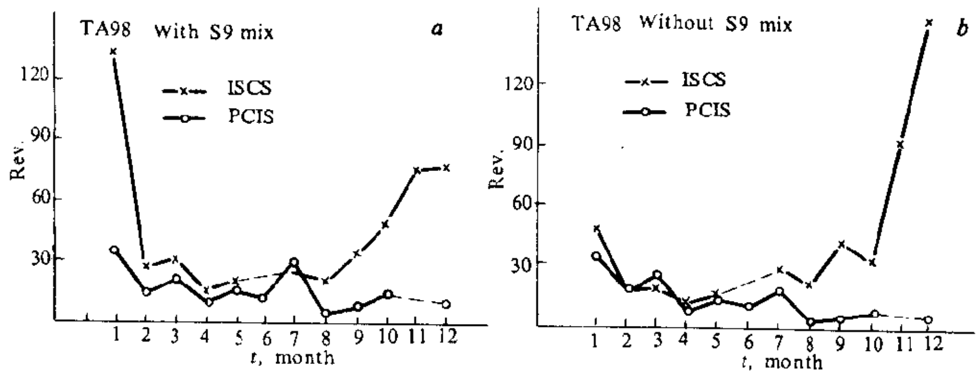

Fig. 3 The mutagenicity of the extracts collected from the petrochemical complex site and the iron-steel complex site

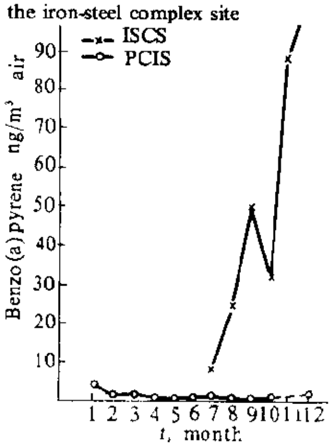

Fig. 4 The concentration of benzo (a) pyrene in the airborne particulates in the petrochemical complex site and the iron-steel complex site

To sum up, the characteristics of air particulates in petrochemical industrial area are different from those in other area. Air pollution due to particulates in the first case is less serious than other districts.

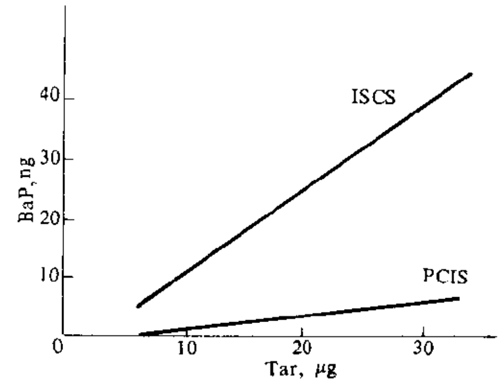

Fig. 5 The relativity of the extract weights with their concentrations of BaP in the petrochemical complex site and the iron-steel complex site

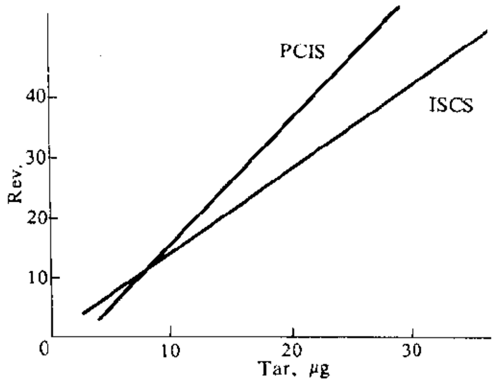

Fig. 6 The relativity of the extract weights with their mutagenicities in the petrochemical complex site and the iron-steel complex site

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