总悬浮微粒中的沥青成分在植物中的累积

贺克斌

（清华大学环境工程系，北京　100084）

摘要　在参照美国试验与材料协会标准分析方法(ASTM D4124)的基础上，对邻近高速公路的多种植物样品和大气中总悬浮颗粒样品中的沥青成分极性芳烃(polar aromatics)、环烷芳烃(naphthene aromatics)和饱和物进行了分析。将分析结果与取自高速公路表面的沥青样品和相应的背景植物样品的分析结果对比得知：3种有机组分在植物中的累积过程中，沥青起了主要作用。在实验所分析的植物样品中，3种有机组分在每g干植物样品中的含量分别为0.29—3.07 mg(极性芳烃)、0.89—3.89 mg(环烷芳烃)和0.37—1.53 mg(饱和物)。

关键词　总悬浮微粒，沥青成分，植物。

由于交通引起的空气污染问题已经越来越受到国内外研究者的关注。有关交通引起的颗粒物对空气的污染及植物的影响，已在柴油机黑烟和机动车轮胎磨损产生的橡胶微粒等方面进行了大量研究[1—4]。沥青已是广泛应用的主要铺路材料，沥青路面磨损也是引起颗粒物的空气污染的重要来源。但迄今还很少有人对路面磨损产生的沥青颗粒物及其对植物的影响开展研究，由于沥青中含有苯并(a)芘等多种致癌物质，有关大气中总悬浮颗粒里的沥青成分在植物中的累积的研究无疑具有十分重要的意义。

1　实验方法

1.1　采样

植物样品的采集在1993-08—1993-09完成。分别在紧靠高速公路地带(试验样)和距高速公路约1.25 km的公园里(背景样)采集了同类的草样和3种树叶样，麦秸样品分别在距公路5 m和10 m以及距公路1 km的位置(作为背景样)采集。大气中颗粒物采集采用ASI/GMW大流量采样器和20.3 cm×25.4 cm石英微量过滤滤纸。沥青样品取自使用中的高速公路表层(最大厚度1 mm)。

1.2　样品萃取

将经过蒸馏水洗涤并干燥后的4—6 g干植物样品在150 ml CH_2Cl_2 和20 ml　5 mol/L的NaOH中用索格利特(Soxhlet)萃取法萃取24 h。萃取完成后的碱液部分由真空分离去除，余下萃取液用蒸馏水小心洗涤后加入20 ml 1 mol/L H_2SO_4 并沸腾0.5 h。将酸液部分由真空分离去除，余下萃取液用蒸馏水洗涤并在室温下蒸发至干燥。加入100 ml正庚烷沸腾2 h后过滤并蒸发至2—4 ml，大气中颗粒物和取自高速公路表层沥青样品用类似方法萃取。

1.3　样品分析

参照ASTM D4124和S. W. Bishara等提出的方法[5,6]，全部样品均在一套高压液相色谱上分析。该分析系统包括LKB2152液相色谱控制器、LKB2150高压泵、LKB 11300梯度控制器、LKB 2151可变波长检测器、以及Milton Roy CI-4100记录仪。分析中采用C-18色谱柱，100×φ3.0 mmID。用无水乙醇和正庚烷作流动相。从分析开始到第15 min，流动相组成由100%无水乙醇线性变化到100%正庚烷；维持5 min后，从第20 min到第30 min，再由100%正庚烷线性变回到100%无水乙醇。流量为0.7 ml/min，用于检测器的波长为280nm，每次进样量为5 μl。

2　结果与讨论

2.1　定性结果

图1给出路面沥青样品和总悬浮颗粒样品

收稿日期：1995-05-05

分析结果。图 2—4 给出了不同植物种类紧靠公路样品和背景样品的分析结果。根据ASTM D4124 和 S. W. Bishara 等给出的结果[5, 6]，以及

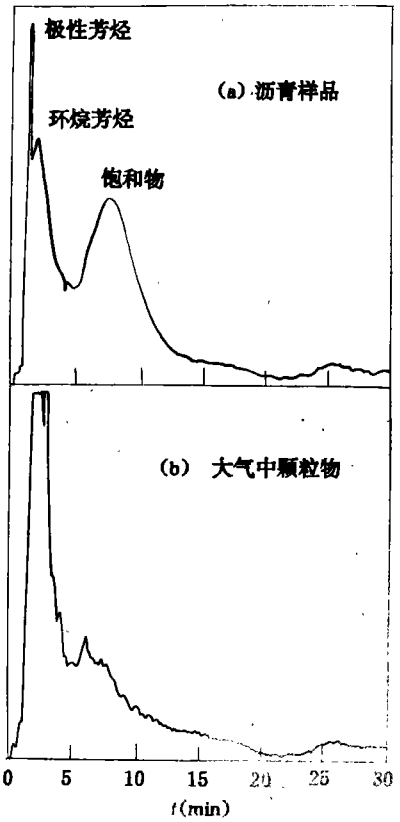

图 1　高压液相色谱分析结果

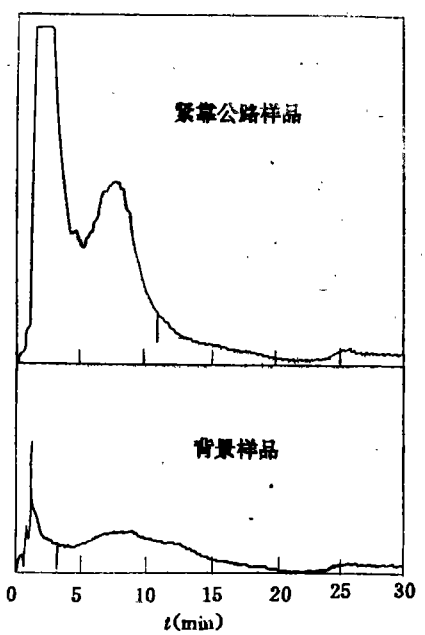

图 2　中样品高压液相色谱分析结果

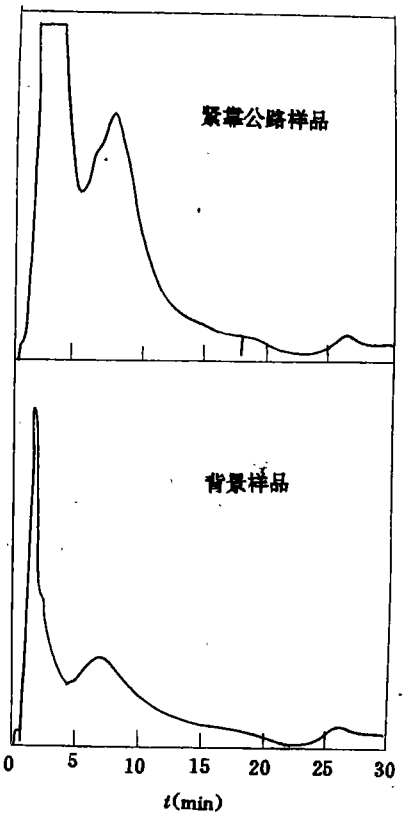

图 3　树叶样品高压液相色谱分析结果

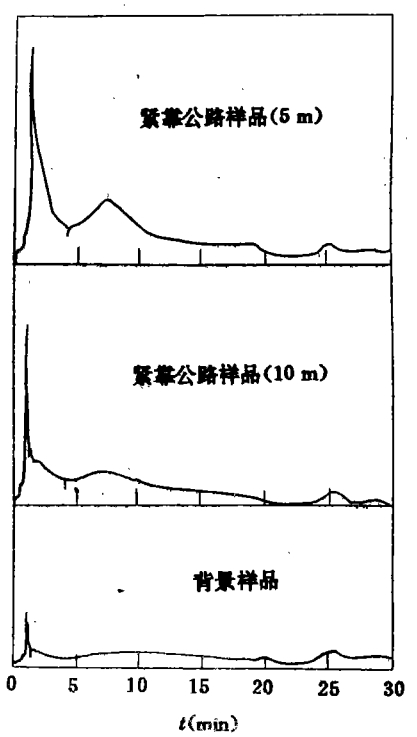

图 4　[illegible]高压液相色谱分析结果

本研究分析过程中所采用的流动相中2种成分的极性系数，可以确定图1(a)中的3个峰应分别代表极性芳烃、环烷芳烃和饱和物(如图1(a)所示)。

表1给出了不同样品分析色谱中代表3种有机组分的峰面积百分构成。经比较图1(b)和(a)并联系到表1中有关沥青样品和大气中颗粒物样品的数据，可确认颗粒物中必有沥青成分存在。从图2—4可以看出：同一种类植物的紧靠公路样品与背景样品分析结果有着很大差别。由于在样品的萃取和分析过程中，对同一种类植物的紧靠公路样品与背景样品都采用了完全相同的干植物样品重量和最终萃取液体积，因此，这种差别只能是由公路交通影响造成的。将图2—4与图1比较并联系到表1中有关数据(植物样均为紧靠公路样品)，可以发现植物样品中代表3种有机组分的峰面积百分构成几乎与沥青样品相同。因此，可以确信，对于3种有机组分在植物中的累积，沥青起了主要作用。

表1 各种样品中3种有机组分的峰面积构成(%)

样 品	极性芳烃	环烷芳烃	饱合物
沥青样品	1.3—2.3	31.9—36.9	61.0—66.1
颗粒物	5.0	38.3	56.7
草	2.6	30.5	66.9
树叶1	0.8	29.8	69.4
树叶2	1.0	33.2	65.9
树叶3	2.0	31.7	66.3
麦秸(5 m)	1.8	28.8	69.3
麦秸(10 m)	0.5	30.2	69.2

2.2 定量结果

根据文献[6]，在分析6个路面沥青样品的基础上，分别求出3种有机组分峰面积与组分质量比例系数(即每mg组分量对应的峰面积)平均值。然后利用该系数求出各样品中有机组分含量。

表2给出了3种有机组分在不同植物中的含量计算结果。从表2中可以看出：3种有机组分在植物中的含量分别为每g干植物样品中0.29—3.07 mg极性芳烃、0.89—3.89 mg环烷烃和0.37—1.53 mg饱和物。表2中数据还表明树叶样品中具有比草样和麦秸样品中更高的沥青成分含量。有关麦秸样品的分析结果表明随着与公路距离的增加，样品中3种有机组分含量呈下降趋势。

表2 各种植物中沥青成分(mg/g干植物样品)

样 品	极性芳烃	环烷芳烃	饱合物
草	0.96	0.89	0.37
树叶1	3.07	3.88	1.53
树叶2	1.46	3.89	1.46
树叶3	0.93	2.91	0.63
麦秸(5 m)	1.10	1.38	0.63
麦秸(10 m)	0.29	1.30	0.56

3 结 论

(1) 极性芳烃、环烷芳烃和饱和物等3种有机组分在植物中的累积过程中，沥青起了主要作用。

(2) 在实验分析的植物样品中，3种有机组分含量分别为每g干植物样品中0.29—3.07 mg极性芳烃、0.89—3.89 mg环烷芳烃和0.37—1.53 mg饱和物。

(3) 分析结果表明：树叶样中具有比草样和麦秸样更高的沥青成分含量；3种有机组分含量随着与公路距离的增加而呈下降趋势。

erected with the mineral saccharide from the Zhuozhou Paper Mill in Hebi Province. By feeding the rice and maize straw treated with the mineral saccharide, sheep had a daliy weight increase by 22.8% and 9.25%, respectively, as compared to those treated with ammonia.

Key words: pulping black liquor, straw feed, waste recycle.

Determination of Dioxin-like PCB in Both Commercially Available PCBs in China and Stack Ash from PCB Incinerator. Li Lingjun and Jiang Ke (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085): *Chin. J. Environ. Sci.*, **16**(6), 1995, pp. 55—58

Considering the fact that the toxicity of PCBs congeners is related to the substituted positions of chlorine atoms, the evaluation of PCBs environmental toxicity depends on the analysis of dioxin-like PCBs, Multi-layer silica column and basic alumina column clean-ups were applied to the pretreatment of samples. The composition and content of dioxin-like PCB congeners in two commercially available PCB in China were determined by GC/MS, and were compared with those from other countries. The determination results of dioxin-like PCB in the stack ash sample from PCBs incinerator showed that the content and toxicity of dioxin-like PCB in stack ash were diminished by 20000 and 50000 times, respectively.

Key words: dioxin-like PCB, incineration, GC/MS.

Study on the Interference Patterns in the 4-Amino Antipyrine Photometric Determination of Volatile Phenols in Wastewater. Yuan Cunguang et al. (Dept. of Chemical Engineering, University of Petroleum, Dongying 257062), Peng Li (Dept. of Environmental Protection, China Petroleum and Natural Gas Corp., Beijing 100724): *Chin. J. Environ. Sci.*, **16**(6), 1995, pp. 59—62

The interference patterns with different mineral oils (crude oil, machine oil and diesel oil), aniline, some metal ions and ClO^-, etc. in the 4-AAP photometric determination of volatile phenols were studied. The recovery of phenols in the presence of different amounts of interference substances was determined spearately. Then, the total recovery equation Y was established. The true concentration C_T of volatile phenols in wastewater was determined with the value C_D found by 4-AAP method and the equation Y. The result from standard addition experiment with mixed interference substances shows that its relative error to the calculated value by the equation Y is below 5%. The determined result of wastewater sample is coincident with the results determined by the derivative photometric method. This method can be used for the determination of volatile phenols in oil-field wastewater.

Key words: volatile phenols, interference patterns, 4-amino antipyrine, photometry.

Accumulation of Asphalt Fractions from Total Suspended Particulate Matters in Various Plant Species. He Kebin (Dept. of Environ. Eng., Tsinghua University, Beijing 100084): *Chin. J. Environ. Sci.*, **16**(6), 1995, pp. 63—65

With reference to ASTM D4124, asphalt fractions, including polar aromatics, naphthene aromatics and saturates, were characterized both in various plant samples and in total suspended particulate sample. In comparison to the results of background plant samples and asphalt cement sample from highway surface, it is concluded that asphalt makes the main contributions to the accumulation of the three organic fractions mentioned above in plant species. For the plant samples used in this research, the concentrations of the three fractions are 0.29—3.07 mg polar aromatics, 0.89—3.89 mg naphthene aromatics and 0.37—1.53 mg saturates per gram dry plant materials.

Key words: total suspended particulate, asphalt fraction, plant, accumulation.

Study on the Distribution Accumulation and Critical Level of Lead in Soil and Rice Along Road Sides. Cao Lixin et al. (Environmental Monito-ring Centre, Ministry of Communications, Beijing 100036): *Chin. J. Environ. Sci.*, **16**(6), 1995, pp. 66—68

The soil and rice samples were collected simultaneously at the sites of 5, 10, 50, 100 and 200 meters away from road, respectively. The analysis results of samples collected along two roads demonstrated that the pollution of lead from automobile exhaust gas was within a range of about 50 m along the roads. The soil characteristics had a significant effect on the distribution and accumulation of lead in soil and rice. The accumulation amount of lead in light loam was less thatn