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POLYCYCLIC AROMATIC HYDROCARBONS AS INDICES OF URBAN AIR POLLUTION

Polycyclic aromatic hydrocarbons in the samples of aerosol particles collected at the sampling/receptor site were identified and determined by gas chromatography and mass spectrometry. Sixteen mutagenic and/or carcinogenic polycyclic aromatic hydrocarbons in the Ljubljana atmosphere have been identified and quantified. The ambient concentration ratios of these polycyclic aromatic hydrocarbons have been related to their emission sources.

1. INTRODUCTION

The most important sources of polycyclic aromatic hydrocarbons (PAHs) in the Ljubljana atmosphere are two large power plants (coal and gas fired), heavy traffic-diesel engines, industrial burnings and residential heating. Virtually, every process, in which carbonaceous fuels are burnt, causes PAHs emisson.

The aim of this paper was to provide an assessment of the sources presently contributing to PAHs loadings at the given receptor site. To solve this problem it is necessary to identify unique chemical indicators emitted by motor vehicles, space heating, industries, incineration and vegetation burning.

2. EXPERIMENTAL PROCEDURE

The location of the Hydrometeorological Institute in Ljubljana was chosen for aerosol particles collection [1]–[3]. The aerosol samples were collected on polytetrafluoroethylene (PTFE) filters using L.B.L. – Sequential Aerosol Sampler [1]–[3]. Air

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samples at 1.5 m above ground level were collected during the summer period in August, 1988. The eight 28.8 m^3, one 16 m^3 and one 40.8 m^3 air samples were collected at the chosen site.

The collected areosol particles were ultrasonicly extracted with distilled dichloromethanol (DCM). The extracts were evaporated to dryness and the residues were dissolved in DCM before testing [1], [2]. The PAH contents in the air sample extracts were analysed using a Hewlett Packard 5890 gas chromatograph (GC) and a Hewlett Packard 5970 mass spectrometer (MSD) [4].

Prior to GC–MS analysis of ambient air samples, a solution of NBS standard reference material was analysed. A chromatogram of SRM 1647 was used for the identificatin and quantification of PAH compounds in the air samples [1], [2].

Total suspended particles (TSP), total carbon (TC), particulate sulphur (Sp) and black carbon (BC) [5] from coincidental quartz filters were analysed.

3. RESULTS AND DISCUSSION

The ambient concentration ratios of polycyclic aromatic hydrocarbons (PAHs) to benzo(a)pyrene (PaP) are shown in the table. The concentration ratios of indeno(1,2,3-cd)pyrene (I) to benzo(ghi)perylene (BghiP) and fluoranthene (FLTH) to pyrene (PYR) and black carbon (BC) to total particulate carbon (TC) are presented in the same table.

The average ambient concentrations of the remaining seven PAHs, i.e. naphthalene, acenaphthylene, acenaphtene, fluorene, phenanthrene, anthracene and dibenzo(ah)anthracene, were: 0.27, 0.07, 0.00, 0.06, 0.21, 0.00 and 0.03 ng/m^3 of air, respectively.

It has been already shown that in the wintertime the ambient concentration ratio of BghiP to BaP is persistently lower than one [2]. This was indicative of the large-scale space heating exhaust in the ambient air of Ljubljana [1], [2]. However, in the summer, the ambient concentration ratios of BghiP to BaP are higher than one. This may be indicative of the prevalent air pollution due to the traffic in the summertime. This can be supported by the summertime concentrations ratios of chrysene (CHR) to BaP and benzo(b)fluoranthene (BbF) toBaP of 1.38 and 1.92, respectively. Chrysene and BbF are present in motor–vehicle exhaust in a far higher concentration (14.8% and 4.6%) than BaP (2.8%).

In addition, the wintertime concentration ratios of chrysene to BaP and BbF to BaP were 1.00 and 0.84 [2], respectively. Moreover, the summertime concentration ratio of fluoranthene to pyrene was 1.12 and the wintertime concentration ratio of the same PAHs was 0.84 [1]. Furthermore, the excess concentrations of indeno(1,2,3-cd)pyrene are evident in the ambient aerosol particles collected in Ljubljana.

The daily differences of PAHs concentrations are evident. In addition, basing on the analyses of ambient concentrations of total carbon (TC) and black carbon (BC) [5], it was stated that the wintertime and the summertime concentration ratios of BC to TC were 0.21 and 0.12, respectively. These concentration ratios are much lower than the data reported [6].

Table

Polycyclic aromatic hydrocarbons (PAHs) and BC/TC ambient ratio data for summer, 1988

PAH ratio	Concentration ratios										Mean value
	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6	Filter 7	Filter 8	Filter 9	Filter 10	
BghiP/BaP	1.00	1.71	1.40	1.00	1.41	0.92	1.46	1.14	1.25	1.33	1.26
BaA/BaP	1.00	0.71	1.00	1.00	0.59	0.74	0.71	0.43	0.83	0.81	0.78
CHR/BaP	2.17	1.00	1.40	1.43	1.24	1.18	1.75	1.06	1.42	1.14	1.38
BbF/BaP	3.17	1.71	1.70	2.43	1.82	1.55	2.46	1.35	1.67	1.33	1.92
BkF/BaP	1.00	1.21	1.40	1.00	1.00	1.00	1.00	0.86	1.00	0.81	1.03
I/BaP	2.17	2.71	2.10	2.00	2.06	1.18	2.04	1.55	2.08	2.14	2.00
I/BghiP	2.17	1.58	1.50	2.00	1.46	1.29	1.40	1.36	1.67	1.61	1.60
FLTH/PYR	1.00	1.00	1.24	1.00	1.00	1.18	1.29	1.30	1.09	1.07	1.12
BC/TC	0.05	0.24	0.13	0.08	0.08	0.07	0.11	0.14	0.14	0.15	0.12

4. CONCLUSIONS

The approach to the identification of the sources of airborne carcinogenic and/or mutagenic PAHs was made by comparing the wintertime and summertime ambient concentration ratios of these compounds. However, it is obvious that the introduction of the complementary markers such as trace elements, BC, TC is necessary for an identification of emission sources of PAHs.

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WIELOPIERŚCIENIOWE WĘGLOWODORY AROMATYCZNE JAKO WSKAŹNIKI ZANIECZYSZCZENIA POWIETRZA W STREFIE MIEJSKIEJ

Zidentifikowano i oznaczono zawartość wielopierścieniowych węglowodorów aromatycznych w próbach cząstek pyłu zebranych w strefie miejskiej. W badaniach wykorzystano chromatografię gazową i spektrometrię masową. Zidentifikowano i oznaczono ilościowo szenaście mutagennych i/lub kancerogennych wielopierścieniowych węglowodorów aromatycznych w atmosferze Ljubljany. Stopień koncentracji tych węglowodorów w atmosferze odniesiono do źródeł ich emisji.

МНОГОЯДЕРНЫЕ АРОМАТИЧЕСКИЕ УГЛЕВОДОРОДЫ КАК ПОКАЗАТЕЛИ ЗАГРЯЗНЕНИЯ ВОЗДУХА В ГОРОДСКОЙ ЗОНЕ

Идентифицировано и обозначено содержание ароматических многоядерных углеводородов в пробах частиц пыли, собранных в городской зоне. В исследованиях использована газовая хроматография и массовая спектрометрия. Идентифицирован А и определены по количеству шестнадцать мутагенных и/или канцерогенных ароматических многоядерных углеводородов в атмосфере города Любляны. Степень концентрации этих углеводородов в атмосфере отнесена к источникам их эмиссии.