





UNIVERSITY OF NOVI SAD  
FACULTY OF TECHNICAL SCIENCES  
DEPARTMENT OF PRODUCTION ENGINEERING  
NOVI SAD, SERBIA

---



11<sup>th</sup> INTERNATIONAL SCIENTIFIC CONFERENCE  
MMA 2012 - ADVANCED PRODUCTION TECHNOLOGIES



**PROCEEDINGS**

---

Novi Sad, 20-21 September 2012

PROCEEDINGS OF THE 11<sup>th</sup> INTERNATIONAL SCIENTIFIC CONFERENCE  
MMA 2012 - ADVANCED PRODUCTION TECHNOLOGIES  
Novi Sad, 2012

---

*Publisher:* **FACULTY OF TECHNICAL SCIENCES  
DEPARTMENT OF PRODUCTION ENGINEERING  
21000 NOVI SAD, Trg Dositeja Obradovica 6  
SERBIA**

---

*Organization of this Conference was approved by Educational-scientific Council of Faculty of Technical Sciences in Novi Sad*

---

*Editor:* Dr Ilija COSIC, *professor, dean*

*Reviewer's team:*

*Dr Bogdan SOVILJ, professor*  
*Dr Dragisa VILOTIC, professor*  
*Dr Djordje VUKELIC, assistant professor*  
*Dr Igor BUDAK, assistant professor*  
*Dr Janko HODOLIC, professor*  
*Dr Marin GOSTIMIROVIC, professor*  
*Dr Milan ZELJKOVIC, professor*  
*Dr Miodrag HADZISTEVIC, associate professor*  
*Dr Miroslav PLANCAK, professor*  
*Dr Slobodan TABAKOVIC, assistant professor*  
*Dr Pavel KOVAC, professor*  
*Dr Velimir TODIC, professor*

*Technical treatment and design:*

*Dr Mijodrag MILOSEVIC, assistant professor*  
*Msc Igor BESIC, assistant*  
*MSc Ivan MATIN, assistant*  
*MSc Alena ZAJAC*  
*MSc Branislav MILANOVIC*  
*MSc Darko MILANKOVIC*

*Manuscript submitted for publication:* September 10, 2012

*Printing:* 1<sup>st</sup>

*Circulation:* 150 copies

*CIP classification:*

CIP - Каталогизacija u publikaciji  
Библиотека Матице српске, Нови Сад

612.7/.9(082)

**INTERNATIONAL Scientific Conference MMA 2012 Advanced  
Production Technologies (11 ; 2012 ; Novi Sad)**

Proceedings [Elektronski izvor] / 11th International Scientific Conference  
MMA 2012 - Advanced Production Technologies, Novi Sad, 20-21  
September, 2012 ; [editor Ilija Cosic]. - Novi Sad : Faculty of Technical  
Sciences, Department of Production Engineering, 2012 (Novi Sad : FTN,  
Graphics Centre GRID). - 1 elektronski optički disk (CD-ROM)  
: tekst, slika ; 12 cm

Nasl. sa naslovnog ekrana. - Tiraž 150. - Bibliografija uz svako rad.

ISBN 978-86-7892-419-4

a) Производно машинство - Зборници  
COBISS.SR-ID 273838087

*Printing by:* FTN, Graphic Centre  
GRID, Novi Sad

---

*Financing of the Proceedings was sponsored by the Ministry of Education, Science and Technological Development of the Republic of Serbia and supported by the Provincial Secretariat for Science and Technological Development of AP Vojvodina.*

---



**11<sup>th</sup> INTERNATIONAL SCIENTIFIC CONFERENCE  
NOVI SAD, SERBIA, SEPTEMBER 20-21, 2012**

## **ACKNOWLEDGEMENT**

Organisation of 11<sup>th</sup> International Scientific Conference MMA 2012 – ADVANCED PRODUCTION TECHNOLOGIES was made possible with understanding and financial help of following sponsors:

- **MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGICAL DEVELOPMENT OF THE REPUBLIC OF SERBIA** – Belgrade
- **PROVINCIAL SECRETARIAT FOR SCIENCE AND TECHNOLOGICAL DEVELOPMENT OF AP VOJVODINA** – Novi Sad
- **FACULTY OF TECHNICAL SCIENCES** - Novi Sad
- **DEPARTMENT FOR PRODUCTION ENGINEERING AT THE FACULTY OF TECHNICAL SCIENCES** - Novi Sad
- **MAJEVICA HOLDING** – Backa Palanka
- **OSA RACUNARSKI INZENJERING** - Belgrade
- **HITARD ENGINEERING** – Novi Sad
- **TEHNOEXPORT** - Indjija
- **TPS** – Novi Knezevac
- **MILE DRAGIC PRODUCTION** – Zrenjanin
- **GASTEH** – Indjija
- **TIM CO** – Belgrade
- **FKL** – Temerin
- **ADAMES** - Ada

*Being held on a regular basis, like some other conferences with long tradition, the MMA 2012 – ADVANCED PRODUCTION TECHNOLOGIES contributes to continuous application of scientific results and professional know-how in the metalworking industry, regardless of the difficulties this industry has been facing during the last two decades.*

*By organizing the MMA 2012 Conference, the research potential of our country relies on its traditional enthusiasm and perseverance in order to contribute to advancement of production engineering in this region – not only through application of scientific results and professional know-how in practice, but also in education of engineers in the field of production technologies and techniques.*

*The eleventh International Scientific Conference MMA 2012 – ADVANCED PRODUCTION TECHNOLOGIES is for the tenth time being held with international participation. Throughout the years, by the number of contributions, their quality and participation of international authors, the Conference has earned a respectable reputation among scientists and industry professionals.*

*This year MMA – ADVANCED PRODUCTION TECHNOLOGIES focuses on the following topics:*

- ◆ METAL CUTTING
- ◆ MACHINE TOOLS AND AUTOMATIC FLEXIBLE TECHNOLOGICAL SYSTEMS, CA<sub>x</sub> AND CIM PROCEDURES AND SYSTEMS
- ◆ METROLOGY, QUALITY, FIXTURES, METAL CUTTING TOOLS AND TRIBOLOGY
- ◆ MECHANICAL ENGINEERING AND ENVIRONMENTAL PROTECTION
- ◆ OTHER PRODUCTION ENGINEERING TECHNOLOGIES
- ◆ BIO-MEDICAL ENGINEERING – CA<sub>x</sub>

*With 129 papers and contributions by international authors from 20 different countries, 11<sup>th</sup> International Scientific Conference MMA 2012 – ADVANCED PRODUCTION TECHNOLOGIES successfully maintains the high level set by the previous conferences. Participation of a large number of domestic and international authors, as well as the diversity of topics, justifies our efforts to organize this conference and contribute to exchange of knowledge, research results and experience of industry experts, research institutions and faculties which all share a common interest in the field of production engineering.*

*Novi Sad, September 2012*

*PROGRAMME AND ORGANIZING  
COMMITTEE*

<b>Sabolová, J., Fedorčáková, M.:</b> HYDRODYNAMIC MODELING OF FLOOD EVENTS IN SELECTED AREA .....	381
<b>Šebo, J., Fedorčáková, M.:</b> ECONOMIC OPTIMIZATION OF RECYCLING ORIENTED DISASSEMBLY OF CONSUMER ELECTRONICS: THE CASE STUDY OF MOBILE PHONE.....	385
<b>Sekulić, M., Hadžistević, M., Kovač, P., Gostimirović, M., Jurković, Z.:</b> CURRENT TRENDS IN SUSTAINABLE PRODUCT DESIGN .....	391
<b>Simonovic, S.:</b> BOTH LEANER AND CLEANER PRODUCTION BY PRODUCT DESIGN .....	395
<b>Tichá, M., Budak, I.:</b> LCA APPLICATION IN EPD AND ECO-EFFICIENCY .....	399
<b>Vasiliev, A., Borodavko, V., Kroutko, V., Kheifetz, M., Gaiko, V.:</b> FORMATION OF QUALITY PARAMETERS IN LIFE CYCLE OF MACHINE DETAILS ON THE BASIS OF TECHNOLOGICAL INHERITANCE .....	403
<b>Vlčej, J., Milanović, B., Milanković, D., Hodolič, J.:</b> IMPLEMENTATION OPTIONS OF LCA METHOD IN PRACTICE IN SLOVAK REPUBLIC .....	407
<b>Vojinović Miloradov, M., Šenk, N., Okuka, M., Turk Sekulić, M., Radonić, J.:</b> POLYPARAMETER MODEL FOR DEFINING PARTITIONING PROCESSES OF SEMIVOLATILE ORGANIC COMPOUNDS .....	411

## **Section F: OTHER PRODUCTION ENGINEERING TECHNOLOGIES**

<b>Alexandrov, S., Lyamina, E., Manabe, K.:</b> A THEORETICAL STUDY ON SURFACE ROUGHING IN PURE BENDING OF VISCOPLASTIC SHEETS.....	415
<b>Božičković, Z., Dobraš, D., Božičković, R.:</b> ELIMINATION OF PERMANENT DEFORMATIONS IN THE LONGITUDINAL WELDING PROCESS OF CONICAL PIPES WITH ONE SEAM .....	419
<b>Brkljač, N., Simić, R., Kovač, P., Brkljač, B.:</b> FEM IN FUNCTION OF PNS - APPLIED IN DERIVING APPROXIMATE FORMULA FOR CALCULATION OF THEORETICAL SCF IN BUTT WELD JOINTS .....	423
<b>Brüning, H., Vollertsen, F.:</b> SELF-ALIGNING CAPABILITY OF LASER BASED FREE FORM HEADING PROCESS .....	427
<b>Deželak, M., Stepišnik, A., Pahole, I., Ficko, M.:</b> METHODS FOR SPRINGBACK PREDICTION AND COMPENSATION .....	431
<b>Ivanisevic, A., Milutinovic, M., Skakun, P., Movrin, D., Kacmarcik, I., Plancak, M., Vilotic, D., Alexandrov, S.:</b> EXPERIMENTAL DETERMINATION OF FORMING LIMIT DIAGRAM FOR BRASS.....	435
<b>Jovanic, D., Jovanovic, M.</b> ECONOMIC EFFICIENCY OF WELDING SIMULATOR USE FOR WELDING PERONNEL TRAINING .....	439
<b>Jovanovic, V., Langraudi, N., Tomovic, M. M.:</b> BOND GRAPH THEORY AND ITS USE FOR HYDRAULIC SYSTEM MODELING .....	443
<b>Karpe, B., Kosec, B., Gojić, M., Anžel, I., Kitak, S., Bizjak, M.:</b> MATHEMATICAL MODELING OF THE MELT COOLING RATE IN THE MELT-SPINNING PROCESS .....	447

11<sup>th</sup> INTERNATIONAL SCIENTIFIC CONFERENCE  
MMA 2012 - ADVANCED PRODUCTION TECHNOLOGIES

## PROCEEDINGS



**Section A:**  
**METAL CUTTING**

Novi Sad, 20-21 September 2012



11<sup>th</sup> INTERNATIONAL SCIENTIFIC CONFERENCE  
NOVI SAD, SERBIA, SEPTEMBER 20-21, 2012

Vojinović Miloradov, M., Šenk, N., Okuka, M., Turk Sekulić, M., Radonić, J.

**POLYPARAMETER MODEL FOR DEFINING PARTITIONING PROCESSES OF SEMIVOLATILE ORGANIC COMPOUNDS**

**Abstract:** In order to define gas/particle partitioning of semivolatile organic compounds, seven EPA polychlorinated biphenyls (PCBs) and sixteen EPA polycyclic aromatic hydrocarbons (PAHs) were chosen, and twenty air samples have been collected at six urban, industrial and highly contaminated locations in Vojvodina. Gas/particle partitioning values of PCBs and PAHs gas molecules, that were gained experimentally, have been compared with polyparameter-linear free energy relationship (PP-LFER) model estimated values. Significant deviation has been noticed during comparative analysis of estimated polyparameter model values for complete set of seven PCBs congeners. Higher agreement of experimental and estimated values was for polycyclic aromatic hydrocarbons, especially for molecules with four rings. These results are in good correlation with literature data where polyparameter model has been used for predicting gas/particle partitioning of studied group of organic molecules.

**Key words:** semi-volatile organic compounds, polyparameter model, gas/particle partitioning

## 1. INTRODUCTION

Air pollution and toxic substances in ambient air are a risk to human population and environment, and one of the global problems of environmental contamination. As a result of conflict situations in Western Balkans (from 1991-1999), total or partial destruction of industrial and military targets, in biotic and abiotic environmental matrix a large amount of pollutants was emitted, including semivolatile organic compounds (SVOCs), primarily polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs), dioxins and other organochlorine compounds. Based on UNEP/UNHCS report, at the territory of Republic of Serbia, there have been identified four ecologically critical locations – hot spots – Novi Sad, Pančevo, Kragujevac and Bor [1]. European Union recognized contamination problems of Western Balkans in the frame of Fifth framework programme accepted APOPSBAL project, that determined the consequences, environmental status and exposition level of human population at the territory of Former Yugoslav Republics [2].

PCBs and PAHs are semi-volatile organic compounds (SVOCs) distributed in the environment with moderate vapor pressure, low solubility and low reactivity. Gaseous molecules in the atmosphere are found free or sorbed to suspended solid phase. PCBs are easily sorbed to suspended solids (aerosols) and associated to organic components of soil and suspended organic matter in aquatic ecosystems and sediment. PCBs are detected in all environmental mediums: water, soil, sediment, air, and living organisms (eg. frog livers). Even though anthropogenic sources of these compounds are reduced to maximum in the last decades, due to ubiquity of PCBs in abiotic and biotic material, atmospheric transport and

cyclic movement, they are still a major pressure to public health and human exposition.

Despite the low vapor pressure (0.03-0.00013 Pa at 20°C, EPA congeners), PCBs evaporate from the soil, and the presence, distribution and transport through the atmosphere are the main mechanism of PCBs gas molecules movement [3]. Three decades after restriction, atmospheric levels of PCBs show state of stationary status. This indicates that PCBs are still emitted in the atmosphere with primary (evaporation from old or damaged equipment with PCBs) or secondary emission sources (contaminated soil, water).

Polycyclic aromatic hydrocarbons are a combination of two or more condensed aromatic rings, and physical and chemical properties of individual compounds differ. Their main property is their semi-volatility or volatility, which makes them mobile through the environment. In the atmosphere, PAHs gas molecules are free in gaseous phase or sorbed to solid particles. Naphthalene, acenaphthene, anthracene, fluorene and phenanthrene are present primarily in gaseous phase. PAHs that have four rings (fluoranthene, pyrene, benz(a)anthracene and pyrene) are present in both gaseous and solid phase, and PAHs with five or more rings (benz(a)pyrene, benzo(ghi)perylene) are sorbed to solid particles [4]. Half life in the atmosphere of particles with diameter in the range of 0.1-0.3µm, and to which PAHs are sorbed onto, is several days.

PCBs and PAHs are detected in all environmental mediums, in regions far away from emission sources (eg. oceans and polar regions), where they were never produced or used [5,6]. Atmospheric transport is the dominant mechanism of dispersion and distribution of PCBs and PAHs gas molecules to thousand kilometers away from emission sources [5-7]. After emission to the

environment, PCBs and PAHs do not subject to degradation processes, but instead, they start dynamic equilibrium cyclic processes and distribution between environmental mediums. PCBs and PAHs have low solubility in water, and high solubility in lipids, resulting in bioaccumulation in adipose tissue and biomagnification through food chain [8,9]. Even at low concentrations, PCBs and PAHs have toxic effect to human population and wildlife, with catalytic action in carcinogenesis, immune dysfunction, neurological diseases, reproductive and endocrine disorders.

Research that provided a broader framework from which the results presented in this paper were gained [10,11], is conceived with the aim of determining the scope, structure and specific quality characteristics, which directly or indirectly define partitioning and transport of PCBs and PAHs through the environmental mediums in Western Balkan territory.

In the research presented in the paper, compatibility of experimentally gained data and values calculated using polyparameter model, for partitioning of PCBs and PAHs in the presence of atypical primary emission sources were analyzed.

## 2. DISTRIBUTION MODELLING OF GAS MOLECULES IN THE ATMOSPHERE

Gas/particle partitioning assessment of PCBs and PAHs gas molecules has been analyzed in many theoretical studies and models [12,13]. Distribution of gas molecules is usually represented with gas/particle partitioning coefficient,  $K_p$  ( $\text{m}^3 \text{air } \mu\text{g}^{-1} \text{aerosol}$ ), equation (1):

$$K_p = \frac{C_p}{C_G TSP} = \frac{\varphi}{TSP - \varphi TSP} \quad (1)$$

where  $C_p$  and  $C_G$  are concentration of analyte in particulate and gaseous phase ( $\text{mol m}^{-3} \text{air}$ ), respectively, and TSP is concentration of total suspended atmospheric solids ( $\mu\text{g aerosol m}^{-3} \text{air}$ ). Fraction of individual compounds sorbed onto particulate phase of the sample in total detected amount  $\varphi$  (0-1), are calculated with the equation (2):

$$\varphi = \frac{C_p}{C_p + C_G} = \frac{K_p TSP}{1 + K_p TSP} \quad (2)$$

The content of atmospheric solids, aerosols, has the dominant effect to sorption processes, which is highly important for transport and behaviour of SVOCs in the atmosphere. Atmospheric particles are structured of different phases, and can be group to adsorbing phase (mineral dust, elemental carbon), and absorbing phase (water soluble organic matter – WSOM, water insoluble organic matter – WIOM and water phase). Nonhomogeneity and mixing of different phases can lead to slowing of sorption processes, if one phase disables distribution of analytes to the other phase, or accelerating of sorption, when two phases form a new one, with different content and properties for sorption processes.

### 2.1. Polyparameter model

Distribution modelling of semivolatile apolar, polar and ionizable organic compounds to WIOM of atmospheric particles with absorption models can be described with PP-LFER model [14].

Gas/particle partitioning of a given compound in the atmosphere for absorption process can be characterized by five molecular descriptors. In the following PP-LFERs these descriptors are shown in equation (3):

$$\log K_{\text{isorbent/air}} = sS_i + aA_i + bB_i + lL_i + vV_i + c \quad (3)$$

where  $S_i$ ,  $A_i$ ,  $B_i$ ,  $L_i$  and  $V_i$  are the compound-specific Abraham descriptors for the polarizability/dipolarizability, electron acceptor (H-bond donor) capability, electron donor (H-bond acceptor) capability, logarithm of the hexadecane/air partitioning coefficient, and McGowan volume, respectively [15]. Abraham descriptors have specific values for individual compounds (sorbate) and measured in laboratory conditions. For a number of different polar, apolar and ionizable organic compounds, these descriptors have been measured and published.

Corresponding to the Abraham descriptors are the sorbent (i.e., particle)-specific descriptors  $s$ ,  $a$ ,  $b$ ,  $l$ , and  $v$ , along with the fitting constant,  $c$ . Sorbent-specific descriptors can be calculated by performing a multiple-linear regression using experimental  $\log K_p$  values as the dependent variables and Abraham descriptors as the independent variables [14].

Based on the research results [14, 15], for apolar, polar and ionizable organic compounds, it is recommended to use sorbent-descriptors that showed typical sorption properties, Berlin W and Duebendorf F.

PP-LFER model based on Abraham descriptors shows a valuable degree of accuracy, and at the same time it is applicable for a numerous different polar, apolar and ionizable organic compounds. However, the usage of PP-LFER model is difficult for compounds that do not have Abraham descriptors calculated yet (PCDDs/Fs, PBDEs etc.).

## 3. MATERIAL AND METHOD

A total number of 20 air samples was obtained from six urban and industrial monitoring stations in two cities of Vojvodina region, Serbia – Novi Sad and Pančevo. In Novi Sad, locations were chosen based on the distance from emissions of PCBs and PAHs. With this criteria three locations were selected – Oil refinery Novi Sad (location N1), Sangaj (location N2) and City center (location N3). With similar criteria, three locations in Pančevo were chosen – Oil refinery Pančevo (location P1), Chemical industry (location P2) and City hall (location P3).

Conventional high volume sampling method was applied, with quartz filters for collecting the atmospheric particles and polyurethane foam filters (PUF) for retaining the free gas molecules of PCBs and PAHs. The samples were analyzed using GC-ECD (HP 5890) supplied with a

Quadrex fused silica column 5% Ph for PCBs, while 16 US EPA polycyclic aromatic hydrocarbons were determined in samples using a GC-MS instrument (HP 6890 - HP 5972) supplied with a J&W Scientific fused silica column DB-5MS. All analytical procedures were done in the laboratories of the Research Centre for Environmental Chemistry and Ecotoxicology (RECETOX), Masaryk University, Brno, CR, coordinated by dr. Jana Klanova and dr. Ivan Holoubek.

#### 4. RESULTS AND DISCUSSION

In figure 1. only four experimentally gained values of gas/particle partitioning coefficient for polychlorinated biphenyls, at locations in Vojvodina, are in domain of model assessed log  $K_p$  values, which represents 9.5% of total number of experimentally gained values, i.e. 16% if only relevant data are observed. Three of four values that

are in domain of mathematical assessment of the model, are for congener PCB 52, that is frequently detected, and just one for congener PCB 153. Values on x-axis are results of low experimental  $K_p$  values, and are not relevant for analysis of the results.

Deviation of experimental and modelled values is the highest for PAHs that are dominantly in gaseous phase (naphthalene, acenaphtylene, acenaphtene, fluorene, phenanthrene and anthracene, fig. 2). Best compatibility between experimentally gained and modelled log  $K_p$  values is for PAHs that are present in both gaseous and particulate phase (fluoranthene, pyrene, benz(a)anthracene and chrysene). As a result of some PAHs not being present in gaseous phase, log  $K_p$  values are marked as zero, and it does not represent a relevant data, and also was not considered in the analysis.

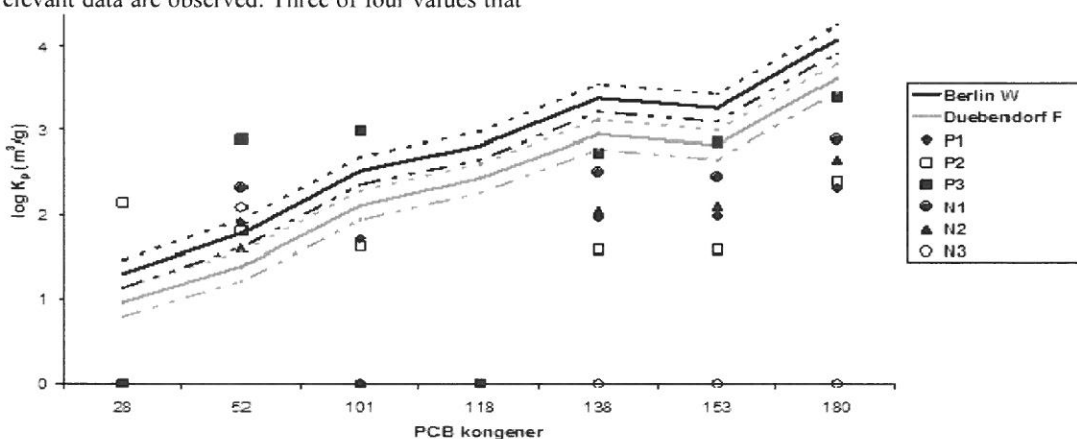


Fig. 1 Experimentally gained and PP-LFER model estimated log  $K_p$  values at 15 °C and 50% relative humidity using PP-LFER for the Berlin W and Duebendorf F samples at localities in Novi Sad and Pančevo for polychlorinated biphenyls.

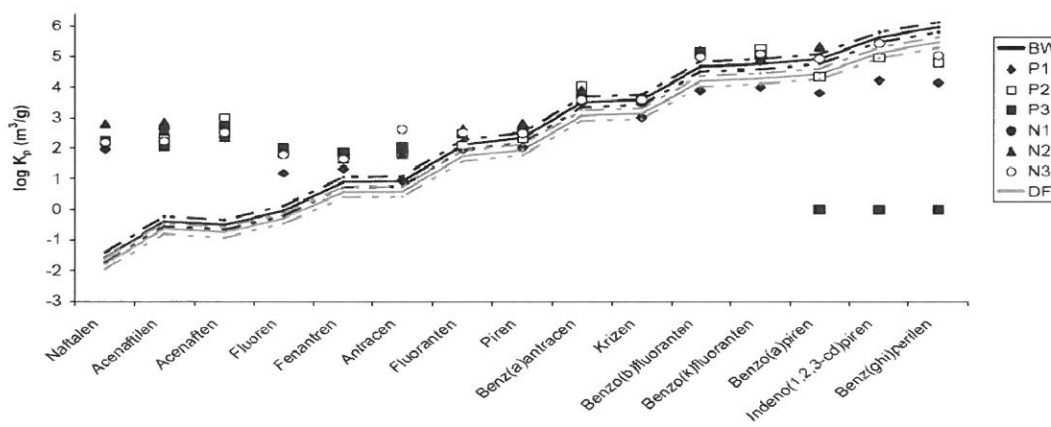


Fig. 2 Experimentally gained and PP-LFER model estimated log  $K_p$  values at 15 °C and 50% relative humidity using PP-LFER for the Berlin W and Duebendorf F samples at localities in Novi Sad and Pančevo for polycyclic aromatic hydrocarbons

#### 5. INSTEAD OF CONCLUSION

In the paper, experimentally gained gas/particle partitioning coefficients of polychlorinated biphenyls and polycyclic aromatic hydrocarbons in heterogenous multicomponent system in 20 ambient air samples has

been shown. Samples were collected at the territory of Vojvodina in urban, industrial and residential areas of cities Novi Sad and Pančevo. Experimentally gained data were compared to mathematically modelled values, using log  $K_p$  parameter model.

Based on the conclusions from comparison of experimentally gained and modelled values, polyparameter model is not recommended for modelling of PCBs congeners' behaviour in specific ambiental conditions in Novi Sad and Pančevo. Positive match of experimentally gained and PP-LFER modelled values was gained in only 9.5% of ambient air samples, i.e. in 16% if only relevant data are observed. Parallel analysis of adsorption, absorption and polyparameter model gas/particle partitioning of PCBs congeners shows that the best Junge-Pankow simulation of realistic conditions is the best for representing ecostatus of Western Balkan. For polycyclic aromatic hydrocarbons, assessment of  $K_p$  values with PP-LFER model is gained for PAHs with four rings, compounds that are found in both gaseous and particulate phase – fluoranthene ( $C_{16}H_{10}$ ), pyrene ( $C_{16}H_{10}$ ), benz(a)anthracene ( $C_{18}H_{12}$ ) and chrysene ( $C_{18}H_{12}$ ). Experimentally gained values are in domain of allowed deviation and are matching modelled values up to 62.5%. Gained results are in consistency with literature evaluations of polyparameter model. For other EPA PAHs, deviation is higher, only 20 data are in domain of allowed deviation, which is 21% from total number of experimentally gained values, and 24% if only relevant data are observed. Based on the results, polyparameter model is not recommended for polycyclic aromatic hydrocarbons primarily present in gaseous phase.

#### ACKNOWLEDGEMENT

This research was supported by FP5 EU (ICFP501A2PR02 – APOPSBAL) and Ministry of Education and Science, Republic of Serbia (III46009).

#### 6. REFERENCES

- [1] UNEP (1999), The Kosovo conflict – consequences for the environment and human settlements. <http://www.grid.unep.ch/btf/final/finalreport.pdf>
- [2] APOPSBAL, Assessment of the selected POPs in the atmosphere and water ecosystems from the waste generated by warfare in the area of former Yugoslavia, Final report, 2005.
- [3] M. Turk Sekulić, Rasprostiranje, depozicija i raspodela polihlorovanih bifenila u heterogenom multikomponentnom sistemu, Doktorska disertacija, Fakultet tehničkih nauka, Univerzitet u Novom Sadu, Novi Sad, Srbija, 2009.
- [4] J. Radonić, Atmosferski transport i modelovanje raspodele između čvrste i gasovite faze policikličnih aromatičnih ugljovodonika, Doktorska disertacija, Fakultet tehničkih nauka, Univerzitet u Novom Sadu, Novi Sad, Srbija, 2009.
- [5] I. Iwata, S. Tanabe, N. Sakai, R. Tatsukawa, Distribution of persistent organochlorines in the oceanic air and surface seawater and the role of ocean on their global transport and fate, Environ. Sci. Technol. 27 (1993) 1080–1098.
- [6] D.E. Schulz-Bull, G. Petrick, R. Bruhn, J.C. Duinker, Chlorobiphenyls (PCB) and PAHs in water masses of the northern North Atlantic, Mar. Chem. 61 (1998) 101–114.
- [7] C.J. Halsall, A. J. Sweetman, L.A. Barrie, K.C. Jones, Modelling the behaviour of PAHs during atmospheric transport from the UK to the Arctic, Atmos. Environ. 35 (2001) 255–267.
- [8] J. Skei, P. Larsson, R. Rosenberg, P. Jonsson, M. Olsson, D. Broman, Eutrophication and contaminants in aquatic ecosystems, Ambio 29 (2000) 184–194.
- [9] J.E. Baker, Critical pathways of Bioaccumulation in aquatic food webs, State of the art workshop: Bioaccumulation of organic compounds and mercury in aquatic food webs, Ispra, Italia., JRC. 2002.
- [10] M. Turk, J. Jaksic, M. Vojinovic Miloradov, J. Klanova, Determination of POPs in Gaseous Phase by Active and Passive Sampling Methods, Environ. Chem. Lett. J. 5 (2007) 109–113.
- [11] J. Radonić, M. Turk Sekulić, M. Vojinovic Miloradov, P. Čupr, J. Klánová, Gas-particle partitioning of persistent organic pollutants in the Western Balkan countries which suffered recent PCB spills, Environ. Sci. Pollut. Res. 16(1) (2009) 65–72.
- [12] J.F. Pankow, T.F. Bidleman, Interdependence of the slopes and intercepts from log-log correlations of measured gas-particle partitioning and vapor pressure-1. Theory and analysis of available data, Atmos. Environ. 26A (1992) 1071–1080.
- [13] W.E. Cotham, T. Bidleman, Polycyclic aromatic hydrocarbons and polychlorinated biphenyls in air at an urban and a rural site near lake Michigan, Environ. Sci. Technol. 29 (1995) 2782–2789.
- [14] H.P.H. Arp, R.P. Schwarzenbach, K.U. Goss, Ambient Gas/Particle Partitioning. 2. The Influence of Particle Source and Temperature on Sorption to Dry Terrestrial Aerosols, Environ. Sci. Technol. 42 (2008b) 5951–5957.
- [15] H.P.H. Arp, R.P. Schwarzenbach, K.U. Goss, Ambient Gas/Particle Partitioning. 1. Sorption Mechanisms of Apolar, Polar, and Ionizable Organic Compounds, Environ. Sci. Technol. 42 (2008) 5541–5547.

**Authors: Prof. emeritus Dr. Mirjana Vojinović Miloradov, M.Sc. Nevena Šenk, M.Sc. Marija Okuka, Assist. Prof. Dr. Maja Turk Sekulić, Assist. Prof. Dr. Jelena Radonić**, University of Novi Sad, Faculty of Technical Sciences, Department of Environmental Engineering and Occupational Safety and Health, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia, Phone: +381 21 485 2405, Fax: +381 21 6350 696  
E-mail: [miloradov@uns.ac.rs](mailto:miloradov@uns.ac.rs),  
[nevenasenk@uns.ac.rs](mailto:nevenasenk@uns.ac.rs),  
[marijaokuka@uns.ac.rs](mailto:marijaokuka@uns.ac.rs),  
[majaturk@uns.ac.rs](mailto:majaturk@uns.ac.rs),  
[jelenaradonic@uns.ac.rs](mailto:jelenaradonic@uns.ac.rs)