HRVATSKO UDRUŽENJE ZA ZAŠTITU ZRAKA
CROATIAN AIR POLLUTION PREVENTION ASSOCIATION

DESETI HRVATSKI ZNANSTVENO-STRUČNI SKUP

ZAŠTITA ZRAKA '17

TENTH CROATIAN SCIENTIFIC AND PROFESSIONAL ASSEMBLY

AIR PROTECTION '17

Zbornik sažetaka
Abstracts

PRIMOŠTEN, 03.-07. listopada 2017.
PRIMOŠTEN, Croatia, October 03-07, 2017

Izdavač
HRVATSKO UDRUŽENJE ZA ZAŠTITU ZRAKA
Zagreb, Ksaverska c. 2

Za izdavača
Dr.sc. Gordana Pehnec

Urednici
Dr.sc. Jagoda Doko Jelinić i dr.sc. Silva Žužul

Tehnički urednici
Dr.sc. Ranka Godec
Dr.sc. Silvije Davila

Recenzenti
Znanstveno-stručni odbor

Kompjutorski slog
topgrafika, Velika Gorica

Tisak
topgrafika, Velika Gorica

Naklada:
200 primjeraka

ISSN 1848-185X

Hrvatsko udruženje za zaštitu zraka
Institut za medicinska istraživanja i medicinu rada
Državni hidrometeorološki zavod
European Federation of Clean Air and Environmental Protection Associations - EFCA
International Union of Air Pollution Prevention and Environmental Protection Associations - IUAPPA

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP

ZAŠTITA ZRAKA 2017

ZBORNIK SAŽETAKA

Primošten, 3. – 7. listopada 2017.

Pokrovitelji:
Ministarstvo zaštite okoliša i energetike

Znanstveno-stručni odbor:
Jagoda Doko Jelinić – predsjednica
Silva Žužul
Renata Peternel
Krešimir Šega
Ivan Bešlić
Mirjana Čačković
Zdravko Špirić
Zdenko Franić
Ana Alebić Juretić
Cleo Kosanović

Organizacijski odbor:
Gordana Pehnec - predsjednica
Nina Zovko
Vladimira Vađić
Ranka Godec
Silvije Davila
Lukša Kraljević
Predrag Hercog
Vedran Vađić
Jasmina Rinkovec

Savjetodavni odbor:
Ana Lucić-Vrdoljak
Nataša Strelec Mahović
Tomislav Ćorić
Thomas Reichert
John Murlis

KAZALO

Uvodna predavanja

Tema 1 – Upravljanje kvalitetom zraka – inspekcija i nadzor

Tema 2 – Emisije onečišćenja u atmosferu

Tema 3 – Onečišćenje vanjske atmosfere – imisije

Tema 4 - Razvoj i provjera mjernih metoda

Tema 5 - Procjena izloženosti onečišćenjima u zraku i učinci na zdravlje

Tema 6 – Zaštita zraka u sustavu prostornog uređenja, graditeljstva i zaštite okoliša

Tema 7 – EFCA sekcija: "Air Quality in Europe – Current State and New Challenges"

Tema 8 – IUAPPA sekcija: Air Pollution in Cities: International Perspectives

Posteri

UVODNA RIJEČ

I ove godine Hrvatsko udruženje za zaštitu zraka nastavlja svoju dugogodišnju tradiciju organiziranja znanstveno – stručnog skupa na temu zaštite zraka. X. skup „Zaštita zraka 2017“ s međunarodnim sudjelovanjem održava se ove godine u Primoštenu, lijepom dalmatinskom gradiću poznatom po svojom zanimljivoj arhitekturi i kristalno bistrom moru.

Dokaz zainteresiranosti stručne javnosti, domaće i inozemne, o sve prisutnijem problemu onečišćenja zraka koje ima utjecaj na zdravlje ljudi i okoliš je veliki broj prijavljenih sudionika te 65 prijavljena izlaganja, prikazanih u ovom zborniku sažetaka.

Svakodnevne aktivnosti praćenja kvalitete zraka zahtijevaju znanje, iskustvo, odgovarajuću opremu, primjenu zakonske regulative... Na skupu „Zaštita zraka 2017“ sudionici će prezentirat iskustva i probleme s kojima se susreću u svom radu kroz slijedeće teme:

1. Upravljanje kvalitetom zraka – inspekcija i nadzor
2. Emisije onečišćenja u atmosferu
3. Onečišćenje vanjske atmosfere – imisije
4. Razvoj i provjera mjernih metoda
5. Procjena izloženosti onečišćenjima u zraku i učinci na zdravlje
6. Zaštita zraka u sustavu prostornog uređenja, graditeljstva i zaštite okoliša
7. EFCA sekcija “Air Quality in Europe – Current State and New Challenges“
8. IUAPPA sekcija “Air Polllution in Cities: International Perspectives“

Veliko zadovoljstvo nam je najaviti EFCA sekciju, koja se po treći puta organizira pod pokroviteljstvom Europske federacije udruženja za čisti zrak i zaštitu okoliša (European Federation of Clean Air and Environmental Protection Associations) kao i novu, IUAPPA sekciju, pod pokroviteljstvom Međunarodne unije udruženja za zaštitu zraka i okoliša (International Union of Air Pollution Prevention and Environmental Protection Associations)

Pozitivna iskustva prethodno održanih skupova daju nadu u uspješnost i ovog skupa. Svim sudionicima želimo uspješno izlaganje, korisne izmjene iskustva, plodonosne rasprave i ugodno druženje.

Jagoda Doko Jelinić i *Gordana Pehnec*

FOREWORD

The Croatian Air Pollution Prevention Association continues its longstanding tradition of organising scientific and professional conferences on air protection. The tenth edition of Air Protection (2017) with international participation is held this year in Primošten, a beautiful Dalmatian town known for its astounding architecture and crystal-clear sea.

The large number of participants and the 65 submitted presentations in this Book of Abstracts clearly prove that both the international and domestic professional community are more than interested to learn about and discuss the ever-growing and threatening impact of air pollution on human health and the environment. As we are all aware, the everyday activities of regular air quality monitoring require knowledge, experience, adequate equipment, good legislation, as well as many other factors to coincide and fall into place. The participants of the Air Protection 2017 conference will present their experiences and the issues they encounter in their work through the following topics:

1. Managing air quality – inspection and control
2. Atmospheric emissions of pollutants
3. Monitoring ambient air pollution
4. Developing and testing measuring methods
5. Estimating exposure to air pollutants and impact on health
6. Air Protection in physical planning, construction, and environmental protection
7. EFCA session "Air Quality in Europe – Current State and New Challenges"
8. IUAPPA session "Air pollution in Cities: International Perspectives"

It is our great pleasure to announce the EFCA session, organised for the third time under the auspices of the European Federation of Clean Air and Environmental Protection Associations (EFCA), as well as a new session under the auspices of the International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA).

Positive memories from previous conferences assure us that this year's edition will be just as successful. We wish all of the participants a fruitful professional stay and a lovely time in Primošten.

Jagoda Doko Jelinić and *Gordana Pehnec*

Uvodna predavanja

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Kertész, Z.[1,2], Angyal, A.[1], Bétéri, G.[2], Furu, E.[1], Major, I.[2], Papp, E.[1], Szikszai, Z.[1], Szoboszlai, Z.[1], Török, Z.[1], Molnár, M.[2]

SOURCES OF PARTICULATE MATTER POLLUTION IN FIVE HUNGARIAN CITIES

Keywords: *urban particulate matter pollution, elemental composition, TC/EC/OC, fossil and modern carbon, source apportionment, transboundary contributions*

In this work, the concentration, composition, and sources of atmospheric aerosol pollution were studied in five Hungarian cities. Daily $PM_{2.5}$ and PM_{10} samples were collected simultaneously two times a week at three urban background (Debrecen, Budapest, Pécs) and two traffic sites (Miskolc, Nyíregyháza) from January to August 2015. At each site, 62-65 $PM_{2.5}$ and PM coarse samples were gathered using Gent-type stacked filter units. In the heating season, another 12 PM_{10} samples were collected per site on pre-baked quartz filters with high volume samplers for EC/OC and C-14 analysis. The PM mass was weighted on a microbalance, elemental composition for Z > 11 and determined by PIXE. Black carbon (BC) content was measured with a light reflectance technique, EC/OC content was quantified using a Sunset Laboratory EC/OC analyser, and the radiocarbon characterization of the samples was done at the EnviroMicadas accelerator mass spectrometer of Atomki. Source apportionment was carried out using the EPA PMF5.0 receptor model in combination with backward trajectory calculations by the NOAA HYSPLIT dispersion model. Seasonal variation, similarities, and differences in concentration, composition, source profiles, and the time pattern of source contributions were studied for differences in geographical locations and site types. Several local, regional, and long-range transport emission episodes were identified during the sampling period. For instance, in April 2015 three different dust episodes were distinguished by different trace element composition and concentration ratios: one was a local dust storm that appeared only in East Hungary, the second one was a Saharan dust intrusion detected at all of the locations and the third was desert dust from middle Asia observed also in the whole country.

Acknowledgement:
This work was prepared within the frame of the János Bolyai Research Fellowship of the Hungarian Academy of Sciences. The research was supported by the European Union and the State of Hungary, co-financed by the European Regional Development Fund in the project of GINOP-2.3.2.-15-2016-00009 'ICER'.

[1] Laboratory of Ion Beam Physics, Institute for Nuclear Research, Hungarian Academy of Sciences, H-4026 Debrecen, Bem tér 18/c, Hungary
[2] Isotope Climatology and Environmental Research Centre, Institute for Nuclear Research, Hungarian Academy of Sciences, H-4026 Debrecen, Bem tér 18/c, Hungary

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Stafilov, T.[1], Špirić, Z.[2]

NADZOR ONEČIŠĆENJA ZRAKA U MAKEDONIJI I HRVASTKOJ KORIŠTENJEM BIOMONITORINGA MAHOVINAMA

Ključne riječi: *onečišćenje zraka, teški metali, biomonitoring mahovinama, rizici za zdravlje i okoliš, Makedonija, Hrvatska*

Antropogene promjene okoliša, povezane uglavnom s kemijskim onečišćenjem, dovode do degradacije prirodnog ljudskog okoliša. Od svih kemijskih zagađivača, teški metali (čak i u tragovima) su od posebnog ekološkog, biološkog i zdravstvenog značaja. Proizvodnja energije i prekomjerno/nekontrolirano korištenje prirodnih resursa su glavni izvor teških metala kao zagađivača. Međutim, i poljoprivredne aktivnosti, posebno primjena gnojiva i pesticida, također značajno doprinose onečišćenju metalima u okolišu. Stoga se sustavni nadzor onečišćenja zraka teškim metalima provodi od 2000./2005. godine na cjelokupnom teritoriju Makedonije i Hrvatske u okviru međunarodnog programa suradnje za proučavanje učinaka onečišćenja zraka na prirodnu vegetaciju (UNECE ICP vegetacija).

Uzorci mahovina prikupljeni su tijekom 2000-2015. na lokacijama koje su ravnomjerno raspoređene po cijeloj Makedoniji i Hrvatskoj s dodatnim uzorcima u velikim urbanim / industrijskim područjima. Koncentracije elemenata u mahovinama određene su korištenjem NAA, ICP-AES i AAS. Također, korištenjem Kjeldahlove analitičke metode utvrđena je koncentracija dušika u prikupljenim uzorcima. Na temelju rezultata mjerenja priređene su karte prostorne i vremenske raspodjele onečišćenja zraka u Makedoniji i Hrvatskoj.

Opći cilj ovog rada je ukazati na potrebu i važnost nastavka provedbe sustavnih multidisciplinarnih znanstvenih istraživanja u cilju boljeg razumijevanja ekoloških i zdravstvenih rizika kao posljedice onečišćenja zraka na lokalnoj, regionalnoj i globalnoj razini.

[1] Institute of Chemistry, Faculty of Natural Sciences and Mathematics, Ss Cyril and Methodius University, Arhimedova 5, 1000 Skopje, Makedonija,
[2] Zelena infrastruktura d.o.o., Fallerovo šetalište 22, HR-10000 Zagreb, Croatia

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Stafilov, T.[1], Špirić, Z.[2]

AIR POLLUTION CONTROL IN MACEDONIA AND CROATIA BY MOSS BIOMONITORING

Keywords: *air pollution, heavy metals, moss biomonitoring, health and environmental risks, Macedonia, Croatia*

Anthropogenic environmental changes, associated mainly with chemical pollution, lead to a degradation of the natural human environment. Among chemical pollutants, trace elements are of special ecological, biological, and health significance. The production of energy and the consumption of natural resources are the main source of trace elements as contaminants. However, agricultural activities, especially the application of fertilisers and pesticides, also contribute significantly to trace metal pollution in the environment. Soil, as a part of the ecosystem, is vital for the survival of mankind which is closely connected to its productivity. Therefore, surveys of the air pollution by heavy metals on the territories of Macedonia and Croatia were performed within the framework of the International Cooperative Programme for the study of the effects of air pollution on natural vegetation and crops (UNECE ICP Vegetation) since 2000 and 2005, respectively.

For that purpose, terrestrial moss samples were collected at locations evenly distributed all over Macedonia and Croatia. Various spectrometric (atomic absorption spectrometry, inductively coupled plasma – atomic emission spectrometry, and inductively coupled plasma – mass spectrometry) and radioanalytical (neutron activation analysis) techniques were applied. Air pollution was investigated by the application of moss biomonitoring and dust samples (attic dust and house-hold dust). Pollution with heavy metals in particular regions was additionally investigated. It was found that the highest pollution is present in areas with abandoned or active mines, metallurgical plants, or thermoelectrical power plants. High content of some heavy metals was also found in areas were their contents usually vary gradually across the geochemical landscape and depend on the geochemistry of the underlying lithology. The distributions of such elements reflect natural processes indicated by elements that are either rarely or never involved in industrial processes. The obtained data were statistically processed and spatial and temporal distribution maps for each specific element were prepared to yield a proper interpretation of the obtained results.

The overall aim of this paper is to further initiate, develop, and strengthen comprehensive systematic multidisciplinary scientific research as the key to achieving a better understanding of the environmental and health risks that result from air pollution on a local, regional, and global scale.

[1] Institute of Chemistry, Faculty of Natural Sciences and Mathematics, Ss Cyril and Methodius University, Arhimedova 5, 1000 Skopje, Macedonia,
[2] Green Infrastructure Ltd., Fallerovo šetaliste 22, HR-10000 Zagreb, Croatia

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Song, J.H.[1], Kang, J.-H.[1], Hwang, I.J.[2]

APPLICATIONS OF ODOUR CONTROL METHODS TO COLLECTION SYSTEMS FOR DOMESTIC FOOD WASTE

Ključne riječi: *food waste, odour unit, odour control, chemical scrubber, bioscrubber*

A vacuum pipeline system to collect domestic food waste has been installed and operated at a newly-developed town in Korea. The automated vacuum system was built to handle domestic food waste that was discharged from 129 drop chutes and load stations located residential households and commercial buildings. The vacuum system was designed to convey the domestic waste of approximately 8.5 ton/day through the underground pipelines using an airflow of 350 m3/min. The airflow, which was withdrawn through the underground pipeline to the waste handling station, contained malodourous compounds and dusts. The predominant compounds based on their odour intensities were found to be acetaldehyde, methyl mercaptan, and trimethylamine. The relative strength of the odour, determined in terms of a dilution to threshold (D/T) by a five-odour-panel assessment, ranged from 1,440 to 10,000 odour units (OU/m^3). In order to control the odour and dust problems, an air treatment module, consisted of a bag filter, a chemical scrubber, and a bioscrubber in series, was installed in the waste handling station. A sodium hydroxide solution was used in the chemical scrubber to improve the solubility of acidic compounds, and a mixture of microbial strains and a nutrient solution were applied to the bioscrubber. After an adaptation period, odour removal efficiencies were found to be more than 90 %. The engineered system was successfully operated more than two years without any operational failures. This finding suggests that the combined chemical and biological methods are required to abate high-strength malodour with various compounds emitted from domestic, food waste facilities.

[1] Department of Civil and Environmental Engineering, Sejong University, Gwangjin-gu, Seoul, 05006, Korea
[2] Department of Environmental Engineering, Daegu University, Gyeongsan, Gyeongbuk, 38453, Korea

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Vađić, V.[1], Pehnec, G.[1]

MEĐUNARODNE AKTIVNOSTI HRVATSKOG UDRUŽENJA ZA ZAŠTITU ZRAKA

Ključne riječi: *EFCA, HUZZ, IUAPPA, povijesni pregled*

Hrvatsko udruženje za zaštitu zraka (HUZZ) okuplja znanstvenike i stručnjake u svrhu zaštite i promicanja zajedničkih strukovnih interesa iz područja zaštite zraka od onečišćenja, a pod ovim imenom djeluje od 1993. godine. Međutim, počeci rada udruge vezani su uz osnivanje republičke sekcije za SR Hrvatsku u sklopu Jugoslavenskog društva za čistoću zraka 1973. godine u Zagrebu. Kasnije se iz republičke sekcije razvilo Društvo za zaštitu zraka SR Hrvatske, a nakon raspada Jugoslavije i međunarodnog priznanja Hrvatske 1992. godine udruga počinje djelovati samostalno. Hrvatsko udruženje za zaštitu zraka iste je godine na svjetskom kongresu u Montrealu u Kanadi, primljeno u Međunarodnu uniju udruženja za zaštitu zraka (IUAPPA) te je postalo njen punopravni član. IUAPPA je osnovana 1964. godine te okuplja nacionalna udruženja iz cijelog svijeta s ciljem razmjene znanstvenih i stručnih informacija te razvijanja učinkovitih politika za prevenciju i smanjenje onečišćenja zraka. U skladu sa svojim ciljevima IUAPPA svake tri godine organizira svjetski kongres o zaštiti zraka, kao i brojne druge skupove i sastanke. Europska federacija udruženja za čisti zrak i zaštitu okoliša (EFCA) osnovana je 1997. godine na inicijativu europskih članova IUAPPA-e kao neprofitna, nevladina i nepolitička federacija nacionalnih udruženja iz Europe u području zaštite zraka i okoliša od onečišćenja. Federacija je posvećena razvijanju znanja o okolišu, a njen poseban cilj je približavanje znanstvenih spoznaja s europskom politikom rješavanja problema zaštite zraka. HUZZ je član EFCA-e od 1998. godine.

Članovi HUZZ-a aktivno su sudjelovali na međunarodnim skupovima i sastancima iz područja zaštite zraka i mnogo prije formalnog primitka Udruženja u međunarodne organizacije. Prikazani su glavni događaji koji su prethodili primitku HUZZ-a u IUAPPA-u i EFCA-u te je dan pregled međunarodnih aktivnosti Udruženja u posljednjih 25 godina.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska cesta 2, Zagreb

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Vađić, V.[1], Pehnec, G.[1]

THE INTERNATIONAL ACTIVITIES OF THE CROATIAN AIR POLLUTION PREVENTION ASSOCIATION

Keywords: *CAPPA, EFCA, historical overview, IUAPPA*

The Croatian Air Pollution Prevention Association (CAPPA) gathers scientists and professionals devoted to the protection and promotion of common professional goals in the field of air protection. Although CAPPA has acted under this name since 1993, its origin traces back to the foundation of the Republic Section for Croatia within the Yugoslavian Association for Clean Air in 1973 in Zagreb. Later the Republic Sections became Republic Associations for Air Protection, and after the breakup of Yugoslavia and international recognition of Croatia in 1992, CAPPA started to act as an independent association. That same year, at the World Clean Air Congress in Montreal, Canada, CAPPA was admitted into the International Union of Air Pollution Prevention and Environmental Protection Association (IUAPPA) as a full member. IUAPPA was founded in 1964 and gathers national associations from across the world to share scientific and technical information to help develop more effective air pollution control policies. In pursuit of its objectives, IUAPPA organizes the World Clean Air Congress as well as many others regional assemblies and meetings. The European Federation of Clean Air (EFCA) was founded in 1997 on the initiative of European IUAPPA members as a non-political, non-governmental, and non-profit federation of European national associations active in the field of air pollution control and environmental protection. The Federation is committed to the advancement of environmental science and aims at working at the very interface of science and European policy on air pollution problems.

CAPPA members have participated actively at international conferences and meetings from the field of air protection long before its formal acceptance in international associations. The main events that preceded CAPPA's admittance into IUAPPA and EFCA are presented as well as an overview of international activities over the last 25 years.

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Vidič, S.[1]

50 GODINA ISTRAŽIVANJA KVALITETE ZRAKA U DRŽAVNOM HIDROMETEOROLOŠKOM ZAVODU

Ključne riječi: *kvaliteta zraka, istraživanje atmosferskih procesa, mjerenje, modeliranje*

Dan je pregled istraživačkih aktivnosti Državnog meteorološkog zavoda u području kvalitete zraka u razdoblju od sredine 60-tih godina prošloga stoljeća do danas. Iako su se istraživanja najvećim dijelom provodila kao rezultat potreba gospodarstva, mnogobrojne studije i analize imale su kao podlogu bazična istraživanja atmosferskih procesa i pojava. Gledano iz današnje perspektive tematska područja istraživanja možemo grupirati po dekadama. Od 60-tih do 80-tih godina prošloga stoljeća značajna su se sredstva ulagala u eksperimentalna mjerenja i temeljna istraživanja atmosferskih procesa i razvoj metodologija. Glavno obilježje ovoga razdoblja bilo je razvoj i primjena atmosferskih disperzijskih modela u svrhu kvantifikacije utjecaja emisijskih izvora, prvenstveno termoenergetskih i industrijskih, optimizacije visine dimnjaka i slično. Paradigmu disperzijskog modeliranja zamijenila je paradigma atmosfere kao globalnog kontinuuma koja se krajem 70-tih i početkom 80-tih godina razvila pod teretom posljedica zakiseljivanja okoliša, odumiranja biljnog i životinjskog svijeta u jezerima i propadanja šuma i osjetljivih ekosustava. Istraživanja su proširena na skalu regionalnog i daljinskog prijenosa onečišćenja budući da se shvatilo da su za nepoželjne pojave u okolišu zaslužni velikim dijelom izvori emisija izvan područja gospodarskog i političkog utjecaja pojedine zemlje. Posljedično, područje zaštite okoliša je potaknulo intenzivnu međunarodnu stručnu, znanstvenu i političku suradnju kako bi se postigli ciljevi učinkovitog smanjivanje emisija na području Europe. Treće razdoblje, od 90-tih godina do danas može se smatrati „hibridnim“ razdobljem koje obilježava primjena metoda modeliranja lokalnih procesa, modeliranje regionalnih utjecaja i daljinskog prijenosa onečišćenja kao i uvođenje obveznih programa mjerenja kvalitete zraka prema zadanim programima i kriterijima. Sve Europske zemlje u tom su razdoblju razvile pravni okvir u području zaštite zraka i uspostavile sustave u kojem se rezultati atmosferskih istraživanja koriste kao podloga za donošenje odgovarajućih mjera i politika u zaštiti zraka i okoliša. Istraživanja u Državnom hidrometeorološkom zavodu pratila su ovaj razvoj koji danas ima težište na primjeni atmosferskih modela i sintezi rezultata mjerenja i modeliranja s ciljem ostvarivanja učinkovitije zaštite okoliša. U radu su prikazani primjeri istraživanja karakteristični za pojedinu fazu razvoja zaštite zraka u Hrvatskoj i Europi.

[1] Državni hidrometeorološki zavod, Grič 3, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Vidič, S.[1]

50 YEARS OF AIR QUALITY RESEARCH AT METEOROLOGICAL AND HYDROLOGICAL SERVICE OF CROATIA (MHSC)

Keywords: *air quality, research of atmospheric processes, monitoring, modelling*

In this paper, the overview of air quality research activities at MHSC since the mid-sixties is presented. Even though there was a request that research should support the needs of economic development, most of the early projects and studies were based on fundamental and theoretical research of atmospheric processes. From today's perspective, research prevalence can be identified decade-wise. Between sixties and eighties of the last century considerable number of projects were based on field experiments, theoretical studies of atmospheric processes and targeted measurements. Pollution transport and dispersion studies were supported by industry and energy sectors in expansion with the motivation to secure air quality protection in the vicinity of emission stacks. This paradigm changed in the late seventies and early eighties in connection with the newly recognised distressing environmental issues – acid rain, acidification end eutrophication of environment, extinction of life in lakes, dying forests. It has been realised that short-term local solutions of dispersion modelling created long-term continental air pollution problems. As a result, environmental topics broadened, research activities encompassed aspects of regional and long-range transboundary transport of air pollutants and general awareness developed that atmosphere is continuum absorbing and transmitting pollutants regardless the place of its origin. Consequently, strong and long-lasting international scientific, research and political cooperation have developed with the goal to enable science-oriented political decision-making platform for emission reduction strategies in Europe. The third period, from early nineties till now covers the full range of research activities in atmospheric sciences. It is characterised with extensive use of atmospheric numerical models of different spatial and temporal scales, higher and higher spatial grid resolutions and nesting. It includes urban scale models, road transport models, dispersion models, source-receptor models, source apportionment models, integration of measurements and model calculations, validation of used methodologies. MHSC has followed and participated in this development. In this work, we present results and examples of our research activities over the period of last fifty years with reflection on periods characteristic for different phases of air protection policy development in Croatia and worldwide.

[1] Meteorological and Hydrological Service, Grič 3, 10000 Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Pezelj - Meštrić, S.[1], Šimunić, S.[1]

ULOGA INSPEKCIJE ZAŠTITE OKOLIŠA U SUSTAVU PRAĆENJA KVALITETE ZRAKA

Ključne riječi: *inspekcija zaštite okoliša, kvaliteta zraka, Zakon o zaštiti zraka*

Provedba i inspekcijski nadzor u području praćenja kvalitete zraka u Republici Hrvatskoj regulirani su Zakonom o zaštiti zraka („Narodne novine“ br. 130/11, 47/14 i 61/17). Inspekcija zaštite okoliša ovlaštena je nadzirati industrijska postrojenja, ispitne laboratorije te jedinice lokalne i regionalne samouprave. Nadzor praćenja kvalitete zraka je opsežan i zahtjevan postupak, a od inspektora zaštite okoliša očekuje se poznavanje tehničkih propisa, propisa iz područja zaštite okoliša te iskustvo iz prakse. Kako bi se unaprijedili inspekcijski nadzori, postigla učinkovitija i funkcionalnija kontrola sa svrhom postizanja bolje kvalitete zraka u Hrvatskoj, Uprava za inspekcijske poslove sudjeluje u projektu financiranom sredstvima Europske unije, IPA 2013.

[1] Ministarstvo zaštite okoliša i energetike, Radnička c. 80, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Pezelj - Meštrić, S.[1], Šimunić, S.[1]

ROLE OF ENVIRONMENTAL INSPECTION IN MONITORING OF AIR QUALITY SYSTEM

Keywords: *environmental inspector, air quality, Air Quality Act*

Enforcement and inspection in the area of air quality monitoring in Republic of Croatia are regulated by Air Protection Act (Official Gazette 130/11, 47/11 and 61/17). Environmental inspection is authorized to inspect industrial installations, testing laboratories, local and regional authorities. Inspection of air quality monitoring is very demanding and comprehensive process, it requires experienced and skilled inspectors, together with good knowledge of technical standards, environmental legislation and practical experience. In order to improve environmental inspections, to achieve more efficient and functional controls, with purpose to achieve better air quality in Croatia, Directorate for Inspectional Affairs participates in a project funded by the European Union under the IPA 2013.

[1] Ministry of Environment and Energy, Radnička c. 80, Zagreb, Croatia

Tema 1
Upravljanje kvalitetom zraka – inspekcija i nadzor

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Pejaković D.[1]

AKCIJSKI PLANOVI ZA POBOLJŠANJE KVALITETE ZRAKA

Ključne riječi: *akcijski planovi, kvaliteta zraka, izvješćivanje, okoliš*

Sukladno Zakonu o zaštiti zraka (NN 130/11, 47/14) ukoliko u određenoj zoni ili aglomeraciji razine onečišćujućih tvari prekoračuju bilo koju graničnu ili ciljnu vrijednost, u svakom od tih slučajeva donosi se akcijski plan za poboljšanje kvalitete zraka za tu zonu ili aglomeraciju kako bi se, u što kraćem vremenu, osiguralo postizanje graničnih ili ciljnih vrijednosti. Informacije o akcijskim planovima predstavničko tijelo jedinice lokalne samouprave dostavlja Hrvatskoj agenciji za okoliš i prirodu u informacijski sustav zaštite zraka koristeći formate i protokole iz Odluke Komisije 2011/850/EU koje Agencija objavljuje na svojim internetskim stranicama. Pravilnik o uzajamnoj razmjeni informacija i izvješćivanju o kvaliteti zraka i obvezama za provedbu Odluke Komisije 2011/850/EU (NN 3/16) propisuje informacije o akcijskim planovima o kojima je Hrvatska agencija za okoliš i prirodu obvezna izvijestiti Europsku komisiju: informacije o planovima za poboljšanje kvalitete zraka (H), informacije o raspodjeli izvora (I), informacije o scenariju za godinu postizanja (J), informacije o mjerama za poboljšanje kvalitete zraka (K). Informacije o akcijskim planovima se odmah po donošenju dostavljaju u repozitorij podataka koji je uspostavljen od Europske komisije u suradnji s Europskom agencijom za zaštitu okoliša, a najkasnije u roku od dvije godine od kraja one godine u kojoj je utvrđeno prekoračenje. Plan se obično donosi na više godina, međutim, svake godine se Europska komisija izvješćuje o provedbi višegodišnjeg plana. Plan može obuhvaćati jednu ili više zona te sadržavati mjere za snižavanje razina koncentracija jedne ili više onečišćujućih tvari (jedno ili više prekoračenja). Hrvatska agencija za okoliš i prirodu do sada je dostavila Europskoj komisiji informacije o sljedećim akcijskim planovima, donesenim na lokalnoj razini: Akcijski plan za smanjivanje razina koncentracija lebdećih čestica PM_{10} na području Grada Siska (siječanj, 2014.), Akcijski plan za poboljšanje kvalitete zraka na području Grada Zagreba (ožujak, 2015.), Akcijski plan smanjenja onečišćenja česticama (PM_{10}) za Grad Osijek (srpanj, 2015.), Akcijski plan smanjenja emisija PM_{10} u Gradu Kutini (prosinac, 2015.), Akcijski plan za smanjenje onečišćenja prizemnim ozonom za Grad Rijeku (travanj, 2016.), Akcijski plan poboljšanja kvalitete zraka za Grad Slavonski Brod (srpanj, 2016.). Godina 2013. je referentna godina prvog prekoračenja za sve navedene planove.

[1] Hrvatska agencija za okoliš i prirodu, Radnička 80/7, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Pejaković D.[1]

AIR QUALITY PLANS

Keywords: *air quality plans, air quality, reporting, environment*

According to the Air Protection Act (OG 130/11, 47/14) air quality plans should be developed for zones and agglomerations within which concentrations of pollutants in ambient air exceed the relevant air quality target values or limit values so that the exceedance period can be kept as short as possible. Information on air quality plans have to be submitted by local authorities to the Air Quality Information System using the formats and protocols of the Commission Decision 2011/850/EU that the Croatian Agency for the Environment and Nature publishes on its website. According to Ordinance on the reciprocal exchange of information and air quality reporting requirements under the 2011/850/EU Commission Implementing Decision (OG 3/16) the mandatory elements of the air quality plans which Croatian Agency for the Environment and Nature submits to European Commission are: information on air quality plans (H), information on source apportionment (I), information on the scenario for the attainment year (J), information on measures (K). Those plans shall be communicated to the Commission without delay, but no later than two years after the end of the year the first exceedance was observed. A plan usually covers several years (multiannual); however, every year it must be sent to data repository, that has been established by European Commission in cooperation with the European Environment Agency, the annual follow up of the multiannual Plan. The plan can be targeted to one or more zones, containing measures to reduce the levels of one or more pollutant (one or many exceedance situations). Croatian Agency for the Environment and Nature submitted to European Commission the following information on local air quality plans: Action plan for reducing concentration PM_{10} in Sisak City (January '14), Action plan for air quality improving in Zagreb City (March '15), Action plan for reducing particulate matter pollution (PM10) in Osijek City (July '15), Action plan for reducing PM_{10} emission in Kutina City (December '15), Action plan for reducing ground level ozone pollution in Rijeka City (April '16), Action plan for air quality improving in City of Slavonski Brod (July '16). Reference year of first exceedance was 2013.

[1] Croatian Agency for the Environment and Nature, Radnička 80/7, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Bobić, V. [1]

VJEŠTAČENJE U ZAŠTITI OKOLIŠA-OSIGURANJE DOKAZA, MJERENJA, ZAKONODAVSTVO I SUDSKI POSTUPAK

Ključne riječi: *vještačenje, osiguranje dokaza, mjerenja, sudski postupak, imisije, ekološka tužba*

Ustavom Republike Hrvatske je propisano kako su, među ostalim, očuvanje prirode i čovjekova okoliša najviše vrednote ustavnog poretka Republike Hrvatske. Također, propisano je da država osigurava uvjete za zdrav okoliš te da je svatko dužan u sklopu svojih ovlasti i djelatnosti, osobitu skrb posvećivati zaštiti zdravlja ljudi, prirode i ljudskog okoliša. Zakon o zaštiti okoliša, Nacionalna strategija zaštite okoliša i Nacionalni plan djelovanja na okoliš te niz podzakonskih akata trebali bi osiguravati u Hrvatskoj pravo svakog građanina na zdrav okoliš koje je izraženo i u Ustavu jer zdrav okoliš je osnovni preduvjet kvalitete života i očuvanja zdravlja čovjeka.

Utvrditi da li je tako u praksi i u kojoj mjeri građani Republike Hrvatske u okviru građansko pravne zaštite okoliša mogu računati na očuvanje svog zdravlja na temelju postojećih zakonskih akata, sudskog postupka i vještačenja stručnjaka za pojedina područja, cilj je ovog rada.

Osiguranje dokaza u postupku tužbe zbog imisija, smetanja posjeda odnosno u postupku ekološke tužbe obuhvaća poznavanje niza činjenica i stručnih mjerenja koja jedino mogu biti temelj za dokazivanje negativnog utjecaja na okoliš. Upravo u tom dijelu sudskog postupka tuženik, posjednik izvora opasnosti (najčešće pravna osoba) ne samo da neće staviti na raspolaganje potrebne podatke već će pokušati primarno osporiti nalaze mjerenja kao i nalaz mišljenje vještaka te će često promijeniti i tijek i intenzitet samog tehnološkog procesa kako bi rezultati mjerenja i utvrđivanja činjenica išli njemu u korist. Iz tog razloga bilo bi nužno da sudski vještaci pojedinih struka koji su pozvani od suda za ocjenu dokaza imaju iskustvo u radu akreditiranih i ovlaštenih mjeritelja kao i iskustvo u provođenju samog postupka mjerenja imisija odnosno pojedinih štetnih tvari koje su predmet tužbe.

Sud bi trebao biti upoznat s činjenicom da tuženik može utjecati na osiguranje dokaza na način da mijenja sastavnice tehnoloških procesa (različitih proizvodnih pogona, ložišta, otpadnih voda, vrsta otpada) i na temelju tih saznanja voditi sudski postupak na način da takve namjere spriječi. Bez tih preduvjeta – stručnosti vještaka, sprečavanja utjecaja na osiguranje dokaza i znanja suda o tim procesima građani Republike Hrvatske neće moći u svojim tužbama uspjeti osigurati uvjete za zdrav život iako im to, bar deklarativno, pružaju i Ustav RH i niz zakonskih akata.

[1] Stalni sudski vještak zaštite okoliša i zaštite na radu

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Bobić, V.[1]

EXPERTISE IN ENVIRONMENTAL PROTECTION – EVIDENCE ASSURANCE, MEASUREMENTS, LEGISLATION AND JUDICAL PROCEEDING

Keywords: *expert witnessing, evidence assurance, measurements, court proceedings, immissions, ecological lawsuit*

The Constitution of the Republic of Croatia stipulates that, among other things, the preservation of nature and human environment is the highest value of the constitutional order of the Republic of Croatia. It is also prescribed that the state provides conditions for a healthy environment, and that everyone is obliged, within their authority and activities, particular care should be devoted to the protection of human health, nature and the human environment. The Environmental Protection Act, the National Environmental Strategy and the National Environmental Action Plan, and a series of legal acts, should ensure the right of every citizen to a healthy environment in Croatia, as expressed in the Constitution, because a healthy environment is a basic prerequisite for quality of life and human health preservation.

Determining whether the citizens of the Republic of Croatia, within the framework of civil legal protection, can count on preserving their health based on existing legal acts, court proceedings and expertise in specific areas, is the goal of this paper.

The provision of evidence in litigation proceedings due to immissions, trespassing or the procedure of an environmental complaint involves the knowledge of a series of facts and professional measurements that can only be grounds for proving a negative impact on the environment. In this part of the judicial proceeding, the defendant, a source of pollution (usually a legal person) will not make the necessary information available but also will try to disprove the findings of the survey and the expert opinion. By changing the course and intensity of the technological process itself, the defendant will try to affect results of the measurements so established facts went in his favour. For this reason, it would be necessary for the expert witnesses of the particular profession who are called by the court, to have experience in the work of accredited and authorized persons who measure as well as the experience in conducting the measuring process itself, i.e. of the harmful substances that are the subject of the lawsuit.

The court should be aware of the fact that the defendant may influence the securing of evidence by changing the components of technological processes (different production plants, combustion plants, wastewaters, waste types) and, based on those findings, conduct the judicial proceedings in such a way as to prevent such intentions. Without these prerequisites - expertise of expert witnesses, the prevention of the influence on the provision of evidence and knowledge of the court on these processes, the citizens of the Republic of Croatia will not be able to satisfy the conditions for a healthy life in their lawsuits. Although the Constitution of the Republic of Croatia and a series of legal acts provide them all, that is at least declaratively.

[1] Expert witness for environmental protection and occupational health

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Davila, S. [1], Pečar Ilić, J.[2], Bešlić, I.[1]

UPOTREBA RAČUNALNE ARHITEKTURE U SVRHU PRAĆENJA KVALITETE ZRAKA

Ključne riječi: *kvaliteta zraka, SOMA, UML, Europa2020, informacijski sustav*

U okviru strategije Europa 2020 i njezine inicijative Digitalna agenda za Europu ističe se integracija naprednih digitalnih tehnologija u gospodarstva i društva Europske unije. Koncept „e-Okoliš" odnosi se na primjenu informacijskih i komunikacijskih tehnologija (engl. Information and Comunication Technology, ICT) za učinkovitu zaštitu okoliša, održivo upravljanje prirodnim resursima te izvješćivanje javnosti. U projektima HORIZON 2020 s temom održivog razvoja pametnih gradova primjenjuje se ICT za integriranu infrastrukturu, te smanjenje emisija stakleničkih plinova i onečišćenja zraka.

Noviju paradigmu i pomak u programskom inženjerstvu predstavlja arhitektura temeljena na uslugama (engl. Service-Oriented Architecture (usmjereno uslužna arhitektura), SOA) kojom se podiže razina apstrakcije tako da se grupiraju zajedničke funkcionalnosti poslovnih procesa te se izlažu kao novi sloj usluga (Web-usluge). SOA omogućuje učinkovit (brz i relativno jeftin) razvoj aplikacija temeljenih na slabo povezanim i složenim uslugama sastavljenim od jednostavnijih višekratno upotrebljivih usluga. Kao jedna od najraširenijih metoda istaknuta je IBM SOMA (engl. Service Oriented Modeling and Architecture (Usmjereno modeliranje usluga i arhitektura sustava)) jer propisuje najbolju razinu aktivnosti, koraka te ulaze i izlaze za pojedine faze oblikovanja uslužno usmjerene arhitekture sustava.

U razvoju složenih uslužno usmjerenih informacijskih sustava, IBM SOA referentna arhitektura može se koristiti kao temeljna polazišna arhitektura te time doprinijeti učinkovitijoj izgradnji konačne arhitekture sustava. U znanstvenoj i stručnoj literaturi najčešće se opisuju poslovni informacijski sustavi (engl. Enterprise SOA). Ističu se primjeri detaljnog opisa primjene SOMA metode za razvoj uslužno usmjerene arhitekture sustava iz bankarskog sektora te opisom primjene UML (Unified Modeling Language, Jedinstveni jezik za modeliranje) / SoaML jezika (Jezik za modeliranje usluga orijentirane arhitekture) za proces spajanja zrakoplova s izlaznom postajom na zračnoj luci.

Međutim, malobrojni su primjeri razvoja specijaliziranih informacijskih sustava temeljenih na SOA-i za potrebe složenih problemskih domena kojoj pripada i upravljanje kvalitetom zraka. Kao primjer iz održivog upravljanja okolišem u radu je opisan pristup razvoja višeslojne arhitekture sustava s izraženim dinamičkim ponašanjem primjenjujući UML dijagramske tehnike za formalni opis. Također, upotrebom SOMA metode po prvi put je opisana arhitektura realiziranog informacijskog sustava za praćenje kvalitete zraka u stvarnom vremenu.

[1]Institut za medicinska istraživanja i medicinu rada, Ksaverska cesta 2, Zagreb, Hrvatska
[2]Institut Ruđer Bošković, Bijenička c. 54, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Davila, S. [1], Pečar Ilić, J.[2], Bešlić, I.[1]

THE PURPOSE OF COMPUTER ARCHITECTURE IN AIR QUALITY MONITORING

Keywords: *Air quality, SOMA, UML, Europa2020, information system*

Within the Europe 2020 Strategy and its Digital Agenda for Europe initiative, the emphasis is on the integration of advanced digital technologies into the economies and society of the European Union. The concept of "e-Environment" refers to the use of Information and Communication Technology (ICT) for efficient environmental protection, sustainable management of natural resources and reporting to the public. In the "Horizon 2020" projects with the theme of sustainable development of smart cities, ICT for integrated infrastructure and the reduction of greenhouse gas emissions and air pollution are applied.

The newer paradigm and shift in program engineering is Service-Oriented Architecture (SOA), which raises the level of abstraction by grouping common business process functionality and expanding as a new layer of services (Web Services). SOA enables effective (fast and relatively inexpensive) development of applications based on poorly-connected and complex services made up of simpler, more-used services. As one of the most widely used methods, IBM SOMA (Service Oriented Modelling and Architecture) is featured, as it provides the best level of activity, steps, and inputs and outputs for each phase of service-oriented system architecture.

In developing complex, service-oriented information systems, the IBM SOA reference architecture can be used as a basic starting architecture, thus contributing to more efficient building of the ultimate architecture of the system. In the scientific and professional literature, business information systems (Enterprise SOA) are most often described. Examples of the detailed description of the application of the SOMA Method for the Development of Service-Oriented System Architecture from the Banking Sector are highlighted, as well as the description of the UML (Unified Modeling Language) / SoaML Language Application for Aircraft Connection Process at the Outbound Station at the Airport.

However, there are few examples of the development of specialized information systems based on SOAs for the needs of complex problem domains to which the quality of air management also belongs. An example of sustainable work environment management is the approach to developing a multilayer architecture system with a strong dynamic behaviour using UML diagrammatic techniques for formal description. Also, using the SOMA method for the first time, the architecture of a real-time information system for real-time air quality monitoring is described.

[1]Institute for Medical Research and Occupational Health, Zagreb, Ksaverska c. 2, Croatia
[2]Ruđer Bošković Institute, Bijenička c. 54, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Hercog, P.[1], Abramović B.[1], Peternel, R.[2], Vađić V[1]

MJERENJA NH_3, H_2S I MERKAPTANA U REPUBLICI HRVATSKOJ REGULATIVA I PRAKSA

Ključne riječi: *NH_3, H_2S, merkaptani, indikativna mjerenja, kvaliteta zraka*

U posljednjih nekoliko godina ispitni laboratorij tvrtke EKONERG zaprimio je veliki broj upita za mjerenja amonijaka (NH_3), sumporovodika (H_2S) i merkaptana po odredbama članka 32 (rješenja o okolišnoj dozvoli, prihvatljivosti zahvata za okoliš ili rješenja o objedinjenim uvjetima zaštite okoliša koja izdaje Ministarstvo zaštite okoliša i energetike) i članka 33 (sumnja na prekomjerno onečišćenje) Zakona o zaštiti zraka. Većina upita odnosi se na diskontinuirana mjerenja u trajanju 15 do 30 dana tijekom ljetnog i zimskog razdoblja. U Pravilniku o praćenju kvalitete zraka u Prilogu 8 Ciljevi kvalitete podataka u tablici A1 propisani su minimalni obuhvat podataka i minimalna vremenska pokrivenost za indikativna mjerenja određenih onečišćujućih tvari u zraku. Međutim NH_3, H_2S i merkaptani nisu navedeni u toj tablici pa shodno tome niti nema regulatorne obaveze prema kvaliteti mjerenja ovih onečišćujućih tvari. Cilj ovoga rada je ukazati na nedorečenost regulative koja za posljedicu može imati malu vrijednost informacije o kvaliteti zraka koja se dobiva ovakvim mjerenjima, a samim time i pogrešnu informaciju o utjecaju gospodarskih subjekata na razinu onečišćenosti zraka.

Bez standardizirane minimalne vremenske pokrivenosti, slučajno ili namjerno loše odabranom dinamikom mjerenja NH_3, H_2S i merkaptana (intervali i vremenska pokrivenost), može se dobiti potpuno kriva procjena kvalitete zraka. U svrhu simulacije takvih mjerenja u ovome radu obrađeni su službeni podatci za H_2S na postajama za kontinuirani monitoring Jakuševec i SB-1. Za svaku postaju odabran je set podataka od 30 dana u ljetnom i u zimskom periodu. Na postaji Jakuševec koja je u 2015. imala 337 prelazaka satne granične vrijednosti (GV) (najveći broj prelazaka u RH te godine) obradom izabranog perioda od 30 dana u zimi i 30 dana u ljeti dobiveno je samo 7 prekoračenja satne GV. Obradom istog perioda dobiveno je 0 prekoračenja 24-satne GV, a u toj godini ih je bilo 28. Ista analiza napravljena je i za postaju SB-1. Na postaji SB-1 koja je u 2015. imala 145 prekoračenja satne GV, obradom rezultata u periodu od 30 dana zimi i 30 dana ljeti dobiveno je 9 prekoračenja satne GV. Za isti period dobiveno je 0 prekoračenja 24-satne GV, a u toj godini ih je bilo 12. Naglašavamo kako u regulativi nigdje nije navedeno kako evaluirati ovakve rezultate s obzirom da je u Uredbi o razinama onečišćujućih tvari u zraku naveden samo dozvoljeni broj prekoračenja za cijelu godinu.

Iz ove analize zaključili smo da dinamika diskontinuiranih mjerenja navedenih onečišćujućih tvari kao i evaluacija dobivenih rezultata treba biti regulatorno uređena na odgovarajući način. Jedino tako bi se indikativnim mjerenjima mogla dobiti realna slika utjecaja gospodarskih subjekata na kvalitetu zraka s obzirom na NH_3, H_2S i merkaptane.

[1]EKONERG-Institut za energetiku i zaštitu okoliša, 10000 Zagreb, Koranska 5, Hrvatska
[2]Veleučilište Velika Gorica, 10410 Velika Gorica, Zagrebačka c. 5, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Hercog, P.[1], Abramović B.[1], Peternel, R.[2], Vađić V[1]

MEASUREMENTS OF NH_3, H_2S I MERCAPTANS IN REPUBLIC OF CROATIA LEGISLATION AND PRACTICE

Keywords: *NH_3, H_2S, mercaptan, indicative measurements, air quality*

In the last few years testing laboratory of company EKONERG received large number of quote inquires for measurement of ammonia (NH_3), hydrogen sulphide (H_2S) and mercaptan with regards to paragraph 32 (environmental license) and paragraph 33 (possible extensive pollution of the air) of Croatian Air protection act. Most of inquiries were for discontinues measurement of 15 to 30 days in summer and in winter period. In Croatian Air quality Ordinance in Annex 8 Data quality objectives Table A1 minimum time coverage and minimum data capture are given for indicative measurements for number of pollutants but NH_3, H_2S and mercaptan are not mentioned in that table. This means that there are no regulatory data quality objectives for those pollutants. This paper aims to emphasize possible poor air quality assessment estimated with data gained in present discontinues measurements of NH_3, H_2S and mercaptan in Croatia, and need to introduce data quality objectives for those pollutants.

It is possible that without reasonable data quality objectives (minimum time coverage and minimum data capture) measurement of these pollutants, by accident or by purpose, give misleading results and wrong information of influence of polluters on air quality in their vicinity. In this paper we analysed official measurement results of H_2S in 2015 from continues monitoring station Jakuševec (near landfill facility) and similar station SB-1 (near oil refinery). To simulate discontinues measurement, set of H_2S concentrations for one month in winter and one in summer from these stations were analysed. On station Jakuševec (site with biggest number of H_2S limit value (LV) exceedances in Croatia in 2015) 7 exceedances of hourly limit LV and 0 exceedances of daily LV were found. Number of exceedances in 2015 on that station was 337 of hourly and 28 of daily LV. On station SB-1 9 exceedances of hourly limit LV and 0 exceedances of daily LV were found. Number of exceedances in 2015 on that station was 145 of hourly and 12 of daily LV. We emphasize that there is no legislative guideline how to assess air quality from such set of data since number of exceedances not to be exceeded are given only for whole year data set.

From this analyses we concluded that regulatory stated data quality objectives and guidelines on air quality assessment for discontinues (indicative) measurements of NH_3, H_2S and mercaptan are necessary in order to properly assess air quality and thus influence of polluters on air quality, which is main purpose of such measurements.

[1] EKONERG-Energy and Environmental Protection Institute, Zagreb, Koranska 5, Croatia
[2] University of Applied Sciences Velika Gorica, Velika Gorica, Zagrebačka c. 5, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Zubak, V.[1], Mifka, B.[1], Alebić-Juretić, A.[1,2]

TREND KONCENTRACIJA TROPOSFERSKOG OZONA U RIJEČKOM ZALJEVU - DA LI JE POTREBNA NOVA REGULACIJA OZONA?

Ključne riječi: *trend, ozon, gradijent, Riječki zaljev*

Ozon (O_3) je sekundarno onečišćenje koje nastaje iz dušikovih oksida (NO_x) i u zraku prisutnih hlapivih ugljikovodika (VOC) pri povišenim temperaturama (>20°C). Kao posljedica pojave globalnog zagrijavanja, očekuje se i porast troposferskog ozona. Prvo sustavno mjerenje ozona u Riječkom zaljevu započelo je 1999. (iako su prva kratkotrajna "snap-shot" mjerenja izvršena već u ranim 80-ima), na mjernoj stanici u širem centru grada, da bi se 2003. proširilo na 5 dodatnih stanica (Opatija, Bakarski zaljev). Analiza troposferskog ozona u Riječkom zaljevu za razdoblje 1999.-2007. pokazala je trend smanjenja, iako su trendovi u drugim dijelovima Europe pokazivali rast. Međutim, isti je trend smanjenja koncentracija ozona zabilježen i na visinskoj stanici na Puntijarki, što je potvrdilo naše rezultate. U istom su periodu zabilježena mnogobrojna prekoračenja ciljne vrijednosti za ozon (8-satni pomični prosjek) na svim, i prekoračenja AOT40 vrijednosti na većini stanica u Riječkom zaljevu. Nadalje, zbog kompleksne orografije i kružnog kretanja zračnih masa, u Riječkom zaljevu dolazi do formiranja gradijenta ozona s porastom koncentracija prema većim visinama. Daljnja analiza trenda koncentracija ozona do 2016. potpuno mijenja sliku: od 2009. godine dolazi do porasta koncentracija ozona na svim mjernim stanicama. Te su godine u Rijeci i Opatiji izmjerene najveće koncentracije ozona, unatoč činjenici da je zabilježena i najveća koncentracija NO_2 od početka mjerenja u Rijeci. Ovaj porast nije posljedica NO_x kemije, jer su koncentracije NO_2 u razdoblju nakon 2010. na istoj razini. Porast koncentracija ozona umanjuje prije spominjani gradijent ozona po visini, koji je još uvijek prisutan. Kako se ciljne vrijednosti za ozon prekoračuju na čitavom području Sredozemlja, potrebno je provesti daljnja i detaljnija ispitivanja mogućeg štetnog utjecaja ozona na vegetaciju i zdravlje čovjeka, te prema dobivenim rezultatima i prema potrebi korigirati ciljne vrijednosti za ozon.

[1]Nastavni Zavod za javno zdravstvo, Krešimirova 52a, Rijeka , Hrvatska
[2]Medicinski fakultet, Sveučilište u Rijeci, Braće Branchetta 20, Rijeka, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Zubak, V.[1], Mifka, B.[1], Alebić-Juretić, A.[1,2]

TEMPORAL TRENDS OF AIRBORNE OZONE CONCENTRATIONS IN THE RIJEKA BAY AREA, CROATIA – NEW REGULATION REQUIRED?

Keywords: *temporal trend, ozone, gradient, Rijeka Bay*

Ozone (O_3) is a secondary pollutant generated by nitrogen oxides (NO_x) and volatile organic compounds (VOC) in the atmosphere at higher temperatures (>20°C). As a result of global warming, an increase of tropospheric O_3 is expected. The first systematic monitoring of the tropospheric O_3 in the Rijeka bay area started in 1999 (though some "snap shots" were done already in the early 1980s) within the urban background station in the city centre and extended to 5 more station in 2003 (Opatija, Bakar Bay). Evaluation of airborne O_3 in these areas showed a declining temporal trend for the period 1999-2007, contrary to the European trend of increasing. The declining trend was nevertheless in agreement with data from the remote site at Puntijarka, thus providing proof for the observations. In spite of the declining trend, high numbers of 8-h moving average exceedances, as well as exceedance of AOT40 values were observed at most stations. Furthermore, complex orography and circular air mass circulation in the Rijeka Bay area were responsible for the formation of the O_3 gradient, with concentrations rising with altitude. Further analyses leading up to 2016 revealed a different situation: since 2009, an increasing trend of O_3 was observed at all of the monitoring stations. In the same year, 2009, the highest O_3 concentrations were registered in Rijeka and Opatija, in spite of the fact that NO_2 also reached the highest values ever measured in Rijeka. The increasing trend of airborne O_3 was not due to NO_x chemistry, since NO_2 levels were not changed. The increased levels of O_3 diminished the previous altitude-dependent ozone gradient, which was now less pronounced, though still existent. As a result, the number of exceedances of target values for O_3 was further increased. As the target limits for O_3 cannot be adhered to throughout the entire Mediterranean region, there is need for further research in this field regarding possible consequences on vegetation and/or human health, having in mind a revaluation of the actual target values for O_3 and adjusting them if necessary.

[1]Teaching Institute of Public Health, Krešimirova 52a, Rijeka, Croatia,
[2]Faculty of Medicine, University of Rijeka, Braće Branchetta 20, Rijeka, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Tarnik, T.[1], Babačić, M.[2], Roksa, I.[3]

UTJECAJ PRIJEDLOGA DIREKTIVE 2003/87/EC RADI POBOLJŠANJA TROŠKOVNO UČINKOVITIH SMANJENJA EMISIJA I ULAGANJA ZA NISKE EMISIJE UGLJIKA NA HEP

Ključne riječi: *revizija, EU-ETS direktiva, sektor energetike*

U ovom radu analiziran je utjecaj promjena iz prijedloga EU-ETS direktive (tzv. direktive o trgovanju emisijskim jedinicama stakleničkih plinova) i povećanja cijene EUA na poslovanje Hrvatske elektroprivrede. Promjene koje donosi EU-ETS direktiva u odnosu na treće razdoblje trgovanja, a odnose se na sektor energetike su: povećanje linearnog faktora smanjenja emisijskih jedinica u sustavu s današnjih 1,74 % godišnje na 2,2 % godišnje počevši od 2021. godine, povlačenje dijela emisijskih jedinica u rezervu kako bi se smanjio višak na tržištu i povećala cijena EUA tzv. MSR (Rezerva emisijskih jedinica) počevši od 2019. godine, nastavak dodjele besplatnih emisijskih jedinica tzv. carbon-leakage postrojenjima, dodjela besplatnih emisijskih jedinica za emisije CO_2 koje se ispuštaju u procesu proizvodnje električne energije za 10 zemalja članica EU (u koje se ubraja i Hrvatska) koje su 2013. godine imale niži BDP od 60 % prosjeka BDP-a EU, uvođenje Fonda za modernizaciju energetskog sektora i Fonda za inovacije.

[1] HEP d.d., Ulica grada Vukovara 37, Zagreb, Hrvatska
[2] HEP-Proizvodnja d.o.o., Ulica grada Vukovara 37, Zagreb, Hrvatska
[3] HEP-Proizvodnja d.o.o., TE-TO Sisak, Industrijska cesta 10, Sisak, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Tarnik, T.[1], Babačić, M.[2], Roksa, I.[3]

IMPACT OF THE DIRECTIVE 2003/87 / EC PROPOSAL AMENDMENTS FOR COST EFFECTIVE REDUCTION OF EMISSIONS AND INVESTMENTS FOR LOW CARBON EMISSIONS ON HEP

Keywords: *revision, EU-ETS directive, power sector*

This paper analyses the impact of the EU-ETS proposal (directive on emission trading system) and the increase of EUA prices on the Croatian Electric Power Industry business. The changes introduced by the EU-ETS directives in relation to the third trading period, relating to the energy sector, are: the increase of the linear emission reduction factor in the system from today's 1.74 % per annum to 2.2 % per annum starting in 2021, Part of the emission units in the reserve to reduce the surplus in the market and increase the price of the EU ETS Market Stability Reserve (MSR) starting from 2019, the continuation of the allocation of free emission units of so-called "Carbon leakage facilities", the allocation of free emission allowances for CO_2 emissions released during the electricity production process for 10 EU member states (including Croatia) which in 2013 had a lower GDP of 60 % of the EU average, the introduction of the Energy Sector Modernization Fund and the Innovation Fund.

[1] HEP d.d., Ulica grada Vukovara 37, Zagreb, Croatia
[2] HEP-Proizvodnja d.o.o., Ulica grada Vukovara 37, Zagreb, Croatia
[3] HEP-Proizvodnja d.o.o., TE-TO Sisak, Industrijska cesta 10, Sisak, Croatia

Tema 2
Emisije onečišćenja u atmosferu

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Babačić, M.[1], Roksa, I.[2], Tarnik, T.[3]

UTJECAJ DIREKTIVE O OGRANIČENJU EMISIJA ODREĐENIH ONEČIŠĆUJUĆIH TVARI U ZRAK IZ SREDNJIH UREĐAJA ZA LOŽENJE NA RAD POSTROJENJA HEP PROIZVODNJE D.O.O.

Ključne riječi: *srednji uređaji za loženje, izgaranje, granične vrijednosti emisija*

Direktiva 2015/2193 o ograničenju emisija određenih onečišćujućih tvari u zrak iz srednjih uređaja za loženje (u nastavku MCP Direktiva) usvojena je 25. studenog 2015.g. i države članice Europske Unije imaju obvezu ugraditi odredbe ove direktive u svoju regulativu najkasnije od 19. prosinca 2017. g. MCP direktiva se primjenjuje na tzv. srednje uređaje za loženje (motore s unutarnjim izgaranjem koji rade prema Otto (benzin ili plin) ili Diesel (plinsko ulje) ciklusu, te na plinske turbine i kotlove) s ulaznom toplinskom snagom jednakom ili većom od 1 MW i manjom od 50 MW, bez obzira na vrstu goriva koju upotrebljavaju.

Pomoćni kotlovi HEP Proizvodnje spadaju prema MCP direktivi u postojeće srednje uređaje za loženje. Problem zadovoljenja GVE-a propisanih MCP direktivom postoji kod izgaranja loživih ulja dosadašnje kvalitete u pomoćnim kotlovima: PK 100, PK 200 i PK 300 TE Rijeke, PK1 i PK2 TE-TO Sisak, SBK 1, SBK 2 i SBK 3 TE-TO Osijek, te kod izgaranja plinskog ulja u pomoćnom kotlu BKG 40 KTE Jertovec koji prekoračenje GVE za NO_x propisanu MCP direktivom. Pri tome pomoćni kotlovi PK 100, PK 200 i PK 300 TE Rijeke zadovoljavaju MCP direktivom propisane GVE kod izgaranja plinskog ulja, a svi ostali, prethodno nabrojani kotlovi, zadovoljavaju MCP direktivom propisane GVE kod izgaranja prirodnog plina.

U radu su analizirane emisije u zrak te opisan način usklađenja pomoćnih kotlova HEP-Proizvodnje MCP direktivi.

[1] HEP-Proizvodnja d.o.o., Ulica grada Vukovara 37, Zagreb, Hrvatska
[2] HEP-Proizvodnja d.o.o., TE-TO Sisak, Industrijska cesta 10, Sisak, Hrvatska
[3] HEP d.d., Ulica grada Vukovara 37, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Babačić, M.[1], Roksa, I.[2], Tarnik, T.[3]

HEP-PROIZVODNJA D.O.O. - IMPACT OF THE MEDIUM COMBUSTION PLANT DIRECTIVE

Keywords: *medium combustion, combustion, emission limit values*

Directive (EU) 2015/2193 on the limitation of emissions of certain pollutants into the air from medium combustion plants (Medium Combustion Plant (MCP) Directive) was adopted on 25 of November 2015. Member States of the European Union have an obligation to incorporate the provisions of this Directive into their legislation no later than 19 of December 2017. The MCP Directive applies to medium combustion engines (internal combustion engines operating at Otto (gasoline or gas) or Diesel gas cycle, as well as gas turbines and boilers) with an input heat power equal to or greater than 1 MW and less than 50 MW regardless of the kind of fuel they use.

Auxiliary boilers of the HEP Proizvodnja fall under the MCP directive into existing combustion plants. The problem of satisfying the ELVs stipulated by the MCP directive exists in combustion of fuel oils of the former quality in the auxiliary boilers: PK 100, PK 200 and PK 300 TE Rijeka, PK1 and PK2 TE-TO Sisak, SBK 1, SBK 2 and SBK 3 TE-TO Osijek, and in the combustion of gas oil in the auxiliary boiler BKG 40 KTE Jertovec which exceeds the emission limit values for NO_x prescribed by the MCP directive. In this case, the auxiliary boilers PK 100, PK 200 and PK 300 TE Rijeka comply with the MCP directive prescribed by the emission limit values for combustion of gas oil, and all other boilers previously listed comply with the MCP directive prescribed by emission limit values in the case of natural gas combustion.

This paper analyses the emissions into the air and describes how to adjust the auxiliary boilers of the HEP Production to MCP Directive.

[1] HEP-Proizvodnja d.o.o., Ulica grada Vukovara 37, Zagreb, Croatia
[2] HEP-Proizvodnja d.o.o., TE-TO Sisak, Industrijska cesta 10, Sisak, Croatia
[3] HEP d.d., Ulica grada Vukovara 37, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Keliš, Ž. [1], Kovačević, Z.[1], Topić, Ž.[1], Butković, G.[1]

PROCJENA NESIGURNOSTI EMISIJA STAKLENIČKIH PLINOVA ZA POSTROJENJA U EU ETS-U

Ključne riječi: *procjena nesigurnosti, granica dopuštene pogreške, metodologija proračuna, umjernica, ovjernica, pragovi nesigurnosti, MID Direktiva*

Kako je za svaku izmjerenu veličinu bitno utvrditi mjernu nesigurnost tako se i u praćenju, izvješćivanju i verifikaciji EU ETS-a osnovno pitanje procjena nesigurnosti prikazanih emisija. Iz godišnjeg izvještaja o emisijama samo se jedna vrijednost unosi u tabelu za verificirane emisije registar EU. Operater postrojenja ne može predati „N± x%“ jedinica, već samo točnu vrijednost N. Zato je u nužno kvantificirati i smanjiti nesigurnost „x“ u najvećoj mogućoj mjeri.

Procjena nesigurnosti se odnosi na mjerni instrument ili mjerni sustav kod:

- *metodologije proračuna u kojoj se određuje nesigurnost za podatke o aktivnosti (količine materijala ili goriva) i faktore proračuna (donja ogrjevna vrijednost i emisijski faktor),*
- *metodologiju mjerenja (primjenjive norme EN 14181 i EN 15259),*
- *nadomjesni pristup – proračun nesigurnosti za cijelo postrojenje.*

Naglasak u analizi procjene nesigurnosti odnosi se na metodologiju proračuna koja je najzastupljenija metodologija u praćenju i izvješćivanju emisija. U ovom području podaci za procjenu nesigurnosti se prikupljaju iz umjernica mjernih instrumenata ili ovjernica (izvješće o završnom ispitivanju mjerila koja imaju obvezu zakonskog mjeriteljstva). U ovakvim izvješćima se iznosi podatak granici dopuštene pogreške (GDP) prema MID Direktivi, što je kod operatera često izazivalo nedoumice pri izradi postupka procjene nesigurnosti, jer su pragovi nesigurnosti izraženi kao ±1,5 %, ±2,5 %, ±5,0 % i ±7,5 %. Za mjerne instrumente koji nemaju obveze zakonskog mjeriteljstva umjeravanja obavljaju laboratoriji akreditirani prema EN ISO/IEC 17025 te izražavaju rezultate standardne mjerne nesigurnosti pomnožene s faktorom pokrivanja k=2 koji uz normalnu razdiobu odgovara vjerojatnosti pokrivanja 95 % pouzdanosti. Ovako izražena mjerna nesigurnost je usporediva s već navedenim pragovima nesigurnosti.

S ciljem olakšavanja procjene nesigurnosti mjernih instrumenata i sustava, EU je pripremila vodiče za procjenu nesigurnosti te dodatno provela trening o procjeni nesigurnosti u 2016., radi lakšeg rješavanja brojnih otvorenih pitanja koja su se javljala pri procjeni nesigurnosti. Pitanja vezana za granici dopuštene pogreške kolnih vaga riješeno je od strane nadležnog tijela RH i kroz radne materijale treninga o procjeni nesigurnosti.

[1]Metroalfa d.o.o., Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Keliš, Ž. [1], Kovačević, Z.[1], Topić, Ž.[1], Butković, G.[1]

UNCERTAINTY ASSESSMENT OF THE EMISSIONS OF GREENHOUSE GASES FOR INSTALLATIONS IN THE EU ETS

Keywords: *uncertainty assessment, maximum permissible error, calculation-based methodology, calibration certificate, certificate of conformity, uncertainty threshold, MID Directive*

Since we are aware of the fact that for every measured value it is necessary to establish measurement uncertainty, it is also necessary to establish the uncertainty assessment of the displayed emissions, during monitoring, reporting and verification to the EU ETS. In the annual emissions report there is only one value that should be put in the table for the verified emission int he EU register. The operator of the plant cannot submit „N±x%“ units, but only the exact value of the N. Therefore, it is in everybody´s interest to quantify and reduce the uncertainty of „x“ to the fullest possible extent.

The uncertainty assessment refers to the measurement instrument or to the measurement system at:

- *Calculation-based methodology in which we must define the uncertainty of activity data (quantity of material or fuel) and calculation factors (net calorific value and the emission factor),*
- *Methodology of the measurement (applicable norms EN 14181 and EN 15259),*
- *Substitution approach – the calculation of the uncertainty for the whole plant.*

The accent of the uncertainty assessment analysis is at the methodology of calculation, which is the most common methodology of reporting and performing. In this area, the information used in the uncertainty assessment are collected from the calibration certificate of the measurement instruments or from the certificate of conformity (final test report of metrics that holds an obligation of legal metrology). In reports like this, it us usual to report the data on maximum permissible error (MPE), according to MID Directive, which has caused a lot of confusion with the operators during the making of the uncertainty assessment procedure, because the uncertainty thresholds are expressed as ±1.5%, ±2.5%, ±5.0% and ±7.5%. For the measurement instruments that do not hold an obligation of legal metrology, the calibration will be done by the laboratory that has been accredited according to EN ISO/IEC 17025 and they will express the results of the standard measurement uncertainty multiplied by the coverage factor k=2, which is equal to the probability of coverage of 95 %. The measurement uncertainty expressed this way is comparable to the uncertainty thresholds that have been listed earlier.

In order to make the uncertainty assessment of the measurement instruments and systems easier, the EU has prepared a guide for the uncertainty assessment, plus performed training on the uncertainty assessment in 2016, so many open questions that have raised during the uncertainty assessment could be easier to settle. The questions that have raised concerning the maximum permissible error of the non-automatic weighing instruments have been resolved by the competent authority and through the working materials that have been issued during the training on the uncertainty assessment.

[1]Metroalfa d.o.o., Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Butković, G.[1], Topić, Ž.[1], Keliš, Ž.[1], Kovačević, Z.[1]

UČINKOVITOST REGENERATIVNE TERMIČKE OKSIDACIJE PRI SMANJENJU EMISIJA ORGANSKIH SPOJEVA PRI PROIZVODNJI FLEKSIBILNIH FOLIJA

Ključne riječi: *organska otapala, hlapivi organski spojevi, regenerativna termička oksidacija, emisije*

IU poduzeću ALUFLEXPACK NOVI d.o.o. - Pogon Drniš provodi se izrada fleksibilnih folija koje se upotrebljavaju u prehrambenoj industriji. U procesima kao što su lakiranje, kaširanje i površinsko čišćenje koriste se velike količine organskih otapala, uglavnom etil-acetata. Kako bi emisije hlapivih organskih spojeva zadovoljile granične vrijednosti emisija (GVE) propisane Uredbom o graničnim vrijednostima emisija onečišćujućih tvari u zrak iz stacionarnih izvora (Narodne novine br. 21/07, 90/14), pristupilo se izgradnji postrojenja za termičku obradu (spaljivanje) otpadnih plinova iz proizvodnog procesa, a koje je izgrađeno tijekom 2011. godine. Postrojenje radi na principu regenerativne termičke oksidacije.

Od početka rada postrojenja provode se redovita godišnja mjerenja emisija hlapivih organskih spojeva. Prije izgradnje postrojenja za regenerativnu termičku oksidaciju vrijednosti emisije na pojedinim nepokretnim izvorima prelazile su 7000 mgC/m^3. Izgradnjom postrojenja za regenerativnu termičku oksidaciju četiri pojedinačna ispusta objedinjena su u jedan ispust. Mjerenjima utvrđene vrijednosti emisija u periodu 2012. – 2017. nisu prelazile propisane granične vrijednosti emisija od 20 mgC/m^3.

[1] Metroalfa d.o.o., Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Butković, G.[1], Topić, Ž.[1], Keliš, Ž.[1], Kovačević, Z.[1]

EFFICIENCY OF REGENERATIVE THERMAL OXIDATION IN EMISSION REDUCTION OF VOLATILE ORGANIC COMPOUNDS IN FLEXIBLE PACKAGING PRODUCTION

Keywords: *organic solvents, volatile organic compounds, regenerative thermal oxidation, emissions*

The ALUFLEXPACK NOVI d.o.o. company - Facility Drniš manufactures flexible packaging for industrial purposes. During processes such as varnishing, laminating, and surface cleaning, a great amount of organic solvents are used (mostly ethyl acetate). To satisfy the emission limit value regulated by the Regulation of emission values of pollution matter from stationary sources to the air (OG 21/07), the construction of a thermic treatment (incineration) plant has begun. The plant was finished in 2011 and functions on the principle of regenerative thermal oxidation.

As the thermic treatment plant started working, the emissions of volatile organic compounds from stationary sources began to be monitored. Before the construction of the regenerative thermal oxidation plant, the emission values of some of the stationary sources exceeded 7000 mgC/m^3. After the construction, 4 emission stationary sources were consolidated into one. During the period 2012-2017, the measured emission values did not exceed the emission value limit of 20 mgC/m^3.

[1] Metroalfa d.o.o., Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Topić, Ž. [1], Kovačević, Z.[1], Keliš, Ž.[1], Butković, G.[1]

PREDNOSTI I NEDOSTACI OPREME ZA SMANJIVANJE EMISIJA HLAPIVIH ORGANSKIH SPOJEVA METODOM ADSORPCIJE NA AKTIVNOM UGLJENU

Ključne riječi: *adsorpcija, aktivni ugljen, emisije, hlapivi organski spojevi (HOS), industrijski procesi*

Prilikom korištenja pripravaka koji sadrže organske spojeve dolazi do emisije organskih spojeva u zrak kroz difuzne izvore (fugitivne emisije) i kroz nepokretne izvore (emisije u otpadnim plinovima). Najčešće korištene metode za smanjivanje emisija HOS-a su adsorpcija na aktivnom ugljenu i termička obrada.

Svrha rada je prikazati prednosti i nedostatke opreme za smanjivanje emisija HOS-a metodom adsorpcije na aktivnom ugljenu, te periodiku zamjene istog.

Radom su prikazane emisijske koncentracije HOS-a u različitim industrijskim djelatnostima te emisije iz postrojenja za uklanjanje neugodnih mirisa, a koje za smanjivanje emisija koriste metodu adsorpcije na aktivnom ugljenu te usporedba s graničnim vrijednostima emisije (GVE) i njihov utjecaj na okoliš.

Tako na primjeru proizvodnje plastičnih proizvoda u procesu laminiranja srednje vrijednosti HOS-a iznose 357 mg/m^3 prije komore za adsorpciju na aktivnom ugljenu, dok nakon komore koncentracije iznose 284 mg/m^3 uz protok zraka kroz komoru od 10800 m^3/h odnosno brzinu strujanja od 13,5 m/s, temperaturu od 24°C i količinu aktivnog ugljena u komori od 160 kg. Smanjenjem protoka kroz komoru na 10000 m^3/h odnosno brzinu strujanja od 12,5 m/s koncentracije nakon komore iznose 239,4 mg/m^3. Vidljivo je da već malim smanjenjem brzine strujanja plina kroz komoru dolazi do smanjenja koncentracije HOS-a, a time i veće učinkovitosti adsorpcije.

Temeljem dobivenih rezultata u nekoliko industrijskih djelatnosti analizirane su i uspoređene koncentracije HOS-a u ovisnosti o protoku zraka i temperaturi te efikasnosti adsorpcije u ovisnosti o korištenim organskih spojevima. Rezultati mjerenja su nam također ukazali na brzinu zasićenja aktivnog ugljena u ovisnosti o potrošnji otapala, njegovu daljnju neefikasnost te prekoračenje propisanih graničnih vrijednosti emisija (GVE).

Također se želi ukazati na sposobnost vezanja različitih hlapivih organskih spojeva na određenu vrstu aktivnog ugljena te time omogućiti bolji uvid u korištenu opremu za smanjenje emisija HOS-a, primjenu najboljih raspoloživih tehnika (BAT) te najbolje prakse u zaštiti okoliša (BEP).

[1] Metroalfa d.o.o., Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Topić, Ž. [1], Kovačević, Z.[1], Keliš, Ž.[1], Butković, G.[1]

ADVANTAGES AND DISADVANTAGES OF EQUIPMENT FOR REDUCING EMISSIONS OF VOLATILE ORGANIC COMPOUNDS BY METHOD ADSORPTION ON ACTIVATED CARBON

Keywords: *adsorption, activated charcoal, emissions, industrial processes, volatile organic compounds (VOC)*

During the use of preparations containing organic compounds, the release of organic compounds into the air occurs through diffuse sources (fugitive emissions) and through stationary sources (emissions in waste gases). The most commonly used methods for reducing VOC emissions are adsorption on activated carbon and thermal treatment.

The purpose of the paper is show the advantages and disadvantages of VOC emission reduction equipment by the active carbon adsorption method and the replacement period

The paper presents the emission concentrations of VOC in various industrial activities and emission from the plant for odour removal using the active carbon adsorption method for emission reduction, comparison with the emission limit values (ELV) and their environmental impact.

So, on the example of the production of plastic products in the laminating process, the average value of HOS is 357 mg/m^3 before the adsorption chamber on activated carbon, and after the chamber concentration is 284 mg/m^3 with air flow through a chamber of 10800 m^3/h i.e. or the flow velocity of 13.5 m/s, temperature of 24 °C and the amount of activated carbon in the chamber of 160 kg. By reducing the flow through the chamber to 10000 m^3/h or the flow velocity of 12.5 m/s concentration after the chamber is 239.4 mg/m^3. It is evident that a small reduction in the gas flow rate through the chamber results in a reduction concentration of HOS, and thus higher adsorption efficiency.

Based on the results obtained in several industrial activities, the comparing HOS concentrations were analysed depending on the air flow, temperature and the adsorption efficiency depending on the used organic compounds. The results of measurement also showed us the saturation rate of activated charcoal depending on solvent consumption and its further inefficiency.

Also in this paper is to draw attention the ability to bind various volatile organic compounds to a particular type of activated carbon, thereby providing better insight into the equipment used to reduce VOC emissions, the application of best available techniques (BAT) and best environmental practice (BEP).

[1] Metroalfa d.o.o., Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Papa, K.[1], Hećimović, J.[1]

ZAMJENSKE SIROVINE U CEMENTNOJ INDUSTRIJI I SMANJENJE EMISIJA CO_2 NA PRIMJERU NAŠICECEMENTA D.D.

Ključne riječi: *cement, stakleničkі plinovi, alternativne sirovine*

Stakleničkі plinovi su jedan od velikih izazova današnjeg doba. Svjedoci smo kontinuiranog truda na globalnoj razini da se ove emisije smanje i dovedu pod kontrolu. Pri tome najveći zagađivači snose i najveću odgovornost.

Cementna industrija je materijalno i energetski intenzivna industrija koja doprinosi sa emisija CO_2 oko 4-5 % na svjetskoj razini. U Republici Hrvatskoj taj udio je oko 10 %. Emisije koje nastaju se mogu podijeliti na procesna emisije i emisije od sagorijevanja. Emisije od sagorijevanja čine oko 40 % udjela u ukupnim emisijama tvornice, a ovise o vrsti goriva koje se koristi. Ostalih 60 % su emisije iz procesa proizvodnje klinkera koje su posljedice tipičnih kemijskih reakcija dekarbonatizacije sirovine. Primarna sirovina koja se koristi za proizvodnju klinkera je vapnenac koji na visokim temperaturama prelazi u vapno uz stvaranje CO_2. Kako je glavni cilj proizvesti klinker bez emisija CO_2, počelo se s istraživanjem zamjenskih sirovina koje bi sadržavale sve bitne metale koji tvore minerale klinkera Ca, Mg, Fe, Si, Al a smanjile emisiju CO_2. Obzirom na sve navedeno, dobre zamjenske sirovine su u stvari nusproizvodi ili otpad iz drugih industrija poput troske koja nastaje pri sagorijevanju fosilnih goriva, ostaci iz proizvodnje metala, muljevi i slično. U Našicecementu se dodaje troska koja je nusproizvod proizvodnje željeza i čelika. Rezultati pokazuju značajne pozitivne utjecaje na emisije CO_2 ali i na proizvodnju i poslovanje.

[1] Našicecement d.d., Našice, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Papa, K.[1], Hećimović, J.[1]

ALTERNATIVE RAW MATERIALS IN THE CEMENT INDUSTRY AND CO_2 EMISSION REDUCTION IN THE COMPANY NAŠICECEMENT

Keywords: *cement, greenhouse gases, alternative raw materials*

Greenhouse gases are one of the greatest challenges of our age. We are witnessing continuous efforts on a global scale to reduce these emissions and control them. With this in mind, the biggest polluters hold the biggest responsibility.

The cement industry is an intense industry with regard to material and energy consumption and contributes 4 to 5 % to total CO_2 global emissions. In Croatia, the cement industry contributes to total national emissions with around 10 %. These emissions can be divided into process emissions and combustion emissions. Combustion emissions represent about 40 % of total facility emissions. They depend on the type of fuel used. The other 60 % are emissions coming from the clinker production process resulting from typical chemical reactions of raw material decarbonisation. The primary raw material used for clinker production is limestone, which at high temperatures breaks down to form lime and CO_2. Since the main aim of production is to produce clinker without CO_2 emissions, researchers have begun to replace primary raw material with alternative ones that still contain all of the necessary metals that form clinker minerals: Ca, Mg, Fe, Si, Al. Taking all this into consideration, acceptable raw materials are actually by-products from other industries such as blast furnace slag, remains from metal production, sludges, and the like. In Našicecement, we use slag as a by-product from the iron and steel industries. The results have shown a positive impact on CO_2 emissions, but also on production and business results.

[1] Našicecement d.d., Našice, Croatia

Tema 3
Onečišćenje vanjske atmosfere – imisije

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Šega, K.[1], Bešlić, I.[1], Godec, R.[1], Davila, S.[1]

GRUBA FRAKCIJA LEBDEĆIH ČESTICA U ATMOSFERI ZAGREBA

Ključne riječi: *PM_{10}, $PM_{2.5}$, gruba frakcija lebdećih čestica, trend, sezonska ovisnost*

Analizirane su i prikazane razine i trendovi masenih koncentracija grube frakcije lebdećih čestica (CF), kao i njihovog masenog udjela u torakalnoj frakciji (CF/PM_{10}). Dnevni uzorci frakcija lebdećih čestica PM_{10} i $PM_{2.5}$ sakupljani su na gradskoj pozadinskoj stanici u Zagrebu tijekom 16-godišnjeg razdoblja od 2001. do 2016. godine. Obuhvat podataka dnevnih koncentracija iznosio je 97,8 % od ukupno 5844 mjernih dana. Vrijednosti koncentracija grube frakcije (CF) određivane su kao razlika koncentracija torakalne (PM_{10}) i respirabilne frakcije ($PM_{2.5}$) uz srednju razinu neodređenosti od 1,43 μg m^{-3} (k=1). Izostavljeni su dani mjerenja kada je nedostajala vrijednost koncentracije jedne ili obje frakcije lebdećih čestica, odnosno kada je neodređenost pojedinog mjerenja bila viša od 2,86 μg m^{-3} (k=2). Dnevni uzorci PM_{10} i $PM_{2.5}$ frakcije lebdećih čestica sakupljani su referentnim sakupljačima Sven Leckel SEQ 47/50 u skladu sa zahtjevima referentne normirane gravimetrijske metode EN 12341:1998, HRN EN 12341:2005, HRN EN 14907:2005 i HRN EN 12341:2014. Za sakupljanje uzoraka korišteni su filtri od kvarcnih vlakana QM-A Whatman. Srednje godišnje koncentracije grube frakcije lebdećih čestica kretale su se kroz mjerno razdoblje u rasponu od 4,7 μg m^{-3} do 10,4 μg m^{-3} sa srednjom vrijednosti od 7,6 μg m^{-3}. Opažen je blago padajući trend od -0,365 μg m^{-3} godišnje, dok sezonska ovisnost masenih koncentracija grube frakcije lebdećih čestica nije uočena. Udio grube frakcije u torakalnoj frakciji lebdećih čestica (CF/ PM_{10}) kretao se kroz mjerno razdoblje od 0,0 % do 87,7 % sa srednjom vrijednosti od 26,9 %. Iskazane vrijednosti pokazuju da se radi o tipičnoj gradskoj sredini. Opažen je padajući trend kroz mjerno razdoblje od -0,329 % godišnje. Ujedno je uočena sezonska ovisnost udjela CF u PM_{10} s povišenim vrijednostima omjera tijekom toplog i sniženim vrijednostima tijekom hladnog razdoblja godine. Iz navedenog je moguće zaključiti da se vrijednosti masenih koncentracija, kao i masenog udjela grube frakcije lebdećih čestica u PM_{10} snižavaju tijekom vremena. Potrebno je istražiti sadržaj pojedinih onečišćenja (metali, ionski sastav te naročito sadržaj ugljika) kako bi se mogli donijeti daljnji zaključci o razinama, trendovima i štetnosti grube frakcije lebdećih čestica po ljudsko zdravlje i okoliš. Ipak i nadalje ostaje zaključak da su razine i sastav respirabilne frakcije ($PM_{2.5}$) glavni problem onečišćenja česticama u atmosferi Zagreba.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Šega, K.[1], Bešlić, I.[1], Godec, R.[1], Davila, S.[1]

COARSE FRACTION OF PARTICULATE MATTER IN ZAGREB ATMOSPHERE

Keywords: *PM_{10}, $PM_{2.5}$, coarse fraction, trend, seasonal dependence*

Mass concentrations and trends of coarse particle fraction (CF), as well as their mass content in thoracic fraction (CF/ PM_{10}) were analysed and presented. Daily samples of PM_{10} and $PM_{2.5}$ fractions were collected at the urban background monitoring site Zagreb during the 16 years long monitoring period 2001-2016. Capture rate of valid days was 97.8 % out of 5844 monitored days. Coarse fraction mass concentrations were calculated as the difference between thoracic (PM_{10}) and respirable fraction ($PM_{2.5}$) concentrations with an uncertainty level of 1.43 µg m^{-3} (k=1). The days when one or both concentrations were missing or when the uncertainty of the result was higher than 2.86 µg m^{-3} (k=2) were excluded from the data set. Daily samples of PM_{10} and $PM_{2.5}$ particle fractions were collected using the referent samplers Sven Leckel SEQ 47/50 and following the reference methods EN 12341:1998, HRN EN 12341:2005, HRN EN 14907:2005 and HRN EN 12341:2014. Samples were collected on QM-A Whatman quartz filters. Yearly averages of coarse fraction concentrations varied between 4.7 µg m^{-3} and 10.4 µg m^{-3} with an average of 7.6 µg m^{-3}. Negative trend of -0,365 µg m^{-3} annually was calculated, while no seasonal dependence was observed. The ratio of thoracic and respirable mass concentrations ($PM_{2.5}$/ PM_{10}) over the monitoring period varied between 0.0 % and 87.7 % with an average value of 26.9 % showing the typical urban environment. Negative trend of -0,329 % annually was observed as well as the seasonal dependence showing higher values during the warm period and lower values during the cold period of the year. It could be concluded that the mass concentrations of the coarse fraction are lowering with time as well as their contribution to the thoracic fraction. Investigation of the coarse fraction content (metals, ions, and especially the carbon content) is needed for more conclusions on concentration levels, trends and the effects on human health and the environment. However, concentration levels and content of respirable fraction ($PM_{2.5}$) remain as the main problem of particulate pollution in Zagreb.

[1] Institute for Medical Research and Occupational Health, Ksaverska c.2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Rinkovec, J.[1], Pehnec, G.[1]

MASENE KONCENTRACIJE PLATINE, PALADIJA I RODIJA U ZRAKU ZAGREBA

Ključne riječi: *ICP-MS, lebdeće čestice, automobilski katalitički pretvornici*

Platina (Pt), paladij (Pd) i rodij (Rh) koriste se u izradi nakita, poljoprivredi, stomatologiji te kemijskoj, naftnoj i farmaceutskoj industriji, no najraširenija primjena im je izrada automobilskih katalitičkih pretvornika koji služe za smanjenje emisija toksičnih ispušnih plinova motornih vozila. Za prepoznavanje i kvantitativno određivanje metala platinske skupine (PGE) potrebne su vrlo osjetljive, selektivne i brze analitičke metode.

Cilj istraživanja je kvantitativno određivanje razina platine, paladija i rodija u lebdećim česticama u zraku. Metoda korištena u ovom radu uključuje tjedno uzorkovanje lebdećih čestica na kvarcne filtre, mikrovalnu razgradnju pod povišenim tlakom i temperaturom u kiselini te analizu tehnikom masene spektrometrije uz induktivno spregnutu plazmu (ICP-MS). Metoda je primijenjena za određivanje masenih koncentracija platine, paladija i rodija u uzorcima frakcije lebdećih čestica PM10 sakupljenim tijekom 2016. godine na tri lokacije (Sjever, Centar i Jug) u različito onečišćenim područjima grada Zagreba.

Rezultati mjerenja masenih koncentracija platine, paladija i rodija u gradu Zagrebu prvi su takvi rezultati za ovo područje. Srednje vrijednosti platine, paladija i rodija za mjernu postaju Sjever iznose redom 0,641 pg m^{-3}, 4,486 pg m^{-3} i 0,620 pg m^{-3}, za mjernu postaju Centar 0,934 pg m^{-3}, 4,908 pg m^{-3} i 0,674 pg m^{-3} te za mjernu postaju Jug 1,044 pg m^{-3}, 5,385 pg m^{-3} i 0,856 pg m^{-3}. Na sve tri lokacije najviše vrijednosti dobivene su za paladij, a najniže za rodij. Prosječne koncentracije PGE u PM_{10} rasle za sva tri elementa u smjeru Sjever < Centar < Jug.

Rezultati prostorne raspodjele masenih koncentracija platine, paladija i rodija pokazuju statistički značajne razlike između mjernih postaja Sjever i Centar te Sjever i Jug za ukupno razdoblje mjerenja s višim koncentracijama platine, paladija i rodija u PM_{10} izmjerenim na mjernim postajama Centar odnosno Jug. Na svim mjernim mjestima više vrijednosti izmjerene su tijekom hladnijeg dijela godine. Ispitani su odnosi između navedenih elemenata platinske skupine i drugih metala vezanih na lebdeće čestice sa svrhom određivanja mogućih izvora onečišćenja zraka metalima platinske skupine.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Rinkovec, J.[1], Pehnec, G.[1]

MASS CONCENTRATIONS OF PLATINUM, PALLADIUM AND RHODIUM IN ZAGREB AIR

Keywords: *ICP MS, airborne particles, automotive catalytic converter*

Platinum (Pt), palladium (Pd) and rhodium (Rh) are used in the jewellery, agriculture, dentistry and chemical, oil and pharmaceutical industries, but most widely in making automotive catalytic converters that serve to reduce toxic emissions from motor vehicles. For the recognition and quantitative determination of platinum group metals (PGE), highly sensitive, selective and rapid analytical methods are required.

The aim of our research was to quantitatively determine the levels of platinum, palladium and rhodium in airborne particles. The method used in this paper includes weekly sampling of airborne particles on quartz filters, microwave digestion in acid under high pressure and temperature, and analysis by inductively coupled plasma mass spectrometry (ICP MS). The method was used to determine the mass concentrations of platinum, palladium and rhodium in PM_{10} fraction of airborne particulates sampled in 2016 at three sites (North, Centre and South) at different polluted areas of the city of Zagreb.

The results of measuring platinum, palladium and rhodium levels in the city of Zagreb are the first results of their kind for this area. The mean values of platinum, palladium and rhodium for monitoring station North were 0.641 pg m^{-3}, 4.486 pg m^{-3} and 0.620 pg m^{-3}, for monitoring station Centre 0.934 pg m^{-3}, 4.908 pg m^{-3} and 0.674 pg m^{-3}, and for monitoring station South 1.044 pg m^{-3}, 5.385 pg m^{-3} and 0.856 pg m^{-3}. The highest values at all three monitoring sites were obtained for palladium, and the lowest for rhodium. The average concentrations of PGE in PM_{10} increased for all three elements in the direction of North <Centre <South.

The results of the spatial distribution of platinum, palladium and rhodium mass concentration showed statistically significant differences between the North and Centre monitoring stations and the North and South for the total measurement period with higher concentrations of platinum, palladium and rhodium in the PM_{10} fraction measured at the monitoring stations Centre and South. At all three of the monitoring sites, higher values were measured during the colder part of the year. The relationships between the mentioned platinum group elements and other metals linked to airborne particles were investigated with the purpose of determining possible sources of air pollution by platinum metal metals.

[1] Institute for Medical Research and Occupational Health, Ksaverska c.2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Godec, R.[1], Šimić, I.[1], Šega, K.[1], Čačković, M.[1], Bešlić, I[1]

SADRŽAJ UGLJIKA U $PM_{2,5}$ FRAKCIJI LEBDEĆIH ČESTICA U ATMOSFERI JUŽNOG DIJELA ZAGREBA

Ključne riječi: *EC, OC, OC/EC omjer, $PM_{2,5}$*

Cilj rada bio je ustanoviti razine masenih koncentracija elementnog i organskog ugljika u frakciji lebdećih čestica $PM_{2,5}$ u zraku te postojanje njihove vremenske raspodjele. Mjerena su provedena radnim danima tijekom 2009. i 2016. godine na urbanoj mjernoj postaji u južnom djelu grada Zagreba.

Uzorci frakcije lebdećih čestica $PM_{2,5}$ sakupljani su iz približno 55 m^3 zraka na filtre od kvarcnih vlakana (Pallflex Tissuequartz 2500QAT-UP, Pall Life Science), prethodno žarenih na 900ºC tijekom tri sata. Masene koncentracije lebdećih čestica određene su gravimetrijski sukladno normama HRN EN 14907:2005 i HRN EN 12341:2014. Sadržaj organskog (OC), elementnog (EC) i ukupnog (TC=EC+OC) ugljika određen je metodom termičko-optičke transmisije (TOT).

Ustanovljeno je postojanje statistički značajnih varijacija masenih koncentracija ugljika u $PM_{2,5}$ frakciji lebdećih čestica između 2009. i 2016. godine, kao i sezonskih varijacija unutar pojedine godine. Najviše dnevne masene koncentracije lebdećih čestica i ugljika u njima zamijećene su zimi dok su najniže dnevne masene koncentracije lebdećih čestica i elementnog ugljika zabilježene tijekom toplijeg dijela godine (proljeće i ljeto). Najniže masene koncentracije organskog ugljika zabilježene tijekom jeseni u obje godine mjerenja. Tijekom 2009., izmjerene su više srednje godišnje vrijednosti masenih koncentracija $PM_{2,5}$ te OC i EC u frakciji lebdećih čestica $PM_{2,5}$ u odnosu na one izmjerene tijekom 2016. godine. Za razliku od masenih koncentracije, maseni udjeli ugljika u česticama su bili su viši u 2016.-toj godini. Nije uočena statistički značajna razlika u omjeru OC/EC između 2009. i 2016. godine, kao ni između sezona u svakoj pojedinoj godini.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Godec, R.[1], Šimić, I.[1], Šega, K.[1], Čačković, M.[1], Bešlić, I.[1]

CARBON MASS CONCENTRATIONS IN THE $PM_{2.5}$ PARTICLE FRACTION IN THE ATMOSPHERE OF SOUTHERN ZAGREB

Keywords: *EC, OC, OC/EC ratio, $PM_{2.5}$*

The aim of the study was to determine the levels of elemental and organic carbon mass concentrations in the $PM_{2.5}$ particle fraction in the air as well as the existence of their temporal distribution. Measurements were performed only during working days, in the years 2009 and 2016 at an urban monitoring station located in the southern part of Zagreb.

Samples of $PM_{2.5}$ particle matter were collected from approximately 55 m^3 of air on quartz fibre filters (Pall flex Tissue quartz 2500QAT-UP, Pall Life Science), previously pre-fired at 900ºC for three hours. The mass concentration of particles was determined gravimetrically according to HRN EN 14907:2005 and HRN EN 12341:2014. The content of organic (OC), elemental (EC) and total carbon (TC = EC + OC) was determined by the thermal-optical transmission (TOT) method.

Statistically significant variations of carbon mass concentrations were found between results for 2009 and 2016, as well as for the seasonal variations within a given year. The highest daily mass concentration of particle matter and carbon in it was observed in winter, while the lowest daily mass $PM_{2.5}$ and EC concentrations were recorded during the warmer part of the year (spring and summer). The lowest OC mass concentrations were recorded during autumn for both years. Higher annual mean values of $PM_{2.5}$ and OC and EC in $PM_{2.5}$ were recorded in 2009 compared to 2016. Unlike the carbon mass concentrations in the particles, the carbon mass contribution to particles was higher in 2016. No statistically significant difference in the OC/EC ratios was observed between the years 2009 and 2016, as well as between the seasons in each particular year.

[1] Institute for Medical Research and Occupational Health, Ksaverska c.2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Frka, S.[1,2], Šala, M.[1], Turšič, J.[3], Grgić, I.[1]

SEZONSKE PROMJENE ORGANSKOG MATERIJALA AEROSOLA RAZDVOJENIH PREMA VELIČINI ČESTICA I NJIHOVIH NITROAROMATSKIH SASTAVNICA

Ključne riječi: *veličinski razdvojeni aerosoli, u-vodi-topljiv organski ugljik, nitroaromatski spojevi, izgaranje biomase, LC-MS/MS*

Unatoč velikom značaju organskog materijala (OM) lebdećih čestica (aerosola) na ljudsko zdravlje i Zemljinu klimu, jedan od najvećih izazova atmosferske kemije danas predstavlja bolje razumijevanje njegovih svojstava te procesa stvaranja i uklanjanja iz atmosfere. Nitroaromatski spojevi (NAS) predstavljaju jednu od značajnih skupina atmosferskog OM povezanog s antropogenim aktivnostima kao i aktivnostima izgaranja biomase (engl. Biomass burning; BB). Danas su poznati sekundarni mehanizmi njihovih transformacija u vodenoj fazi atmosfere. Oni čine i značajni udio u organskoj tvari atmosfere koja ima svojstva adsorpcije UV-Vis zračenja (engl. Brown carbon). NAS su važne industrijske kemikalije današnjice; derivati fenola široko su rasprostranjeni u brojnim prirodnim i farmaceutskim proizvodima. Zbog svog međudjelovanja s DNA, NAS imaju mutagena svojstva i smatraju se štetnima za sva živa bića. Stoga zabrinjava njihova značajna prisutnost u atmosferskim aerosolima, posebice njihovim veličinskim frakcijama koje mogu duboko prodrijeti u dišni sustav ljudi. Bolje razumijevanje atmosferskih procesa koji uključuju NAS kao i procjene njihovog štetnog djelovanja na zdravlje živih bića nije moguće bez njihove identifikacije i kvantifikacije u specifičnim veličinskim frakcijama atmosferskih aerosola. Na urbanom pozadinskom području Ljubljane (Slovenija) provedeno je opsežno sezonsko ispitivanje u vodi topljive organske tvari aerosola razdvojenih prema veličini čestica (10 veličinskih frakcija aerodinamičkog promjera od 0,038 do 15,6 μm) te njihovih specifičnih NAS sastavnica, kao što su (metil)nitrokateholi, (di)/ (metil)nitrofenoli, nitrosalicilne kiseline, (di)nitroguaiakoli, itd. Identifikacija i kvantifikacija NAS, uključujući i 10 do sada potpuno nepoznatih spojeva, provedena je na molekulskom nivou promjenom vezanog sustava tekućinske kromatografije visokog učinka–spektrometrije mase (LC-MS/MS), spektrometrije masa s visokim razlučivanjem (HRMS) te tehnikama nuklearne magnetske rezonancije (NMR). Da bi se dobio uvid u svojstva NAS kao i njihove izvore i transformacijske procese u atmosferi, rezultati su korelirani s koncentracijama mase ukupne čestične tvari, ukupnog ugljika, u vodi topljivog organskog ugljika te levoglukozana kao markera BB procesa.

[1] Department of Analytical Chemistry, National Institute of Chemistry, Ljubljana, Slovenia
[2] Zavod za istraživanje mora i okoliša, Laboratorij za biogeokemiju mora i atmosfere, Institut Ruđer Bošković, Zagreb, Hrvatska,
[3] Environmental Agency of the Republic of Slovenia, Ljubljana, Slovenia

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Frka, S.[1,2], Šala, M.[1], Turšič, J.[3], Grgić, I.[1]

SEASONAL VARIATIONS OF SIZE SEGREGATED ORGANIC AEROSOLS AND THEIR NITROAROMATIC CONSTITUENTS

Keywords: *size-segregated aerosols, water-soluble organic carbon, nitroaromatic compounds, biomass burning, LC-MS/MS*

Despite of their importance for both human health and climate change, the formation, properties, and removal of atmospheric organic particles remain one of the least understood aspects of atmospheric chemistry. Among the large number of unidentified organics related to anthropogenic and biomass-burning (BB) activities, nitroaromatic compounds (NAS) have drawn attention because of their UV light-absorbing ability, being an important portion of atmospheric Brown carbon. Atmospheric NAS are regarded as a significant fraction of organic aerosols, whose (trans)formation in atmospheric water is only the first step in understanding them. NAS are among the largest and most important groups of industrial chemicals in use today; phenol derivatives form one of the largest ubiquitous families of chemicals present in a variety of natural products, flavours, and pharmaceuticals. Reactions involving NAS in the atmosphere are a matter of concern, especially in fractions of inhaled aerosols, as their interactions with DNA and the resulting mutagenicity render them hazardous to human health and wildlife. Thus, to a large extent, understanding the processes and health impact of atmospheric NAS depends on how well these compounds are identified in size-segregated aerosols. A comprehensive study on seasonal aerosol size-segregated (10 stages; aerodynamic diameter from 0.038 to 15.6 µm) water soluble organic matter (WSOM), with focus on its specific NAS, e.g. (methyl)nitrocatechols, (di)/(methyl)nitrophenols, nitrosalicylic acids, (di)nitroguaiacols, etc., through investigation of their molecular level speciation and quantification using liquid chromatography tandem mass spectrometry (LC-MS/MS), high resolution mass spectrometry (HRMS), and nuclear magnetic resonance (NMR) will be presented. An abundance of a range of NAS, including 10 that have never been reported previously, will also be presented. The obtained data were correlated with those for levoglucosan (BB tracer) as well as with aerosol mass, total carbon, and carbon content in WSOM. On the basis of seasonal data collected at an urban background environment of Ljubljana, Slovenia, insight into the characteristics of NAS as well as their potential sources and transformation processes in the atmosphere will be discussed.

[1] Department of Analytical Chemistry, National Institute of Chemistry, Ljubljana, Slovenia
[2] Division for marine and environmental research, Laboratory for marine and atmospheric biogeochemistry, Ruđer Bošković Institute, Zagreb, Croatia,
[3] Environmental Agency of the Republic of Slovenia, Ljubljana, Slovenia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Džepina, K.[1], Mazzoleni, C.[2], Fialho, P.[3], China, S.[4], Zhang, B.[5], Owen, R.C.[2,6], Helmig, D.[7], Hueber, J.[7], Kumar, S.[8], Perlinger, J.A.[2], Kramer, L.[9], Dziobak, M.P.[2], Ampadu, M.T.[2], Olsen, S.[10], Wuebbles, D.J.[11], Mazzoleni, L.R.[2]

MOLEKULARNA KARAKTERIZACIJA LEBDEĆIH ČESTICA SLOBODNE TROPOSFERE SA OPSERVATORIJA PICO PLANINE

Ključne riječi: *lebdeće čestice, slobodna troposfera, masena spektrometrija, Opservatorij Pico planine*

Dalekosežno transportirane lebdeće atmosferske čestice (aerosoli) uzorkovane su u slobodnoj troposferi na Opservatoriju Pico planine (Pico Mountain Observatory, PMO; 38°28'15''N, 28°24'14''W; 2225 m n.v.) na otoku Pico azorskog otočja u Sjevernom Atlantiku. Aerosoli su prikupljani na filterima u ljeto 2012. godine i njihov kemijski sastav određen je analizama organskog i elementarnog ugljika te anorganskih iona. Prosječna masena koncentracija bila im je 0,9 μg m^{-3}, pri čemu su većinu mase činile organske tvari (57 %), uz doprinose sulfata (21 %) i nitrata (17 %). Masene koncentracije aerosola bile su značajno korelirane sa kontinuiranim mjerenjima čađi, te njihovog raspršenja svjetlosti i brojčane koncentracije. Organske tvari topive u vodi (Water-Soluble Organic Compounds, WSOC) uzoraka prikupljenih 24. i 25. 09. (uzorci 9/24 i 9/25) tijekom perioda visokog zagađenja analizirani su upotrebom masene spektrometrije ultravisoke rezolucije (FT-ICR MS). Analiza sa FLEXPART modelom pokazala je kako su te zračne mase putovale do PMO vrlo dugo (>12 dana). U masenim spektrima uzoraka identificirano je ~4000 molekularnih formula (m/z 100-1000) i većina je imala nezasićenu strukturu sa elementarnim sastavom CHO i CHNO. WSOC imale su O/C ~0,45, relativno nisko u usporedbi sa O/C drugih aerosola koji su proveli dugo vrijeme u atmosferi, što je moguće rezultat isparavanja i fragmentacije u dalekosežnom transportu. Viša koncentraciji uzorka 9/24 povezana je FLEXPART-om i MODIS satelitom sa požarima u Sjevernoj Americi. To potvrđuju i markeri požara u prikupljenim WSOC i morfologija čestica određena SEM tehnikom. Prisustvo markera karakterističih za reakcije fenola iz požara u vodenoj fazi sugerira da su aerosoli prošli kroz procesiranje u oblacima. Značne mase uzorka 9/25 putovale su duže (~15 dana) i bile pod utjecajem morskih emisija, kako je indicirano detektiranim organosulfatima i tvarima karakterističnim za morske aerosole (npr. masne kiseline). Razlike u aerosolima u dva uzorka potvrđene su i promjenama u ozonu, etanu, propanu, morfologiji čestica, te sa FLEXPART-om. U ovoj prezentaciji prikazat će se prva detaljna molekularna karakterizacija dalekosežno transportiranih aerosola u slobodnoj troposferi uzorkovanih na PMO.

[1] Michigan Tech, Houghton, MI, SAD; sada na: Sveučilište u Rijeci, Hrvatska
[2] Michigan Tech, Houghton, MI, SAD
[3] Univ Azores, Angra do Heroísmo, Portugal
[4] Michigan Tech, Houghton, MI, SAD; sada na: PNNL, Richland, WA, SAD
[5] Michigan Tech, Houghton, MI, SAD; sada na: National Institute of Aerospace, Hampton, SAD
[6] EPA, Research Triangle Park, NC, SAD
[7] CU Boulder, CO, SAD
[8] Michigan Tech, Houghton, MI, SAD; sada na: National Center for Medium Range Weather Forecasting, Noida, India
[9] Michigan Tech, Houghton, MI, SAD; sada na: University of Birmingham, Velika Britanija
[10] Univ Illinois, Urbana Champaign, IL, SAD; sada na: Xyratex International Ltd, Sacramento, CA, SAD
[11] Univ Illinois, Urbana Champaign, IL, SAD

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Džepina, K.[1], Mazzoleni, C.[2], Fialho, P.[3], China, S.[4], Zhang, B.[5], Owen, R.C.[2,6], Helmig, D.[7], Hueber, J.[7], Kumar, S.[8], Perlinger, J.A.[2], Kramer, L.[9], Dziobak, M.P.[2], Ampadu, M.T.[2], Olsen, S.[10], Wuebbles, D.J.[11] Mazzoleni, L.R.[2]

MOLECULAR CHARACTERIZATION OF FREE TROPOSPHERIC AEROSOL AT THE PICO MOUNTAIN OBSERVATORY (PMO)

Keywords: *atmospheric aerosol, free troposphere, mass spectrometry, Pico mountain observatory*

Long-range transported free tropospheric aerosol was sampled at the PMO (38°28'15''N, 28°24'14''W; 2225 m amsl) on Pico Island of the Azores in the North Atlantic. Filter-collected aerosol during summer 2012 was analysed for organic and elemental carbon, and inorganic ions. The average aerosol ambient concentration was 0.9 µg m^{-3}. Organic aerosol contributed the majority of mass (57 %), followed by sulphate (21 %) and nitrate (17 %). Filter-collected aerosol was positively correlated with on-line aerosol measurements of black carbon, light scattering and number concentration. Water-soluble organic compounds (WSOC) from 9/24 and 9/25 samples collected during a pollution event were analysed with ultrahigh-resolution FT-ICR MS. FLEXPART analysis showed the air masses were very aged (>12 days). ~4000 molecular formulas were assigned to each of the mass spectra between m/z 100-1000. The majority of the assigned molecular formulas have unsaturated structures with CHO and CHNO elemental compositions. WSOC have an average O/C of ~0.45, relatively low compared to O/C of other aged aerosol, which might be the result of evaporation and fragmentation during long-range transport. The increase in aerosol loading during 9/24 was linked to biomass burning emissions from North America by FLEXPART and MODIS fire counts. This was confirmed with WSOC biomass burning markers and with the morphology and mixing state of particles as determined by SEM. The presence of markers characteristic of aqueous-phase reactions of biomass burning phenolic species suggests that the aerosol collected at Pico had undergone cloud processing. The air masses on 9/25 were more aged (~15 days) and influenced by marine emissions, as indicated by organosulphates and species characteristic for marine aerosol (e.g. fatty acids). The change in air masses for the two samples was corroborated by the changes in ozone, ethane, propane, morphology of particles, as well as by FLEXPART. In this presentation we will presents the first detailed molecular characterization of free tropospheric aged aerosol intercepted at the PMO.

[1] Michigan Tech, Houghton, MI, SAD; now at: University of Rijeka, Croatia
[2] Michigan Tech, Houghton, MI, SAD
[3] Univ Azores, Angra do Heroísmo, Portugal
[4] Michigan Tech, Houghton, MI, SAD; now at: PNNL, Richland, WA, SAD
[5] Michigan Tech, Houghton, MI, SAD; now at: National Institute of Aerospace, Hampton, SAD
[6] EPA, Research Triangle Park, NC, SAD
[7] CU Boulder, CO, SAD
[8] Michigan Tech, Houghton, MI, SAD; now at: National Center for Medium Range Weather Forecasting, Noida, India
[9] Michigan Tech, Houghton, MI, SAD; now at: University of Birmingham, UK
[10] Univ Illinois, Urbana Champaign, IL, SAD; now at: Xyratex International Ltd, Sacramento, CA, SAD
[11] Univ Illinois, Urbana Champaign, IL, SAD

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Čačković, M.[1], Gluščić, V.[1], Šega, K.[1], Vađić, V.[1], Pehnec, G.[1], Bešlić, I.[1]

PROSTORNE I VREMENSKE RAZDIOBE MASENIH KONCENTRACIJA U VODI TOPLJIVIH KOMPONENTI U $PM_{2,5}$ FRAKCIJI LEBDEĆIH ČESTICA U ZRAKU

Ključne riječi: *onečišćenje zraka, anioni, kationi, ionska kromatografija*

U radu su prikazani rezultati kontinuiranih mjerenja sadržaja u vodi topljivih komponenti: anioni (Cl^-, NO_3^-, SO_4^{2-}) i kationi (Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) u $PM_{2,5}$ frakciji lebdećih čestica u zraku za razdoblje 2014. - 2016. godine.

Uzorci čestica sakupljani su na dvije pozadinske mjerne postaje i to: urbana mjerna postaja (UMP) u sjevernom dijelu Zagreba i ruralna mjerna postaja (RMP) Plitvička jezera tijekom 24-satnih razdoblja od 01. siječnja 2014. do 31. prosinca 2016. godine (UMP) te od 17. srpnja 2014. do 31. prosinca 2016. godine (RMP). Uzorci su sakupljani sukladno normama HRN EN 14907:2006 (EN 14907:2005) i HRN EN 12341:2014 (EN 12341:2014). Masena koncentracija čestica određena je gravimetrijski sukladno zahtjevima normi. Sadržaj u vodi topljivih komponenti aniona (Cl^-, NO_3^-, SO_4^{2-}) i kationa (Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) u $PM_{2,5}$ frakciji čestica nakon otapanja na ultrazvučnoj kupelji određen je ionskom kromatografijom na uređaju Thermo Scientific – ICS 5000 Capillary.

Razine masenih koncentracija mjerenih onečišćenja pokazuju značajnu prostornu i vremensku ovisnost s višim vrijednostima određenim na pozadinskoj urbanoj mjernoj postaji (UMP). Za promatrano razdoblje mjerenja srednje godišnje vrijednosti masenih koncentracija $PM_{2,5}$ frakcije čestica izmjerene su u rasponu od 19,6 $\mu g\ m^{-3}$ do 22,7 $\mu g\ m^{-3}$ na pozadinskoj urbanoj mjernoj postaji (UMP), dok su za ruralnu postaju (RMP) izmjerene vrijednosti u rasponu od 8,0 $\mu g\ m^{-3}$ do 9,4 $\mu g\ m^{-3}$.

Srednje godišnje vrijednosti masenih koncentracija mjerenih iona na UMP postaji slijedile su niz $SO_4^{2-} > NO_3^- > NH_4^+ > K^+ > Ca^{2+} > Cl^- > Na^+ > Mg^{2+}$, dok je za RMP postaju taj niz bio $SO_4^{2-} > NH_4^+ > NO_3^- > K^+ > Ca^{2+} > Na^+ > Mg^{2+} > Cl^-$. Rezultati korelacije između masenih koncentracija mjerenih onečišćenja upućuju na doprinos više izvora onečišćenja, a na što upućuju i rezultati faktorske analize kojom utvrđeni faktori opisuju i do 95% varijance.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska cesta 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Čačković, M.[1], Gluščić, V.[1], Šega, K.[1], Vađić, V.[1], Pehnec, G.[1], Bešlić, I.[1]

SPATIAL AND TEMPORAL VARIATIONS OF MASS CONCENTRATIONS OF WATER–SOLUBLE COMPONENTS IN $PM_{2.5}$ PARTICLE FRACTION IN AIR

Keywords: *air pollution, anion species, cation species, ion chromatography*

Daily $PM_{2.5}$ samples were taken over three years 2014 – 2016 at two measuring sites classified as urban background site (UBS) in northern part of Zagreb, and rural background site (RBS) at Plitvice Lakes. Samples were analysed for water-soluble anion species (Cl^-, NO_3^-, SO_4^{2-}) and cation species (Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}), to investigate the relationship between pollutant mass concentrations, contribution of measured species to $PM_{2.5}$ mass and prediction of the pollutant sources.

Mass concentrations of $PM_{2.5}$ particle fraction were determined by gravimetry according to the standard HRN EN 14907:2006 (EN 14907:2005) and HRN EN 12341:2014 (EN 12341:2014). Water-soluble ionic species were analysed using Thermo Scientific – ICS 5000 Capillary ion chromatography.

Mass concentrations of measured pollutants were significantly influenced by the season and the location of sampling sites, reaching their high values at UBS. Annual average PM2.5 mass concentration ranged from 19.6 μg m^{-3} to 22.7 μg m^{-3} at UBS and from 8.0 μg m^{-3} to 9.4 μg m^{-3} at RBS, respectively. The annual average ion mass concentrations at UBS followed the order $SO_4^{2-} > NO_3^- > NH_4^+ > K^+ > Ca^{2+} > Cl^- > Na^+ > Mg^{2+}$, dok je za RMP postaju taj niz bio $SO_4^{2-} > NH_4^+ > NO_3^- > K^+ > Ca^{2+} > Na^+ > Mg^{2+} > Cl^-$, respectively. The prediction of the pollutant sources, we ran the principal component analysis (PCA), which was performed using the STATISTICA 12.0 statistical packages. After varimax rotation, the obtained principal component factors were found to account for 95% of the variance. Factor loadings > 0.7 were considered significant.

[1] Institute for Medical Research and Occupational Health, Zagreb, Ksaverska c. 2,

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Ćurkov, D.[1], Brzoja, D.[1], Belavić, M.[1], Brzaj, S.[1], Džaja Grgičin, V.[1], Milić, V.[1], Suhin, J.[1], Vidič, S.[1], Gugec, V.[1]

OCJENA KVALITETE ZRAKA U HRVATSKOJ NA OSNOVI REZULTATA MJERENJA I MODELIRANJA U RAZDOBLJU 2011.-2015. S OBZIROM NA ONEČIŠĆENJE LEBDEĆIM ČESTICAMA PM_{10} I $PM_{2,5}$

Ključne riječi: *kvaliteta zraka, lebdeće čestice, $PM_{2,5}$, PM_{10}, mjerenje, modeliranje, EMEP*

Lebdeće čestice su mješavina kemijskih spojeva i čestica vode različitih veličina i sastava. Po svojim svojstvima i značaju najčešće se dijele na one kojima je aerodinamički promjer manji od 1 μm, 2,5 μm i 10 μm. Izvori emisija lebdećih čestica mogu biti prirodni i antropogeni. Prirodni izvori uključuju morsku sol, prašinu, pelud, šumske požare i vulkanski pepeo, dok antropogeni izvori, koji su dominantni u urbaniziranim područjima, obuhvaćaju izgaranje fosilnih goriva, goriva u prometu i prometovanja vozila, spaljivanje otpada kao i druge vrste prašine koja nastaje uslijed ljudskih aktivnosti. Na lokalnoj, gradskoj prostornoj skali dominantan je utjecaj ljudskih djelatnosti i prometa na iznose prizemnih koncentracija, dok se utjecaj prirodnih izvora prati na regionalnoj i kontinentalnoj skali prijenosa onečišćujućih tvari.

U Republici Hrvatskoj na postajama Državne mreže za trajno praćenje kvalitete zraka mjere se koncentracije lebdećih čestica sve tri gore navedene frakcije. Mjerenja se provode pomoću automatskih analizatora te referentnom gravimetrijskom metodom na pozadinskim i gradskim postajama u aglomeracijama Zagreb, Osijek i Rijeka te u zonama HR01, HR02, HR03, HR04 i HR05.

Za potrebe ovoga rada analizirani su rezultati mjerenja i rezultati proračuna EMEP modelom regionalnog i daljinskog prijenosa i taloženja onečišćujućih tvari. Primijenjena je verzija atmosferskog kemijskog modela EMEP horizontalne rezolucije 50 km x 50 km koji koristi ulazne podatke o emisijama za područje Europe (Centar za emisije i projekcije - CEIP) i 3-D meteorološka polja atmosferskih varijabli (Europski centar za srednjoročnu prognozu - ECMWF). U analizi je dana ocjena kvalitete zraka na području Republike Hrvatske za razdoblje 2011.-2015. na osnovi mjerenih i modeliranih podataka s obzirom na propisane granične vrijednosti (GV), granice tolerancije (GT), gornje i donje pragove procjenjivanja te dugoročne ciljeve prema Uredbi o razinama onečišćujućih tvari u zraku NN 117/2012.

Povišene vrijednosti koncentracije lebdećih čestica $PM_{2,5}$ koje prelaze dozvoljenu godišnju graničnu vrijednost u promatranom razdoblju zabilježene su u zonama HR01 i HR02 dok godišnja granična vrijednost koncentracije lebdećih čestica PM_{10} nije bila prekoračena. Primjećuje se trend opadanja srednje godišnje koncentracije lebdećih čestica PM_{10} u prve četiri godine promatranog razdoblja te porast u posljednjoj godini. Premda je ukupno onečišćenje grubim lebdećim česticama ipak nešto smanjeno nakon 2011. godine, iz gravimetrijskih podataka je vidljivo da u urbanim sredinama (Zagreb, Sisak, Slavonski Brod) prema broju prekoračenja dnevnih srednjih vrijednosti koncentracije PM_{10} i dalje ostaju izvan dozvoljene granice.

[1] Državni hidrometeorološki zavod, Grič 3, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Ćurkov, D.[1], Brzoja, D.[1], Belavić, M.[1], Brzaj, S.[1], Džaja Grgičin, V.[1], Milić, V.[1], Suhin, J.[1], Vidič, S.[1], Gugec, V.[1]

ASSESSMENT OF $PM_{2.5}$ AND PM_{10} POLLUTION LEVELS AND TRENDS IN CROATIA FOR THE PERIOD 2011-2015

Keywords: *air quality, particulate matter, $PM_{2.5}$, PM_{10}, measurement, modelling, EMEP*

Particulate matter (PM), also known as particle pollution, is a term that stands for complex mixture of extremely small particles, chemical compounds and liquid droplets suspended in the air. They consist of inhalable particles, with diameters that are generally 10 micrometres and smaller, fine particles, with diameters smaller than 2.5 μm and ultra-fine particles with diameters smaller than 1 μm. Primary PM originate from both natural and anthropogenic sources. Naturally produced particles come from sea salt, suspended dust, pollen, forest fires and volcanic ash. Anthropogenic sources, predominant in urban areas, comprise of fuel combustion sources in thermal power generation, waste incineration installations, house hold furnaces, vehicle engine exhausts, vehicle tyre and brake and road wear as well as other types of anthropogenic dust. While anthropogenic sources of particulate matter are predominant locally and in urban areas, influence of natural sources is characteristic at regional and continental scale.

Continuous measurements of particulate matter of different fractions in the State Air Quality Monitoring Network of Croatia are obtained by automatic samplers and by the referent gravimetric method at selected measurement sites in zones (HR01, HR02, HR03, HR04 and HR05) and agglomerations (Zagreb, Osijek and Rijeka).

For the purpose of this paper, measurement results as well as results of the EMEP regional model calculations performed over Croatian territory have been analysed. The 50 km x 50 km horizontal resolution version of the EMEP atmospheric chemical model, using emission data for Europe (CEIP) and 3-D meteorological data (ECMWF), has been applied. The analysis enabled the assessment of air quality over Croatian territory for the period 2011-2015. Measured and modelled concentration values have been juxtaposed and verified against the prescribed limit values (GV), exceedances, tolerance limits (GT), upper and lower estimate thresholds and long-term objectives according to the Regulation on levels of air pollutants NN 117/2012.

Concentration levels of $PM_{2.5}$ exceeding the annual limit value in the observed period were recorded in HR01 and HR02 zones while the annual limit value for concentrations of PM_{10} was not exceeded in any zone or agglomeration. Also, there is a noticeable decrease of the average annual concentration of PM_{10} in the first four years of the period but a slight increase in 2015. Based on gravimetric data at urban environments (Zagreb, Sisak, Slavonski Brod) it is noticeable that total coarse particle pollution decreases after 2011. Nevertheless, the number of daily PM_{10} exceedances remains outside permitted levels.

[1] Meteorological and Hydrological Service, Grič 3, 10000 Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Jakovljević, I.[1], Pehnec, G.[1], Vađić, V.[1]

USPOREDBA MASENIH KONCENTRACIJA PAU U PM_{10}, $PM_{2.5}$ I PM_1 FRAKCIJI LEBDEĆIH ČESTICA

Ključne riječi: *BaP, HPLC, sezonske varijacije*

Policiklički aromatski ugljikovodici (PAU) su organski spojevi koji se sastoje od međusobno spojena dva ili više aromatska prstena. Do danas je poznato više od 500 PAU te su jedni od prvih spojeva koji su svrstani u karcinogene supstance. Izvori policikličkih aromatskih ugljikovodika najčešće su povezani s ljudskom aktivnošću. U okoliš mogu dospjeti i prirodnim putem prilikom velikih šumskih požara i vulkanskih erupcija. PAU također nastaju tijekom brojnih industrijskih procesa (proizvodnja ugljena, sirove nafte, teških i lakih metala…) te spaljivanjem otpada i raznih plastičnih masa u nedopuštenim i nekontroliranim uvjetima. Ispušni plinovi automobila također mogu biti jedan od važnih izvora PAU. Uz emisije automobila kućna ložišta se ubrajaju u glavne izvore PAU u naseljima, osobito ako se kao gorivo rabi drvo ili ugljen.

Današnja istraživanja, kako u svijetu tako i u Hrvatskoj, usmjerena su na proučavanje PAU vezanih na čestice aerodinamičkog promjera manjeg od 10 µm (PM_{10}) i 2,5 µm ($PM_{2.5}$). Premda je zakonska regulativa usmjerena na BaP u PM_{10} frakciji, posebnu pažnju treba posvetiti česticama manjeg aerodinamičkog promjera jer je dokazano da se takve čestice duže zadržavaju u atmosferi, prodiru dublje u dišni sustav čovjeka te mogu imati štetne učinke na zdravlje ljudi.

Uzorci PM_{10}, $PM_{2.5}$ i PM_1 frakcije lebdećih čestica sakupljani su tijekom godine dana (od siječanja do prosinca 2013) prosisavanjem zraka kroz filtre od kvarcnih vlakana. Mjerno mjesto nalazilo se u sjevernom dijelu grada Zagreba, koje karakterizira umjerena gustoća prometa. Do analize, uzorci lebdećih čestica su pohranjeni u aluminijske folije u zamrzivaču na temperaturu od -18 ºC. Analiza je provedena kromatografijom visoke djelotvornosti (HPLC) s fluorescentnim detektorom promjenjivih valnih duljina ekscitacije i emisije. Određivani su fluoranten (Flu), piren (Pir), benzo(a) antracen (BaA), krizen (Kri), benzo(b)fluoranten (BbF), benzo(k)fluoranten (BkF), benzo(a)piren (BaP), dibenzo(ah)antracen (DahA), benzo(ghi)perilen (BghiP) i indeno(1,2,3-cd)piren (IP).

Masene koncentracije mjerenih PAU pokazuju sezonske varijacije s povišenim vrijednostima zimi i u jesen, te nižim vrijednostima u proljeće i ljeto. Pronađene su međusobne korelacije između pojedinih PAU vezanih na PM_{10}, $PM_{2.5}$ i PM_1. Uspoređujući PAU u PM_{10} i $PM_{2.5}$ frakciji čestica, pronađeno je, da je više od 80 % PAU mjerenih tijekom zime sadržano u manjim česticama ($PM_{2.5}$), osim Kri, IP i DahA. U ljetnom razdoblju više od 60 % PAU bilo je vezano na $PM_{2.5}$ frakciju lebdećih čestica, (osim DahA), a u proljeće više od 50 %, (osim za Flu, BaP i BbF). Uspoređujući PAU u PM_1 i $PM_{2.5}$ frakciji nađeno je da je većina PAU vezana na sitnije čestice (PM_1). Ta vrijednost je bila najviša tijekom zimskog razdoblja (više od 90 %).

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska cesta 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Jakovljević, I.[1], Pehnec, G.[1], Vađić, V.[1]

COMPARISON BETWEEN MASS CONCENTRATIONS OF PAH IN PM_{10}, $PM_{2.5}$ AND PM_1 PARTICLE FRACTION

Keywords: *BaP, HPLC, seasonal variations*

Polycyclic aromatic hydrocarbons (PAH) are organic compounds that consist of two or more aromatic rings. More than 500 PAHs have been identified in the air and were among the first pollutants established as potential carcinogens. Many sources of PAHs are commonly associated with human activity. Natural sources of polycyclic aromatic hydrocarbons include large forest fires and volcanic eruptions. PAHs also stem from industrial processes (coal, crude oil, heavy and light metals, etc.) and can be formed by burning waste and various types of plastic without control. Automobile exhausts can also be an important source of PAHs, as can domestic heating furnaces, especially if they use wood or coal as fuel.

Today's research, both worldwide and in Croatia, focuses on studying PAHs bound to particles with an aerodynamic diameter of less than 10 μm (PM_{10}), 2.5 μm ($PM_{2.5}$). Croatian legislation is fundamentally based on BaP in PM_{10}, but smaller fractions need to be included because these have been shown to penetrate deeper into the human respiratory system.

Samples of PM_{10}, $PM_{2.5}$, and PM_1 particle fractions were collected on quartz filters during one year (January to December 2013). The measuring site was located in a residential part of Zagreb with medium traffic density. The samples were kept frozen in aluminium foil at -18 º C until HPLC analysis with fluorescence detection and changeable excitation and emission wavelength. Samples were analysed for the following PAHs: fluoranthene (Flu), pyrene (Pyr), benzo(a)anthracene (BaA), chrysene (Chry), benzo(b)fluoranthene (BbF), benzo(k)fluoranthene (BkF), benzo(a)pyrene (BaP), dibenzo(ah)anthracene (DahA), benzo(ghi)perylene (BghiP), and indeno(1,2,3-cd)pyrene (IP).

The mass concentrations of the measured PAHs show seasonal variations, with the highest values in winter and autumn and the lowest in spring and summer. When comparing PAH content in PM_{10} and $PM_{2.5}$ particle fractions, it was found that more than 80 % of PAHs measured in winter were bound to the smaller particle fraction ($PM_{2.5}$), except Chry, IP, and DahA. In summer, more than 60 % of the measured PAHs were bound to $PM_{2.5}$ particles, except for DahA, while in spring, more than 50 % of the measured PAHs were bound to $PM_{2.5}$ particles, except for Flu, BaP and BbF. Furthermore, after comparing PAH content in PM_1 and $PM_{2.5}$ fractions, it was found that most PAHs were bound to particle fraction PM_1, and the percentage of PAHs in PM_1 was the highest in winter (more than 90 %).

[1] Institute for Medical Research and Occupational Health, Ksaverska cesta 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Pehnec, G.[1], Jakovljević, I.[1], Sever Štrukil, Z.[1], Vađić, V.[1]

TREND MASENIH KONCENTRACIJA POLICIKLIČKIH AROMATSKIH UGLJIKOVODIKA U ZRAKU ZAGREB

Ključne riječi: *benzo(a)piren, lebdeće čestice, PM_{10}, ukupni PAU*

Policiklički aromatski ugljikovodici (PAU) su spojevi koji se sastoje od dva ili više povezana aromatska prstena. S obzirom da mnogi od njih imaju karcinogeno i mutageno djelovanje potrebno je kontinuirano pratiti njihove razine u okolišu. Benzo(a)piren (BaP) je najčešće određivani spoj iz te skupine, izraženog kancerogenog djelovanja, te je jedini predstavnik PAU za kojeg je Uredbom o razinama onečišćujućih tvari u zraku (Narodne novine 117/2012) propisana ciljna vrijednost (1 ng/m^3 za godišnji prosjek BaP u PM_{10} frakciji lebdećih čestica). Ista Uredba, kao i Direktiva 2004/107/EC Europskoga parlamenta i Vijeća, u svrhu utvrđivanja doprinosa benzo(a)pirena u sumi ostalih PAU propisuje i mjerenja ostalih policikličkih aromatskih ugljikovodika u zraku, među kojima se nalaze barem sljedeći spojevi: benzo(a)antracen, benzo(b)fluoranten, benzo(j)fluoranten, benzo(k)fluoranten, indeno(1,2,3-cd)piren i dibenzo(a,h)antracen. Koncentracije policikličkih aromatskih ugljikovodika u PM_{10} frakciji lebdećih čestica određuju se u Zagrebu od 2000. godine. Prikazani su rezultati mjerenja PAU u PM_{10} frakciji lebdećih čestica na jednoj lokaciji u Zagrebu u razdoblju od 2007. do 2016. godine. Uzorci PM_{10} frakcije lebdećih čestica sakupljani su u sjevernom, stambenom dijelu grada prosisavanjem približno 50 m^3 zraka kroz filtre od kvarcnih vlakana. Analiza uzoraka provedena je tekućinskom kromatografijom visoke djelotvornosti uz fluorescentni detektor s promjenjivim valnim duljinama pobuđivanja i emisije fluorescencije. Proučavan je trend koncentracija PAU u navedenom desetogodišnjem razdoblju. Srednje godišnje koncentracije BaP kretale su se od 0,735 ng/m^3 (2009. g.) do 1,443 ng/m^3 (2016. g.) te pokazuju trend rasta. Isti trend uočen je i za sumu sedam izmjerenih PAU. Prosječni udio BaP u sumi gore navedenih PAU kretao se između 19,6 % (u 2009. godini) i 25,7 % (u 2011. godini), dok je za određene dane udio BaP dosezao i do 67,7 %. Za razliku od masenih koncentracija PAU, udio BaP u njihovoj sumi ne pokazuje rastući trend.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska cesta 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Pehnec, G.[1], Jakovljević, I.[1], Sever Štrukil, Z.[1], Vađić, V.[1]

TREND OF POLYCYCLIC AROMATIC HYDROCARBON MASS CONCENTRATIONS IN THE AIR OF ZAGREB

Keywords: *benzo(a)pyrene, particulate matter, PM_{10}, total PAHs*

Polycyclic aromatic hydrocarbons (PAHs) are compounds that consist of two or more condensed aromatic rings. As some PAHs are proven carcinogens and mutagens, it is necessary to continuously monitor their levels in the environment. Benzo(a)pyrene is the most investigated compound from the group and has pronounced carcinogenic activity. It is the only PAH representative for which the Regulation on Levels of Pollutants in the Air (Official Gazette 117/2012) sets a target value (1 ng/m^3 for annual BaP average in PM_{10} particle fraction). The same Regulation, as well as Directive 2004/107/EC of the European Parliament and Council requires measurements of other polycyclic aromatic hydrocarbons in the air, including at least: benzo(a)anthracene, benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, and dibenz(a,h)anthracene. These measurements are required in order to assess the contribution of BaP in total PAHs. Concentrations of polycyclic aromatic hydrocarbons in the PM_{10} particle fraction have been measured in Zagreb since 2000. This investigation presents the results of PAH measurements for 2007-2016 at one location in Zagreb. Twenty-four-hour samples of PM_{10} particle fraction were collected in the northern, residential part of Zagreb from approximately 50 m^3 of ambient air on quartz filters. Analysis of samples was carried out by high performance liquid chromatography using fluorescence detection with changeable excitation and emission wavelength. The trend of PAH concentrations over the ten-year period was studied. Average annual concentrations of BaP ranged between 0.735 ng/m^3 (in 2009) and 1.443 ng/m^3 (in 2016), showing an increasing trend. The same increasing trend was observed for total PAHs. The average BaP contribution in the sum of the seven abovementioned PAHs varied between 19.6 % (in 2009) and 25.7% (in 2011), while on some days BaP contribution rose up to 67.7 %. Contrary to PAH mass concentration, the contribution of BaP did not show an increasing trend.

[1] Institute for Medical Research and Occupational Health, Ksaverska cesta 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Suhin, J.[1], Belavić, M.[1], Brzaj, S.[1], Brzoja, D.[1], Ćurkov, D.[1], Džaja Grgičin, V.[1], Milić, V.[1], Vidič, S.[1], Gugec, V.[1]

OCJENA KVALITETE ZRAKA U HRVATSKOJ NA OSNOVI REZULTATA MJERENJA I MODELIRANJA U RAZDOBLJU 2011.-2015. S OBZIROM NA ONEČIŠĆENJE OZONOM

Keywords: *osmosatni srednjaci, ciljne vrijednosti, mjerenje, modeliranje, AOT40*

Ozon je sekundarno onečišćenje koje nastaje fotokemijskim reakcijama u kojima sudjeluju njegovi prekursori, najčešće dušikovi oksidi, hlapivi organski spojevi i ugljikov monoksid. Ozon je tvar izrazitih oksidacijskih svojstava sa štetnim posljedicama na zdravlje ljudi i vegetaciju, a kao plin staklenika utječe i na globalno zatopljenje. Ozon predstavlja značajan problem kvalitete zraka u cijeloj Europi, osobito u područjima s izraženim fotokemijskim aktivnostima (Mediteran, Jugoistočna Europa) gdje se zbog jakog sunčevog zračenja prirodnim putem pojačavaju negativni učinci antropogenih izvora emisija prekursora ozona i njihovog daljinskog, prekograničnog i interkontinentalnog prijenosa. U ovome radu proučavani su mjereni i modelirani podaci prizemnih koncentracija ozona. Mjerenja koncentracija prizemnog ozona u Republici Hrvatskoj provode se na 17 postaja Državne mreže za trajno praćenje kvalitete zraka. Obrađeni modelirani podaci dobiveni su pomoću EMEP modela horizontalne rezolucije 50 km x 50 km. Model kao ulazne podatke koristi trodimenzionalna meteorološka polja dobivena meteorološkim modelom i podatke o godišnjim emisijama različitih kemijskih spojeva za područje Europe (ugljikov monoksid, nemetanski hlapljivi organski spojevi, itd.). Podaci o emisijama dobiveni su od Centra za emisije i projekcije (CEIP) dok su ulazni meteorološki podaci dobiveni modelom Europskog centra za srednjoročnu prognozu vremena (ECMWF).Ocjena kvalitete zraka rađena je na osnovi kriterija propisanih Uredbom o razinama onečišćujućih tvari u zraku (NN 117/2012) - najviša dnevna osmosatna srednja vrijednost, AOT40 parametar za zaštitu vegetacije i šuma, prag obavješćivanja i prag upozorenja. Uredbom su propisane ciljne vrijednosti i dugoročni ciljevi te dozvoljeni godišnji broj prekoračenja tih parametra. U promatranom razdoblju prekoračenja propisanih ciljnih vrijednosti najviših dnevnih osmosatnih srednjaka i AOT40 parametra zabilježena su na gotovo svim postajama. Ovdje izuzetak predstavljaju gradske postaje (Kutina, Osijek, Slavonski Brod) na kojima zbog lokalnog onečišćenja prvenstveno dušikovim spojevima (promet, industrija) dolazi do procesa kojima se uklanja ozon iz atmosfere, što za posljedicu ima niže koncentracije u odnosu na vrijednosti u ruralnim područjima. Kod modeliranih podataka prekoračenja se pojavljuju uglavnom nad područjem Jadrana.

[1] Državni hidrometeorološki zavod, Grič 3, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Suhin, J.[1], Belavić, M.[1], Brzaj, S.[1], Brzoja, D.[1], Ćurkov, D.[1], Džaja Grgičin, V.[1], Milić, V.[1], Vidič, S.[1], Gugec, V.[1]

ASSESSMENT OF OZONE POLLUTION LEVELS AND TRENDS IN CROATIA FOR THE PERIOD 2011-2015

Keywords: *AOT40, ozone, measurements, air quality modelling, EMEP*

Ozone is a secondary pollutant formed by photochemical reactions involving its precursors, predominantly nitrogen oxides, volatile organic compounds and carbon monoxide. Ozone is well-known as highly oxidizing compound with adverse effects on human health and vegetation. In addition, ozone is also a greenhouse gas that can contribute to global warming. Due to its photo-oxidant properties, capacity for regional, long-range continental transport and local production and destruction, ozone represents a significant air quality problem throughout Europe, particularly in areas with high photochemical activity (Mediterranean, Southeast Europe). In these areas, ozone pollution episodes can be intensified by strong solar radiation, local anthropogenic and natural emissions of ozone precursors as well as long-range and intercontinental transport of ozone precursors. In this paper we examine ozone pollution levels and trends in Croatia over the period 2011-2015 in order to assess the intensity and degree of pollution, both by measurement and EMEP model results. Since 2010 ground level measurements of ozone in Croatia are carried out at 17 stations of the State Air Quality Monitoring Network. EMEP regional transport and deposition model at 50 km x 50 km horizontal resolution scale was used for the assessment of concentration levels in areas where measurements are not established. Model input data, annual emissions (Source: CEIP LRTAP Convention) and meteorological fields (source: The European Centre for Medium-Range Weather Forecasts (ECMWF)) were used for each respective year calculations and model results compared with measurements. The analysis enabled the assessment of ozone pollution levels over Croatian territory for the period 2011-2015. Measured and modelled concentration values have been juxtaposed and verified against prescribed target value, maximum daily 8-hour mean and its exceedances, AOT40 parameter for the protection of forests and vegetation, notification and warning thresholds in accordance with the Regulation on levels of air pollutants NN 117/2012. Results of the analysis showed that at almost all stations, maximum daily 8 hour mean and AOT40 values were exceeded over the observed period. Exceptions are urban stations (Kutina, Osijek, Slavonski Brod), due to chemical titration processes sustained by local emissions of ozone precursors, primarily nitrogen and volatile organic compounds (traffic, industry). Concentrations in these urban areas are therefore lower compared to the values in rural areas. Modelled data compare well with measurements, although exceedances are obtained mainly at coastal areas and Adriatic islands.

[1] Meteorological and Hydrological Service, Grič 3, Zagreb,

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Franić, Z.[1], Marović, G.[1], Senčar, J.[1]

DUGOROČNO ISTRAŽIVANJE DISTRIBUCIJE OMJERA AKTIVNOSTI $^{134}Cs/^{137}Cs$ U UZORCIMA IZ OKOLIŠA U REPUBLICI HRVATSKOJ

Ključne riječi: *radiocezij, omjer aktivnosti $^{134}Cs/^{137}Cs$, radioaktivne oborine, nuklearni udes*

Poslije nesreća u nuklearnim elektranama u Černobilu (godine 1986.) i Fukushima Daiichi (2011.) u okoliš su se oslobodile velike količine radiocezija. Budući da se ^{134}Cs u eksplozijama fisijskog nuklearnog oružja, koje se dešavaju u milisekundama, ne stvara u značajnijim količinama, taj radionuklid tijekom perioda intenzivnih atmosferskih pokusa nuklearnog oružja nije bio prisutan u globalnim radioaktivnim oborinama (fallout), a stoga niti u okolišu. Međutim, ^{134}Cs se nalazi u reaktorskom inventaru zbog dugoga vremena ozračivanja reaktorskog goriva, gdje nastaje zahvatom neutrona od stabilnog ^{133}Cs, koji je uobičajeni fisijski produkt. Posljedično, prisutnost ^{134}Cs u okolišu jasno ukazuje da se desio nuklearni udes. U ovom istraživanju su predstavljeni rezultati dugogodišnjeg istraživanja omjera aktivnosti $^{134}Cs/^{137}Cs$ i njegov transfer od zraka i radioaktivnih oborina u ostale uzorke iz okoliša u Republici Hrvatskoj nakon nuklearnih nesreća u Černobilu i Fukushima Daiichi. Nakon černobilske nesreće vrijednost omjera aktivnosti $^{134}Cs/^{137}Cs$ od oko 0,55 zabilježena je u gotovo svim uzorcima iz okoliša, te je odražavao inventar radiocezija u jezgri oštećenog reaktora. Međutim, nakon nesreće u Fukushima Daiichi elektrani, iako je omjer aktivnosti $^{134}Cs/^{137}Cs$ u zraku i radioaktivnim oborinama u Republici Hrvatskoj bio sličan onome koji je zabilježen na samome mjestu nesreće, u ostalim uzorcima iz okoliša bio je vrlo varijabilan, budući da je na njega utjecala koncentracija aktivnosti ^{137}Cs prisutna u okolišu iz pred-fukushimskog razdoblja.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c.2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Franić, Z.[1], Marović, G.[1], Senčar, J.[1]

LONG TERM INVESTIGATION OF DISTRIBUTION OF THE $^{134}Cs/^{137}Cs$ ACTIVITY RATIO IN ENVIRONMENTAL SAMPLES IN THE REPUBLIC OF CROATIA

Keywords: *radiocaesium, $^{134}Cs/^{137}Cs$ activity, fallout, nuclear accident*

Large amounts of radiocaesium were released into the environment by the Chornobyl (1986) and Fukushima Daiichi (2011) nuclear power plant accidents. As ^{134}Cs is not in significant amounts produced in nuclear explosions of fission weapons, which occur in milliseconds, it was not during the period of intensive atmospheric tests of nuclear weapons present in the global fallout and therefore in the environment. ^{134}Cs is, however, found in reactor inventories due to long irradiation times of reactor fuels where it is produces via neutron capture from stable ^{133}Cs, which is a common fission product. Therefore, the presence of ^{134}Cs in the environment clearly indicates that the nuclear accident occurred. In this work are presented the results of long term investigations of $^{134}Cs/^{137}Cs$ activity ratio in Republic of Croatia and its transfer from air and fallout to other environmental samples after respective Chornobyl and Fukushima Daiichi nuclear accidents. After the Chornobyl nuclear accident this ratio, of about 0.55, has been quite similar in most of the samples analysed in Republic of Croatia, reflecting the radiocaesium inventory in the core of the damaged reactor. After the Fukushima Daiichi accident, although $^{134}Cs/^{137}Cs$ activity ratio observed in air and fallout samples collected in Croatia, was quite similar to the value reported for accident site, in other environmental samples it was extremely variable as it was influenced by the pre-Fukushima ^{137}Cs activity concentration already present in the environment.

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Vidič, S.[1], Džaja Grgičin, V.[1], Igrec, I.[1]

TREND KEMIJSKOG SASTAVA OBORINE (1981.-2016.) U HRVATSKOM DIJELU PANONSKOG PODRUČJA

Ključne riječi: *kvaliteta oborine, taloženje, modelirane vrijednosti koncentracija, dugoročni trend*

Doprinos atmosferskog taloženja oborinom prati se u Hrvatskoj na postajama Državnog hidrometeorološkog zavoda od 1981. godine. Iz dnevnih uzoraka oborine određuje se njena kiselost i koncentracije glavnih iona. Iako se općenito, smatralo se da je atmosferski doprinos oborinom relativno mali u usporedbi onim koji je praćen u industrijskim zemljama Zapadne Europe, skandinavskim zemljama i zemljama Srednje Europe, mjerenja su pokazala da je bio značajan kao pokazatelj daljinskog, prekograničnog prijenosa onečišćenja te kao indikator i mjerilo uspješnosti provođenja zajedničke politike smanjivanja emisija onečišćujućih tvari na području Europe u posljednjih 30 godina.

U ovome radu prikazane su prostorne i vremenske promjene kemijskog sastava oborine na 18 mjernih postaja u razdoblju od 1981.-2016. godine. Izrađena je analiza sezonskih i godišnjih trendova primjenom neparametarskog Mann-Kendall-ovog testa jačine trenda i Sen's-ovog estimatora nagiba trenda.

Rezultati analize pokazuju da su se koncentracije iona sulfata i nitrata u oborini, komponenata najzaslužnijih za procese eutrofikacije i zakiseljivanja okoliša, postepeno smanjivale tijekom razmatranog razdoblja, osobito u središnjem dijelu i na jugu Hrvatske. Najveći trend smanjenja uslijedio je sredinom 90-tih godina prošloga stoljeća. Središnji i južni dijelovi Hrvatske gdje je trend statistički značajan pokazuju i slična obilježja s obzirom na jačinu i nagib trenda dok je u području Panonske Hrvatske trend blaži i slabe je statističke značajnosti. Zbog toga možemo zaključiti da su se okolnosti prijenosa onečišćujućih tvari na područje Hrvatske promijenile, da nisu jedinstvenog predznaka u svim regijama i da ih treba dovoditi u vezu s redistribucijom glavnih emisijskih područja u Europi i našem neposrednom okruženju. Dok su se emisije u zemljama zapadne Europe značajno smanjile (više od 80 % u slučaju sumporovih oksida) emisije u zemljama istočne Europe i zemljama Balkana i dalje se zasnivaju na ugljenu kao sirovini npr. u energetskom sektoru. Nakon ekonomske krize 2008. godine kućanstva su također postala značajniji izvor onečišćenja budući da se prešlo na loženje drvnom masom kao jeftinijim gorivom. Posljedice ovih promjena u ponašanju i navikama postale su mjerljive i u kemijskom sastavu oborine tako da se Panonsko područje počelo izdvajati kao područje najvećeg opterećenja taloženjem iona sulfata i nitrata.

[1] Državni hidrometeorološki zavod, Grič 3, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Vidič, S.[1], Džaja Grgičin, V.[1], Igrec, I.[1]

PRECIPITATION CHEMISTRY TRENDS (1981-2016) IN CROATIAN PART OF THE DANUBE REGION

Keywords: *precipitation quality, deposition, model calculations, long-term trends*

The contribution of atmospheric input to the overall deposition of pollutants through precipitation has never been considered a serious problem in Croatia. Relatively low emission rates of pollutants, especially when compared to ones of industrially developed European countries, created an impression that this region could not be dramatically affected by pollution of atmospheric origin. Nevertheless, atmospheric deposition monitoring programme has been established and operationally run within regular meteorological observational network since 1981. Chemical composition of precipitation, sampled on a daily basis, has been used as a valuable indicator for regional and long-range transport of pollutants and matrix for successfulness of emission reduction policies in Europe over the last 30 years.

Spatial, temporal and trend changes in precipitation chemistry over the period 1981-2016 were analysed using the data from 18 sampling sites spatially distributed over Croatian territory. Volume weighted average concentrations of major ions in precipitation samples (sulphate, nitrate, chloride, ammonium, calcium, magnesium, sodium, potassium) and acidity (pH) are calculated for each year and season. The trend analysis was performed and tested by nonparametric Mann-Kendall test and Sen's slope estimator.

Results showed that sulphate and nitrate ion concentrations significantly decreased for majority of sites in central and southern regions of Croatia. The main decline of sulphate ion concentration occurred after 1990. Changes in anthropogenic sulphur emission patterns over Europe in the last two decades resulted in different acidity and sulphate ion concentrations in relation to particular sector compared to earlier times. In additions, precipitation chemistry is influenced by geographical and climatological diversity. While central and southern parts of Croatia exhibit similar trend behaviour (trend slope and significance level), results for Pannonian region show a much slower decrease without statistical significance. Therefore it cannot be assumed that decline of atmospheric deposition of pollutants is significant. Main reasons could be related to the fact that in most neighbouring countries (Slovenia, Serbia, Bosnia and Herzegovina, and Bulgaria) locally mined coal with higher content of sulphur is used in industry and electrical power generation as major fuel. This became much more pronounced since 2008 with economic crisis that also reversed the trend of cleaner fuel usage for residential heating. Due to the lower prices households started to use again cheaper solutions for burning, like wood or coal, instead of already installed natural gas option. Effects of these behavioural changes are therefore measurable in precipitation chemistry parameters of the last decade in Croatian part of Pannonian basin.

[1] Meteorological and Hydrological Service, Grič 3, 10000 Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Žužul, S.[1], Rinkovec, J.[1], Mihaljević, A.[1], Vađić, V.[1]

RAZINE METALA U UKUPNOJ TALOŽNOJ TVARI U ZAGREBU U RAZDOBLJU OD 2000. DO 2016. GODINE

Ključne riječi: *arsen, kadmij, nikal, olovo, trend*

U cilju očuvanja kvalitete življenja, zaštite vegetacije i ekosustava, a posredno i zaštite zdravlja ljudi, kao jedan od parametara praćenja onečišćenja zraka hrvatska zakonska regulativa propisuje praćenje ukupne taložne tvari (UTT) i metala u ukupnoj taložnoj tvari. Razina ukupne taložne tvari, te olova i kadmija u ukupnoj taložnoj tvari u gradu Zagrebu određuje se već dulji niz godina (prva mjerenja taložne tvari započela su još 1961. godine) dok su kontinuirana mjerenja arsena i nikla u ukupnoj taložnoj tvari u gradu Zagrebu započela 2007. godine.

Cilj ovog istraživanja bio je prikazati kretanje razine ukupne taložne tvari i metala arsena, kadmija, nikla i olova u ukupnoj taložnoj tvari te ispitati njihov trend. Mjesečni uzorci ukupne taložne tvari sakupljani su Bergerhoffovim sakupljačem na mjernoj postaji smještenoj u sjevernom dijelu grada Zagreba, a ukupna taložna tvar određena je gravimetrijski. Razine arsena, kadmija, nikla i olova određene su metodama atomske apsorpcijske spektrofotometrije i spektrometrijom masa uz induktivno spregnutu plazmu. Rezultati pokazuju da su srednje godišnje vrijednosti količine UTT u razdoblju od 2000. do 2016. godine iznosile od 61 mg/(m^{2}d) do 127 mg/(m^{2}d). Rezultati pokazuju slabo padajući trend koji nije statistički značajan. Srednje godišnje vrijednosti olova u razdoblju od 2000. do 2016. iznosile su od 2,5 μg/(m^{2}d) do 20,0 μg/(m^{2}d), dok su se za kadmij vrijednosti kretale od 0,02 μg/(m^{2}d) do 2,18 μg/(m^{2}d). Razine olova i kadmija u UTT od 2000. godine imaju statistički značajan padajući trend, dok u razdoblju od posljednjih deset godina nema jasnog trenda. Srednje godišnje vrijednosti arsena u UTT u razdoblju od 2007. do 2016. godine iznosile su od 0,41 μg/(m^{2}d) do 0,81 μg/(m^{2}d), a nikla od 2,82 μg/(m^{2}d) do 5,34 μg/(m^{2}d). Rezultati dobiveni za arsen i nikal ne pokazuju jasan trend. Ocjena kvalitete zraka prema Uredbi o razinama onečišćujućih tvari u zraku (NN br. 117/2012) pokazuje da su sve vrijednosti za mjerena onečišćenja u promatranom razdoblju bile ispod graničnih vrijednosti, osim za kadmij u 2005. godini.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Žužul, S.[1], Rinkovec, J.[1], Mihaljević, A.[1], Vađić, V.[1]

LEVELS OF METALS IN TOTAL DEPOSITED MATTER IN ZAGREB FROM 2000 TO 2016

Keywords: *arsenic, cadmium, lead, nickel, trend*

With the objective of protecting the quality of life, flora and fauna, ecosystems, and indirectly, human health, Croatian legislation set out to regulate the monitoring of total deposited matter (TDM) and metal content in TDM. Deposited matter and levels of lead and cadmium in deposited matter have been monitored in Zagreb's air for many years (first measurement of deposited matter started in 1961), while the continuous measurement of arsenic and nickel in TDM started in 2007.

The aim of this investigation was to examine the levels of total deposited matter and arsenic, cadmium, nickel and lead in TDM and determine their trends. Monthly samples of total deposited matter were collected with a Bergerhoff-type deposit gauge at a sampling site in the northern part of Zagreb and the amount of TDM was determined by gravimetry. Contents of arsenic, cadmium, nickel and lead in TDM were analysed with atomic absorption spectrometry and inductively coupled plasma mass spectrometry. Results showed that the annual mean values of TDM in the period from 2000 to 2016 were between 61 mg/(m^{2}d) and 127 mg/(m^{2}d). The results also showed a slightly decreasing trend but the decrease was not statistically significant. The annual mean values of lead in TDM in the period from 2000 to 2016 were from 2.5 μg/(m^{2}d) to 20.0 μg/(m^{2}d) and for cadmium from 0.02 μg/(m^{2}d) to 2.18 μg/(m^{2}d). Levels of lead and cadmium decreased significantly, but with no trend over the last ten years. The annual mean values of arsenic in TDM between 2007 and 2016 varied from 0.41 μg/(m^{2}d) to 0.81 μg/(m^{2}d) and for nickel from 2.82 μg/(m^{2}d) to 5.34 μg/(m^{2}d) with no significant trend. All of the values of the observed pollutants were below limit values according to the Regulation on Levels of Pollutants in Ambient Air (OG No. 117/2012), except for cadmium in 2005.

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Milić, V.[1], Džaja Grgičin, V.[1], Belavić, M.[1], Brzaj, S.[1], Brzoja, D.[1], Ćurkov, D.[1], Suhin, J.[1], Vidič, S.[1], Gugec, V.[1]

OCJENA KVALITETE ZRAKA U HRVATSKOJ NA OSNOVI REZULTATA MJERENJA I MODELIRANJA U RAZDOBLJU 2011.-2015. S OBZIROM NA ONEČIŠĆENJA NO_2, CO I C_6H_6

Ključne riječi: *dušikov dioksid, ugljikov monoksid, benzen, mjerenje, modeliranje kvalitete zraka, EMEP*

U atmosferi možemo naći veliki broj spojeva dušikovih oksida (NO_x), ali s aspekta utjecaja na ljudsko zdravlje dušikov dioksid (NO_2) od osobitog je interesa. Dušikov dioksid je vrlo jak oksidans te kao značajan atmosferski plin ne samo da utječe na ljudsko zdravlje nego i apsorbira sunčevo zračenje u vidljivom dijelu spektra, smanjuje atmosfersku vidljivost, te kao plin staklenika može imati neposredni utjecaj na klimatske promjene. Osim toga, zajedno s dušikovim monoksidom (NO) ima važnu ulogu u atmosferi kao regulator oksidacijskog kapaciteta kontrolirajući stvaranje i sudbinu slobodnih radikala u troposferi te ima kritičnu ulogu u stvaranju i razaranju troposferskog ozona i u čistoj i u onečišćenoj atmosferi. Zbog toga je praćenje koncentracija dušikovih oksida uspostavljeno kao zakonska obveza u svim zemljama Europske unije (i šire) i propisane su granične vrijednosti, kao zaštitni mehanizam, kako s obzirom na zdravlje ljudi tako i s obzirom na zaštitu vegetacije i opterećenje okoliša općenito. Ugljikov monoksid je plin bez boje i mirisa, prisutan u tragovima u atmosferi te također ima ulogu prilikom stvaranja prizemnog ozona i smoga. Većina antropogenih emisija ugljikovog monoksida posljedica je nepotpunog izgaranja fosilnih goriva. Prirodni izvori ugljikovog monoksida su prostorno i vremenski varijabilni (vulkani, požari). Ugljikov monoksid zadržava se u prosjeku dva mjeseca u troposferi jer prirodnim procesima oksidira u ugljikov dioksid. Benzen je bezbojna, lako hlapljiva, zapaljiva, kancerogena i otrovna tekućina jakog mirisa te postoji dobro utvrđena veza između dugoročnog izlaganja parama benzena i pojave raka kod ljudi. Zbog lake hlapljivosti benzen se ne zadržava u tlu i vodi te izloženost ovoj tvari proizlazi iz koncentracija prisutnih u zraku. Najveći izvori benzena su promet i industrija. Ocjena kvalitete zraka za sve tri navedene tvari rađena je prema Uredbi o razinama onečišćujućih tvari u zraku NN 117/2012 kojom su definirane godišnje granične vrijednosti za NO_2, CO i C_6H_6, satna/8-satna granična vrijednosti i učestalost dozvoljenih prekoračenja za NO_2. Analizirani su podaci koncentracije plinova sa postaja Državne mreže za trajno praćenje kvalitete zraka u razdoblju 2011.-2015. godine. Analiza rezultata modeliranja rasprostiranja i taloženja onečišćujućih tvari (EMEP) provedena je s ciljem stjecanja što potpunije slike o stanju kvalitete zraka i na područjima gdje se mjerenja ne provode. Rezultati mjerenja i modeliranja pokazuju da su vrijednosti satnih i dnevnih vrijednosti koncentracija promatranih spojeva većinom unutar dozvoljenih granica, ali da postoji karakterističan godišnji hod koji pokazuje da su u hladnom dijelu godine vrijednosti višestruko više nego u toplom dijelu godine, te da se usprkos tome što su godišnje razine koncentracija zadovoljavajuće razine moraju planirati mjere za smanjivanje negativnog utjecaja promatranih spojeva u zimskom periodu, osobito u gradskim sredinama s velikim udjelom prometnih izvora.

[1] Državni hidrometeorološki zavod, Grič 3, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Milić, V.[1], Džaja Grgičin, V.[1], Belavić, M.[1], Brzaj, S.[1], Brzoja, D.[1], Ćurkov, D.[1], Suhin, J.[1], Vidič, S.[1], Gugec, V.[1]

ASSESSMENT OF NITROGEN DIOXIDE, CARBON OXIDE AND BENZENE POLLUTION LEVELS AND TRENDS IN CROATIA FOR THE PERIOD 2011-2015

Keywords: *nitrogen dioxide, carbon monoxide, benzene, measurement, air quality modelling, EMEP*

There is a large number of nitrogen oxide compounds (NO_x) in the atmosphere, but from the aspect of human health impact nitrogen dioxide (NO_2) is of particular interest. Nitrogen dioxide is a very strong oxidant, absorbs solar radiation in the visible part of the spectrum, thus reducing atmospheric visibility, and as a greenhouse gas, can have a direct impact on climate change. Additionally, and together with nitrogen monoxide (NO) it plays an important role as a regulator of oxidizing capacity of the free troposphere by controlling the build-up and the fate of free radical species. Together, they play a critical role in the cycle of creation and destruction of tropospheric ozone (in clean and polluted atmosphere). Consequently, the monitoring of nitrogen oxides concentrations has been established as a legal obligation in all EU countries (and worldwide). Exceedance limit values are set as a safeguard mechanism for both, human health and protection of the environment. Carbon monoxide is a colourless and odourless gas, present in traces in the troposphere. It also contributes to the formation of ground level ozone and smog. Most of the anthropogenic carbon monoxide comes as a direct result of incomplete combustion of fossil fuels. Natural sources of carbon monoxide are generally attributed to forest fires and volcanic activity, and as such are temporally and spatially varied. Carbon monoxide persists in the troposphere for about two months, oxidizing to carbon dioxide by natural processes. Benzene is a colourless, volatile, flammable, carcinogenic and poisonous liquid with strong odour. It is a regulated substance since a well-established link between long term exposure and cancer in humans exists. Due to its volatility, benzene is not persistent in soil and surface waters; consequently, major exposure path comes via inhalation. Main emission sources of benzene are traffic and industry. Air quality assessment of these substances was made taking into account provisions of the Regulation on limit values of air pollutants (NN 117/2012). Regulation defines annual limit values for NO_2, CO, C_6H_6, hourly and 8-hourly limit value for NO_2 and CO respectively, and the number of exceedances for NO_2 hourly and daily concentration values. Concentration values for the period 2011-2015 were obtained from continuous measurements of these pollutants at the State Air Quality Monitoring Network. In order to provide a comprehensive and complete assessment of air quality in areas where there are no direct measurements EMEP regional transport model has been used. Both, measurement and modelling results show that hourly and daily concentration values of all analysed pollutants (NO_2, CO and benzene) fulfil required criteria set out in the Regulation and are below prescribed limit values. Nevertheless, there is a characteristic annual course depicting considerably higher concentrations in a wintertime periods, particularly in urban environments that suggests the need for continuous efforts for reducing emissions of these pollutants in the cities.

[1] Meteorological and Hydrological Service, Grič 3, 10000 Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Brzaj, S.[1], Džaja Grgičin, V.[1], Belavić, M.[1], Brzoja, D.[1], Ćurkov, D.[1], Milić, V.[1], Suhin, J.[1], Vidič, S.[1], Gugec, V.[1]

OCJENA KVALITETE ZRAKA U HRVATSKOJ NA OSNOVI REZULTATA MJERENJA I MODELIRANJA U RAZDOBLJU 2011.-2015. S OBZIROM NA ONEČIŠĆENJE SUMPOROVIM DIOKSIDOM, SUMPOROVODIKOM I AMONIJAKOM

Ključne riječi: *kvaliteta zraka, sumporov dioksid, sumporovodik, amonijak, EMEP model*

Prirodni izvori sumporovih oksida poput vulkana i šumskih požara doprinose pozadinskom onečišćenju atmosfere sudjelujući u njihovom daljinskom i prekograničnom prijenosu, dok je industrijska aktivnost najveći izvor onečišćenja ovim spojevima na lokalnoj i regionalnoj skali. Na visoke koncentracije sumporovog dioksida posebno su osjetljive osobe sa zdravstvenim problemima dišnog sustava. Sumporna kiselina, koja se razvija nizom reakcija iz sumporovih oksida, štetno djeluje na vegetaciju i prirodan ekosustav. Sumporovodik je bezbojan plin izrazito neugodnog mirisa te u povećanim koncentracijama utječe negativno na kvalitetu življenja. Nadalje, sumporovodik i amonijak indikatori su industrijskog onečišćenja. Ocjena kvalitete zraka na teritoriju Republike Hrvatske rađena je prema kriterijima propisanim Uredbom o razinama onečišćujućih tvari u zraku (NN 117/2012). Neki od promatranih parametara su broj prekoračenja satne i dnevne granične vrijednosti s obzirom na zaštitu zdravlja ljudi, pragovi procjene koncentracija s obzirom na zaštitu vegetacije i prirodnog ekosustava te granične vrijednosti koncentracija s obzirom na kvalitetu življenja (dodijavanje mirisom). U radu su korišteni petogodišnji satni vremenski nizovi mjerenih podataka prizemnih koncentracija sumporovog dioksida te sumporovodika dobiveni iz Državne mreže za trajno praćenje kvalitete zraka. Nadalje, obrađeni su modelirani podaci proračunatih prizemnih koncentracija sumporovog dioksida na osnovi EMEP regionalnog modela prijenosa i taloženja onečišćujućih tvari horizontalne rezolucije 50 km x 50 km. Ulazni podaci modela su godišnje vrijednosti emisija onečišćujućih tvari (npr. sumporovi oksidi, lebdeće čestice, nemetanski hlapljivi organski spojevi i dr.) za područje Europe (izvor: Centar za emisije i projekcije (CEIP) LRTAP Konvencije) te meteorološki podaci dobiveni modelom Europskog centra za srednjoročnu prognozu vremena (ECMWF). Rezultati analize promatranog petogodišnjeg razdoblja pokazuju da dozvoljen broj prekoračenja dnevnih i satnih graničnih vrijednosti koncentracija sumporovog dioksida s obzirom na zaštitu zdravlja ljudi nije prekoračena niti na jednoj postaji, dok je dozvoljen broj prekoračenja satne granične vrijednosti koncentracija sumporovodika s obzirom na kvalitetu življenja (dodijavanje mirisom) prekoračen na postajama Slavonski Brod-1 i Sisak-1.

[1] Državni hidrometeorološki zavod, Grič 3, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Brzaj, S.[1], Džaja Grgičin, V.[1], Belavić, M.[1], Brzoja, D.[1], Ćurkov, D.[1], Milić, V.[1], Suhin, J.[1], Vidič, S.[1], Gugec, V.[1]

ASSESSMENT OF SULPHUR DIOXIDE, HYDROGEN SULPHIDE AND AMMONIA POLLUTION LEVELS AND TRENDS IN CROATIA FOR THE PERIOD 2011-2015

Keywords: *air quality, sulphur dioxide, hydrogen sulphide, ammonia, model EMEP*

Natural sources of sulphur oxides such as volcanoes and forest fires contribute to the background pollution of the atmosphere by participating in their remote and transboundary transmission, while industrial activities represent the largest source of respective pollution on a local and regional scale. Individuals with health problems of the respiratory system are particularly sensitive to high concentrations of sulphur dioxide. Sulfuric acid, produced as a result of series of sulphur oxide reactions, has a well-known adverse effect on vegetation and natural ecosystem. Hydrogen sulphide, a colourless gas of extremely unpleasant odour that in increased concentrations negatively affects the quality of life, as well as ammonia, signifies characteristic industrial pollution indicators. In this work we examine observed and modelled concentration levels of these pollutants, their time evolution and assessment over the period 2011-2015. An assessment is made in accordance with provisions of the Regulation on limit values of air pollutants (NN 117/2012), comprising the number of exceedances of hourly and daily limit values for the protection of human health, the thresholds of concentration estimation with regard to the protection of vegetation and natural ecosystems and the limit values concerning the quality of life (smell nuisance). In addition, five-year time series of ground level concentrations of sulphur dioxide, measured at monitoring sites of the State Air Quality Monitoring Network were analysed in parallel with model calculations. The EMEP regional transport and deposition model at 50 km x 50 km horizontal resolution scale was used for the assessment of concentration levels in areas where measurements are not established. Model input data, annual emissions (Source: CEIP LRTAP Convention) and meteorological fields (source: The European Centre for Medium-Range Weather Forecasts (ECMWF)) were used for each respective year calculation. The results of the analysis showed that, with respect to the health protection criteria for the number of exceedances of daily and hourly limit values for sulphur dioxide, there are no exceedances, while the number of exceedances of the hourly limit value for hydrogen sulphide concentrations regarding the quality of life (smell nuisance) criteria were exceeded at Slavonski Brod-1 and Sisak-1 measurement stations, both located in the industrial zone (zone HR02).

[1] Meteorological and Hydrological Service, Grič 3, 10000 Zagreb, Croatia

Tema 4
Razvoj i provjera mjernih metoda

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Radanović, T.[1], Zobaj, E.[1]

STANDARDNI REFERENTNI FOTOMETAR UMJERNOG LABORATORIJA DHMZ-A – BUDUĆI NACONALNI ETALON ZA PRIZEMNI OZON

Ključne riječi: *ozon, sljedivost, standardni referentni fotometar, umjerni laboratorij*

Osiguranje sljedivosti mjerenja prizemnog ozona sukladno normi HRN EN ISO/IEC 17025 predstavlja jedan od temeljnih uvjeta Direktive 2008/50/EC Europske Unije (tzv. „CAFE“ direktive) kao i priloga VI. i IX. Direktive 2015/1480. Poslove umjeravanja i osiguranja sljedivosti provode se u svrhu zadovoljenja kvalitete podataka na mjernim postajama Državne mreže za praćenje kvalitete zraka i EMEP-ovim mjernim postajama za čiji rad i validaciju podataka je odgovoran Državni hidrometeorološki zavod (DHMZ) Republike Hrvatske unutar kojeg je ustrojena Samostalna služba za umjerni laboratorij (DHMZ-SOUL). Priča o prizemnom ozonu počela je još 2002. godine kada je nabavljen prvi etalon s generatorom ozona a 2012. godine SOUL je od strane Hrvatske akreditacijske agencije akreditiran za umjeravanje mjerila prizemnog ozona. U 2016. godini unaprjeđenje rada i etalonske opreme rezultiralo je nabavom i instalacijom standardnog referentnog fotometra (SRP broj 58), svjetski priznatog primarnog etalona za prizemni ozon, kojeg proizvodi National Institute for Standards and Technology (NIST) iz Sjedinjenih Američkih Država. S obzirom da je SRP definicijski etalon za njega nije potrebno umjeravanje i njegova se sljedivost osigurava izravnim sudjelovanjem u ključnim usporedbama (key-comparisons) koje provodi Bureau International des Poids et Mesures (BIPM) u Parizu. Navedenim dostignućima SOUL ispunjava sve preduvjete za realizaciju nacionalnog etalona za ozon i time osigurava izravnu potporu nacionalnoj mjeriteljskoj infrastrukturi. Trenutno je SOUL DHMZ-a u postupku da postane nacionalni laboratorij za prizemni ozon. Ovim radom prikazuje se hijerarhija osiguranja sljedivosti prizemnog ozona, princip rada i razvoj etalonskog sustava za prizemni ozon u SOUL-u te su prikazani preliminarni rezultati interkomparacije SRP-a DHMZ-a sa međunarodnim primarnim etalonom SRP-om broj 2 koji je u vlasništvu NIST-a. Izuzev navedenog, u radu je dana i usporedba rezultata umjeravanja primarnog standarda sa vlastitim SRP-om i sa SRP-om broj 17 koji je u vlasništvu Češkog hidrometeorološkog instituta iz Praga, a u kojem je primarni standard DHMZ-SOUL-a bio umjeravan do nabave vlastitog SRP-a. Iz rezultata vidljiva je izuzetna stabilnost primarnog etalona te usprkos činjenici da se radi o najnovijem modelu SRP-a i SRP-u broj 17 koji je konstruiran prije mnogo godina (ali su mu dodane sve nadogradnje koje je NIST radio na novijim modelima) O_3 primarni kalibrator DHMZ-a je pokazivao iste ili vrlo slične vrijednosti na odabranim točkama kao i oba SRP-a koja su korištena kao generatori ozona.

[1] Državni hidrometeorološki zavod, Samostalna služba za umjerni laboratorij, Grič 3, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Radanović, T.[1], Zobaj, E.[1]

STANDARD REFERENCE PHOTOMETER (SRP) AT CALIBRATION LABORATORY OF MHSC - NATIONAL STANDARD FOR OZONE IN NEAR FUTURE

Keywords: *ozone, traceability, standard reference photometer, calibration laboratory*

Ensuring the traceability of surface ozone measurements in accordance with the HRN EN ISO/IEC 17025 is one of the key preconditions of the EU Directive 2008/50/EC (so called „CAFÉ" directive) and also of Annex VI. and IX. from Directive 2015/1480. The calibration and traceability assurance activities are carried out for the purpose of satisfying the quality of the data at the National Air Quality Monitoring Network and EMEP metering stations for which the operation and validation of the data are the responsibility of the Meteorological and Hydrological Service of the Republic of Croatia (MHSC) within the Independent Service for Calibration laboratory (MHSC-SOUL) is established. The story of measuring ground-level ozone begins in 2002 when the primary standard with the ground-level ozone generator was procured. In 2012 SOUL has been accredited by Croatian Accreditation Agency for the calibration of ozone analysers. Ongoing improvement process resulted in purchasing and installation of Standard Reference Photometer (SRP) No. 58, a worldwide recognized and accepted primary definition ozone standard, in 2016. SRPs are manufactured by the National Institute for Standards and Technology (NIST) in USA. Traceability assurance of SRPs, is achieved by the key comparisons, organised by the Bureau International des Poids et Mesures (BIPM) in Paris. By the above mentioned achievements MHSC-SOUL fulfils all the necessary preconditions for establishment of the national standard for ozone. Doing so, it provides a direct support to the national metrological infrastructure. Currently, MHSC-SOUL is in the process of becoming a national laboratory for ozone. This paper describes the traceability hierarchy for ozone, working principle and the development of ozone calibration system at SOUL and the preliminary results of the intercomparison with NIST primary definition standard, SRP No. 2 owned by NIST. Also, in this paper is presented a comparison between the results of calibration of primary standard with SRP No. 58 and SRP No. 17 owned by the Czech Hydrometeorological Institute located in Prague, where the primary standard of SOUL-MHSC was calibrated until MHSC didn`t purchase its own SRP. From the results it is visible that primary standard is very stable and that the latest model of SRP and SRP No. 17, which has been designed many years ago (but had included all of the upgrades NIST has been using on newer models). SRP`s were used to generate and measure ozone on fixed points and the O_3 primary calibrator of MHSC showed the same or very similar values as SRP`s.

[1] Državni hidrometeorološki zavod, Samostalna služba za umjerni laboratorij, Grič 3, Zagreb, Hrvatska

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Čavlović, A.O.[1], Šega, K.[2], Bešlić, I.[2]

ANALIZA POUZDANOSTI MJERNE METODE ODREĐIVANJA MASENE KONCENTRACIJE DRVNE PRAŠINE OSOBNIM SAKUPLJAČIMA

Ključne riječi: *drvna prašina, lebdeće čestice, masena koncentracija, minimalno trajanje pouzdanog sakupljanja (t_{minS}), minimalno trajanje sakupljanja za pouzdano vaganje (t_{minV})*

Ovim radom analizirana je pouzdanost mjerne metode određivanja masenih koncentracija respirabilne frakcije i koncentracija ukupne drvne prašine u zraku. Ispitivanja su provedena u šest drvoprerađivačkih proizvodnih pogona i tri stolarije. Normom HRN CEN/TR 15230:2005 Atmosfere radnih prostora – Smjernice za uzorkovanje inhalabilnih, torakalnih i respirabilnih frakcija aerosola definirana je minimalna količina uzorka za analizu izražena minimalnim trajanjem pouzdanog sakupljanja (t_{minS}) i minimalnim trajanjem sakupljanja za pouzdano vaganje (t_{minV}) uzorka lebdećih čestica. Prema izračunatom minimalno potrebnom trajanju uzorkovanja dobiju se i minimalna masa pouzdanog sakupljanja uzorka (m_{minS}) i minimalna masa pouzdanog vaganja (m_{minV}) grupe uzoraka lebdeće drvne prašine sakupljane na istom radnom mjestu.

Cilj analize je odrediti značaj utjecajnih čimbenika na minimalno trajanje pouzdanog sakupljanja i minimalno trajanje sakupljanja za pouzdano vaganje uzorka lebdećih drvnih čestica. Promatran je utjecaj mjernih uređaja, stvarnog vremena sakupljanja uzorka, standardne devijacije mase uzorka te vrijednosti masene koncentracije.

Korišteni su parovi mjerne opreme osobnih sakupljača respirabilne frakcije i ukupne prašine proizvođača Casella (Bedford, UK). Vaganje uzoraka obavljeno je mikrovagom Cahn G.2 (Cahn, USA) odnosno mikrovagom METTLER-TOLEDO MX-5 (Greifensee, Švicarska). Mjernom opremom A uzorkovalo se na 14 različitih mjernih mjesta s prosječno 11 ponavljanja a mjernom opremom B na 11 različitih radnih mjesta s prosječno 13 ponavljanja. Dobivene aritmetičke sredine ukupnih podataka (N_A=308; N_B=286) određivanih masenih koncentracija pokazuju da je sakupljanje lebdećih čestica bilo pouzdanije mjernom opremom A nego opremom B. No zbog velikog rasipanja vrijednosti mase uzoraka, statističko neparametarsko testiranje potvrđuje značajnu razliku pouzdanosti rada dvaju mjernih uređaja samo za respirabilnu frakciju drvne prašine ($p<0,001$) dok razlika pouzdanosti sakupljanja ukupne prašine s uređajima A i B, nije statistički značajna (p_{tminS} =0,3; p_{tminV}=0,64). Pokazalo se da statistički značajan utjecaj na pouzdanost sakupljanja lebdećih čestica ima standardna devijacija mase uzoraka unutar grupe ponavljanja uzorkovanja (k iznosi od 0,4 do 0,9). Isto tako, za veću pouzdanost uzorkovanja potrebno je dulje sakupljati lebdeće čestice pri nižim masenim koncentracijama (k iznosi od -0,2 do -0,3). Izračunata minimalna masa pouzdanog uzorkovanja respirabilnih čestica za opremu A odnosno opremu B iznosi približno 0,3798 mg odnosno 0,396 mg dok izračunata minimalna masa pouzdanog vaganja iznosi 0,3788 mg odnosno 0,3963 mg.

[1] Sveučilište u Zagrebu Šumarski fakultet, Svetošimunska c. 25, Zagreb, Hrvatska
[2] Institut za medicinska istraživanja i medicinu rada, Ksaverska 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Čavlović, A.O.[1], Šega, K.[2], Bešlić, I.[2]

RELIABILITY ANLYSIS OF MEASUREMENT METHOD FOR DETERMINATION OF MASS CONCENTRATION OF AIRBORN WOOD DUST BY PERSONAL SAMPLERS

Keywords: *wood dust, airborne particles, mass concentration, limit of detection (t_{LOD}), limit of quantification (t_{LOQ})*

This is analysis of reliability of measurement method for determination of mass concentrations of respirable fraction and concentrations of total wood dust in surrounding air. Researches were provided in six wood processing manufactures and three carpentries. HRN CEN/TR 15230:2005 Workplace atmospheres – Guidance for sampling of inhalable, thoracic and respirable aerosol fractions define minimum sampled quantity for analysis as minimal sampling time (t_{min}), in other words - limit of detection (t_{LOD}) and limit of quantification (t_{LOQ}). Minimal samples mass for limit of detection (m_{LOD}) and minimal mass for limit of quantification (m_{LOQ}) can be obtained from calculated minimal sampling time values for the group of wood dust samples collected from the equal woodworking place.

The aim of analysis is determination of influence factors (sampling devices, real measurement duration, standard deviation of samples mass and mass concentration) on limit of detection and limit of quantification for airborne wood particles.

Personal samplers were used in pairs for sampling of respirable fraction and total wood dust (Casella, Bedford, UK). For samples weight was used micro scales Cahn G.2 (Cahn, USA) and METTLER-TOLEDO MX-5 (Greifensee, Switzerland). Monitoring with personal sampler A is provided at 14 different woodworking places with approximately 11 repetitions and with personal sampler B at 11 different woodworking places with approximately 13 repetitions. In view of average values of all data (N_A=308; N_B=286) the reliability of determination of mass concentration using personal sampler A was better than using sampler B. Due to great data dissipation (standard deviation), by statistical nonparametric testing, those difference in reliability of two devices was confirmed for the respirable fraction sampling, only ($p << 0.001$) but not in case of total dust (p_{LOD} =0.3; p_{LOQ}=0.64). The significant influence on limit of detection (t_{LOD}) and limit of quantification (t_{LOQ}) has standard deviation amount of mass samples from the same group of repetition (k = 0.4-0.9). Analysed determination method needed large sampling duration for better reliability, especially in case of lower dust concentration (k= -0.2 ÷ -0.3). Using device A and B for determination of mass concentration of respirable fraction, minimal mass of detection (mLOD) were calculated 0.3798 mg and 0.396, respectively. Minimal mass of quantification (mLOQ) using device A and B amounts 0.3788 mg and 0.3963, respectively.

[1] University of Zagreb Faculty of Forestry, Svetošimunska c. 25, Zagreb, Croatia
[2] Institut for Medical Research and Occupational Health, Ksaverska 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Bešlić, I.[1], Davila, S.[1], Šega, K.[1]

ISPITIVANJE ZADOVOLJAVANJA ZAHTJEVA HRN EN 12341:2014 PRI ODREĐIVANJU RAZINA KONCENTRACIJA LEBDEĆIH ČESTICA U ZRAKU.

Ključne riječi: *elektrostatsko izbijanje filtra, rezolucija vage, vrste filtra*

U dodacima D i E standarda HRN EN 12341:2014 opisani su testovi i definirani zahtjevi za filtre i vage pri određivanju masenih koncentracija PM_{10} i $PM_{2.5}$ frakcija lebdećih čestica. Tijekom ovog istraživanja testovi su prilagođeni kako bi se dobile dodatne informacije o vrsti filtara, korištenim vagama i mikroklimatskim uvjetima pri kondicioniranju i vaganju filtara. Cilj istraživanja je bio ispitati razliku u zadovoljenju zahtjeva za dva različita tipa filtara. Nadalje, cilj je bio ispitati utjecaj elektrostatskog izbijanja prije vaganja te da li postoji razlika u zadovoljenju zahtjeva ukoliko su filtri kondicionirani u vagaonici ili klimatizacijskim komorama.

Ispitivani su filtri od kvarcnih vlakana Whatman QMA i teflonski filtri Whatman PTFE promjera 47 mm. Korištene su tri različite vage: Mettler Toledo AX 205 rezolucije 10^{-5} g, Mettler Toledo MX 5 rezolucije 10^{-6} g i Mettler Toledo XP6 rezolucije 10^{-6} g. Ispitivani su četiri kvarcna i četiri teflonska filtra. Po dva kvarcna i dva teflonska filtra kondicionirani su uz uvjete temperature zraka i relativne vlage sukladno zahtjevima standarda (T=20±1°C, RH=47,5±2,5 %) u vagaonici tijekom 48 sati te ponovno 24 sata, dok su preostala dva kvarcna i dva teflonska filtra kondicionirani pri istim uvjetima u klimatizacijskoj komori tijekom istog razdoblja. Nakon kondicioniranja u trajanju od 48 sati, filtri su odvagani 4 puta u razdoblju od 2 sata na sve tri vage. Isti postupak proveden je nakon dodatnog kondicioniranja od 24 sata. Prije svakog vaganja su po jedan kvarcni i jedan teflonski filtar elektrostatski izbijeni dok su po jedan kvarcni i jedan teflonski filtar vagani bez elektrostatskog izbijanja. Isti postupak je proveden za filtre kondicionirane u vagaonici i u klimatizacijskoj komori. Sukladno zahtjevima, najveća razlika između 8 odvaga istog filtra ne bi smjela prelaziti 40 µg, dok standardno odstupanje ne bi smjelo prekoračiti 10 µg. Kvarcni filtri koji nisu bili elektrostatski izbijani nisu zadovoljili zahtjevima bez obzira na to da li su kondicionirani u vagaonici ili klimatizacijskoj komori. Teflonski filtri koji nisu bili elektrostatski izbijani također nisu zadovoljili zahtjevima s tim da je zamijećena izuzetna velika maksimalna razlika u odvagama kod filtara vaganim na mikro-vagama kondicioniranim u vagaonici. Kvarcni filtri koji su bili elektrostatski izbijani i vagani na mikro-vagama zadovoljili su oba zahtjeva bez obzira gdje su kondicionirani, dok oni vagani na vagi rezolucije 10^{-5} nisu zadovoljili zahtjevima. Teflonski filtri koji su bili elektrostatski izbijani zadovoljili su svim zahtjevima bez obzira na mjesto kondicioniranja i vagu kojom su vagani.

Zaključak je kako je bez obzira na vrstu filtra i mjesto pohrane nužno filtre elektrostatski izbijati te vagati na mikro-vagama.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Bešlić, I.[1], Davila, S.[1], Šega, K.[1]

TESTING THE FULFILLMENT OF THE HRN EN 12341:2014 REQUIREMENTS DURING ROUTINE PM MONITORING

Keywords: *balance resolution, electrostatic discharge, filter type*

Annexes D and E of the HRN EN 12341:2014 standard define the tests and technical requirements for balances and filters used in determining mass concentrations of PM_{10} and $PM_{2.5}$ fractions. We tailored the tests to provide additional information about filter type (Whatman QMA quartz vs. Whatman PTFE Teflon), balance resolution (Mettler Toledo AX 205 with 10^{-5} g resolution, Mettler Toledo MX 5 with 10^{-6} g resolution, and Mettler Toledo with 10^{-6} g resolution), and microclimatic conditions used for weighing and filter conditioning. The aim was to see whether the two filters differed in meeting the standard requirements, to determine the effect of electrostatic discharge on the two filter types, and how conditioning in the weighing room vs. climate chamber affected meeting the standard requirements.

For this purpose we prepared four quartz and four teflon filters. Two quartz and two teflon filters were conditioned in the weighing room for 48 h and 24 h under the conditions required by the standard (T=20±1 °C, RH=47.5±2.5 %). Two quartz and two teflon filters were conditioned in the climate chamber over the same period and in the same temperature and humidity conditions. After the 48-hour conditioning the filters were weighed four times on all three balances over two hours. The same weighing procedure was repeated after additional 24-hour conditioning. Before each weighing, one quartz and one teflon filter were electrostatically discharged while one quartz and one teflon filter were weighed without electrostatic discharge. The same procedure was followed for the filters conditioned in the weighing room and in the climate chamber. According to the standard requirements, the maximum difference between the eight weight measurements of the same filter should not exceed 40 µg, and the standard deviation should not exceed 10 µg. Neither undischarged quartz nor teflon filters met the requirements, regardless of conditioning. Furthermore, in the undischarged teflon filter conditioned in the weighing room we observed great differences between maximum and minimum measurements on the microbalances. Discharged quartz filters met both requirements regardless of conditioning, except on the balance with the 10^{-5} resolution. Discharged teflon filters met all requirements regardless of the conditioning or balance resolution.

Our findings suggest that the filter should be discharged regardless of the location of conditioning and type and that weighing should be done on microbalances.

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

Tema 5
Procjena izloženosti onečišćenjima u zraku i učinci na zdravlje

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Doko Jelinić, J.[1]

UČINCI ATMOSFERSKIH ENDOKRINIH DISRUPTORA NA ZDRAVLJE

Ključne riječi: *izloženost endokrinim disruptorima, krivulja doza učinak, bolesti endokrinog sustava*

Ljudsko zdravlje prvenstveno ovisi o dobrom i nesmetanom funkcioniranju endokrinog sustava kojim se regulira oslobađanje određenih hormona, neophodnih za funkcioniranje velikog broja procesa u tijelu. Veliki broj kemijskih tvari ili njihovih mješavina ulaskom u organizam mogu mijenjati jednu ili više funkcija endokrinog sustava i time povećati rizik za razvoj određenih bolesti i poremećaja. Do danas je nađeno preko 800 kemijskih spojeva za koje se zna ili sumnja da mogu interferirati sa sintezom hormona, njihovom konverzijom ili hormonskim receptorima, a nazivamo ih endokrini disruptori. Policiklički aromatski ugljikovodici (PAH), dioksini, DDT i drugi pesticidi, herbicidi, ftalati, poliklorirani bifenili (PCB), alilfenoli (AP) glavni su predstavnici endokrinih disruptora koji se emitiraju u atmosferu tijekom antropogenih aktivnosti i fizikalno-kemijskih reakcija.

Endokrini disruptori imaju ista svojstva kao hormoni i često se upliću u njihove procese, ali ne moraju imati isti afinitet za receptor ili potentnost. Problem je u tome što mogu biti aktivni i pri niskim koncentracijama kojima smo stalno izloženi u okolišu. Nemaju samo estrogena, androgena i tiroidna svojstva, neki istovremeno reagiraju s više receptora, pa mogu imati aditivne i sinergističke učinke koji se ne viđaju kod normalnih hormona. Često ne slijede linearnu krivulju doza – učinak. Vremenski učinak je posebice bitan, jer djelovanje disruptora tijekom razvoja može dovesti do nepovratne štete dok učinak kod odraslih na zrelom organizmu nije tako izražen. Posebno je opasno djelovanje kemijskih endokrinih disruptora u razdoblju fetalnog rasta i razvoja, kada i vrlo male promjene koncentracija hormona mogu imati dalekosežne posljedice koje se mogu se očitovati tijekom djetinjstva i u odrasloj dobi, ovisno ili neovisno o spolu ploda.

Posljedice izloženosti kemijskim endokrinim disruptorima su značajan porast bolesti i rastući trendovi mnogih poremećaja vezanih uz endokrini sustav, što upućuje da u etiologiji postoje još neidentificirani okolišni čimbenici, među kojima značajno mjesto imaju kemijski endokrini disruptori. Uočen je porast reproduktivne abnormalnosti, feminizacija muškaraca i maskulinizaciju žena, smanjena plodnost, razvojni poremećaji, oštećenje neuroloških funkcija, deficiti imunološkog sustava, pa čak i imunološku supresiju, povećana učestalost karcinoma dojke, jajnika, prostate i mozga.

Za većinu kemijskih endokrinih disruptora još uvijek nisu u potpunosti poznati mehanizmi djelovanja i njihov učinak na ljudsko zdravlje. Iako broj znanstvenih publikacija na tu temu eksponencijalno raste, dosadašnje spoznaje o endokrinim disruptorima su ograničene i kontroverzne. Potrebne su velike epidemiološke i kohortne studije kako bi se identificirali zasebni i sinergistički učinci endokrinih disruptora na pojedinca i populaciju na nacionalnoj i globalnoj razini.

[1] Sveučilište u Zagrebu, Medicinski fakultet, Škola narodnog zdravlja „Andrija Štampar“ Zagreb, Rockefellerova 4, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Doko Jelinić, J.[1]

EFFECT ENDOCRINE DISRUPTING CHEMICALS IN THE ATMOSPHERE ON HUMAN HEALTH

Keywords: *exposure to EDCs, dose-response curve, endocrine –related disorders*

Human health depends on a well-functioning endocrine system to regulate the release of certain hormones that are essential for functions number processes in the body. A large number of chemical substances or their mixtures entering in the organism can alter one or more functions of the endocrine system increasing the risk of developing certain diseases and disorders. Close to 800 chemicals, are known or suspected to be capable of interfering with hormone receptors, hormone synthesis or hormone conversion. The major occurring endocrine disruptors in the atmosphere are polycyclic aromatic hydrocarbons (PAHs), dioxins, DDT and other pesticides, herbicides, phthalates, polychlorinated biphenyls (PCBs), alylphenols (APs). They are emitted into the atmosphere during anthropogenic activity physiochemical reaction in environment.

Endocrine disruptors have the same properties as hormones and often interfering with their processes, but do not have the same receptor affinity or potency. The problem is that they can be active at low concentrations that we are constantly exposed to in the environment. They have estrogen, androgen and thyroid properties, some ED react with multiple receptors at the same time, and may have additive and synergistic effects not seen in normal hormones. Often, they do not follow the linear curve of dose - effect. The time effect is particularly important because the activity of the disruptor during the development can lead to irreversible damage while the effect on adults on the mature organism is not so pronounced. Endocrine disruptors may pose the greatest risk during prenatal and early postnatal development and puberty when organ and neural systems are forming and when very small changes in hormone concentrations may have far-reaching effects that may occur during childhood and adulthood, dependent or independent of the sex.

The high incidence and the increasing trends of many endocrine –related disorders in humans in recent decades have been correlated with endocrine chemical disruptors, suggesting that there are still unidentified environmental factors in etiology, among which a significant place has chemical endocrine disruptors. Increased reproductive abnormalities, feminization of men and women's masculinization, reduced fertility, developmental disorders, neurological function impairment, immune system deficits, and even immune suppression, increased incidence of breast, ovarian, prostate, and brain cancers have been observed.

Mechanisms of action, adverse effects, and dose-response relationships for many of these chemicals are poorly understood and no systematic screening of common chemicals for endocrine disrupting effects is currently underway, so questions remain as to the health impacts of these exposures. Large-scale epidemiological and cohort studies are needed to identify the separate and synergistic effects of endocrine disruptors on the individual as well as on national and global populations.

[1] University of Zagreb, School of Medicine, School of Public Health „Andrija Štampar“, Zagreb, Rockefellerova 4, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Peternel, R.[1], Hercog, P.[2]

POJAVA ALERGIJA UZROKOVANIH PELUDNIM I DRUGIM AEROALERGENIMA U ZAGREBU I ZAGREBAČKOJ ŽUPANIJI

Ključne riječi: *aerobiologija, aeroalergeni, alergije*

Cilj istraživanja bio je napraviti korelaciju između pacijenata alergičnih na peludne alergene te pacijenata alergičnih na ostale aeroalergene u Zagrebu i Zagrebačkoj županiji.

Istraživanje se sastojalo iz dva dijela: aerobiološko i epidemiološko koja su se provodila po standardiziranim metodama. Od ukupno 2192 pacijenta na pelud je bilo senzibilizirano 86,72 %, a na ostale aeroalergene u čiju skupinu spadaju alergeni grinja 36,45 %, spora gljiva i plijesni 2,46 %, alergene žohara 2,1 %, perje 1 % i životinjske dlake 2 % pacijenata. Pri tom se mora napomenuti da je većina pacijenata bila polisenzibilizirana na peludne i ostale aeroalergene. Najveći broj pacijenata alergičnih na peludne alergene bio je senzibiliziran na alergene iz peludi biljaka koje pripadaju botaničkoj porodici trava 46,91 %, ambrozije 42,07 %, breze 25,66 %, lijeske 15,19 %. Između urbane i ruralne populacije nisu nađene statistički značajne razlike u udjelima pacijenata alergičnih na pojedine alergene. Pojačani simptomi bolesti kod pacijenata alergičnih na peludne alergene su se u cijelom razdoblju istraživanja podudarali sa razdobljima peludnih sezona. Kod pacijenata alergičnih na ostale aeroalergene simptomi su bili trajni.

[1] Veleučilište Velika Gorica, Zagrebačka c. 5, Velika Gorica, Hrvatska
[2] EKONERG-Institut za energetiku i zaštitu okoliša, Koranska 5, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Peternel, R.[1], Hercog, P.[2]

APEARANCE OF ALLERGIES CAUSED BY POLLEN AND OTHER AEROALLERGENS IN ZAGREB AND ZAGREB COUNTY

Keywords: *aerobiology, aeroallergens, allergies*

The aim of this study was to correlate allergic patients to the pollen allergens and allergic patients to other aeroallergens in Zagreb and Zagreb County. The research consisted of two parts: aerobiological and epidemiological, which were carried out by standardized methods. From a total of 2192 patients 86.72 % was sensitized to pollen allergens, 36.45 % to dust mites allergens, 2.46 % to fungal and mould spores allergens, 2.10 % to cockroach's allergens, 1.00 % to feather allergens and 2.00 % to animal hair. It should be noted that most patients were polysensitized to the pollen and other aeroallergens. The largest number of allergic patients was sensitized to the allergens of plants belonging to the botanical family of grass 46.91 %, the ragweed 42.07 %, the birch 25.66 %, and the hazel 15.19 %. There was no statistically significant difference between urban and rural populations in the share of patients allergic to individual allergens. Increased symptoms in patients allergic to pollen allergens are in the whole period of research coincided with the periods of pollen season. In allergic patients to other aeroallergens symptoms were persistent.

[1] University of Applied Sciences Velika Gorica, Zagrebačka c. 5, Velika Gorica, Croatia
[2] EKONERG-Energy and Environmental Protection Institute, Koranska 5, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Hrga, I.[1], Stjepanović, B.[1], Jergović, M.[1], Večenaj, A.[1], Vucić, A.[2], Puljak, T.[3], Mamić, M.[3], Krivohlavek, A.[1], Šušić, Z.[4]

ALERGENA PELUD, URBANE ZELENE POVRŠINE - SMJERNICE ZA BUDUĆNOST

Ključne riječi: *alergena pelud, klimatske promjene, urbane zelene površine, zakonska regulativa*

Urbane zelene površine pružaju širok raspon „usluga“ ekosustava koje mogu pomoći u borbi protiv nekih od „urbanih bolesti“. Održavajući ekološku cjelovitost gradova, potiču interakciju samih građana te imaju veliku ulogu u zaštititi javnog zdravlja urbanih populacija. Urbane zelene površine su ključni element u planiranju modernih gradova s ciljem promicanja zdravlja ljudi i osiguranja značajnih ekoloških i rekreacijskih koristi samih građana. Izazov, kojem se u svijetu sve više pridaje pažnja, je da se pri planiranju zelenih gradskih površina vodi računa o sadnji vaskularnih biljaka čija pelud posjeduje nizak ili neznatni alergeni potencijal. Kontrolom sadnje egzotičnih vrsta, sadnjom biljaka koje se ne oprašuju vjetrom ili nisko peludnih vrsta, donošenjem odgovarajuće strategije upravljanja i održavanja te aktivnog sudjelovanja stručnjaka raznih profila npr. krajobrazni arhitekti/urbani arhitekti/biolozi/šumari/agronomi pri planiranju zelenih površina s malim utjecajem na razvoj alergija, moguće je dugoročno utjecati na smanjenje pojavnosti alergijskih bolesti u urbanoj sredini. Donošenje strategije prilagodbe klimatskim promjenama, pametno prostorno planiranje uz kontrolu sadnje biljaka s alergenom peludi, aerobiološki monitoring, uvođenje bioloških čestica (osobito alergene peludi) u zraku u zakonsku regulativu politika su budućnosti u prevenciji inhalacijskih alergijskih bolesti kako na lokalnoj tako i na međunarodnoj razini.

[1] Nastavni zavod za javno zdravstvo „Dr. Andrija Štampar“, Mirogojska 16, Zagreb, Hrvatska
[2] Zavod za javno zdravstvo Zadar, Kolovare 2, Zadar, Hrvatska
[3] Nastavni zavod za javno zdravstvo Splitsko-dalmatinske županije, Vukovarska 46, Split, Hrvatska
[4] Zavod za javno zdravstvo Osječko-baranjske županije, Drinska 8, Osijek, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Hrga, I.[1], Stjepanović, B.[1], Jergović, M.[1], Večenaj, A.[1], Vucić, A.[2], Puljak, T.[3], Mamić, M.[3], Krivohlavek, A.[1], Šušić, Z.[4]

ALLERGENIC POLLEN, URBAN GREEN AREAS - GUIDELINES FOR THE FUTURE

Keywords: *pollen allergens, climate change, urban green areas, legislation*

Urban green areas provide a wide range of ecosystem "advantages" that can help fight certain "urban diseases". By maintaining the ecological integrity of cities, they encourage interaction between citizens and have an important role in urban public health protection. Urban green spaces are a key element in planning modern cities with the aim of promoting health and ensuring significant environmental and recreational benefits. More and more attention is being given to planting vascular plants whose pollen has a low or almost no allergenic potential. By controlling the planting of exotic species, planting plants that are not pollinated by wind or with low pollen potential, adopting appropriate strategies of management and maintenance, and active participation of professionals of different profiles such as landscape architects/urban architects/biologists/foresters/agronomists in planning green spaces with little impact on the development of allergies, it is possible to achieve long-term influence on the decrease of the incidence of allergic diseases in urban environments. Adopting a climate change adaptation strategy, smart planning with taking care to control the planting of allergenic plants, pollen monitoring, and introduction of biological air particles (especially allergenic pollen) into legislation is the future of preventing allergy inhalation diseases on both the local and international level.

[1] Andrija Štampar Teaching Institute of Public Health, Mirogojska 16, Zagreb, Hrvatska
[2] Institute of Public Health of Zadar, Kolovare 2, 0 Zadar, Hrvatska
[3] Teaching Institute of Public Health of Splitsko-dalmatinska county, Vukovarska 46, Split, Hrvatska
[4] Institute of Public Health of Osječko-baranjska county, Drinska 8, Osijek, Hrvatska

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Barišin, A.[1], Capak, K.[1] Jergović, M.[2], Doko Jelinić, J.[3]

UTJECAJ TOPLINSKIH VALOVA NA ONEČIŠĆENJE ZRAKA SA ZDRAVSTVENIM POSLJEDICAMA

Ključne riječi: *integrirani zdravstveno ekološki informacijskog sustav, zdravstveni indikatori, kvaliteta zraka, procjena utjecaja na zdravlje*

Pojam zdravlja, pojam klime i pojam kvalitete zraka su u mnogim odrednicama isprepleteni. Značajne humane i analitičke kapacitete, ključne u preventivnim aktivnostima, nalazimo u sustavu državne i lokalnih mreža za trajno praćenje kvalitete zraka (mreže postaja za mjerenje kvalitete zraka i meteoroloških parametara, te u sustavu hitne medicinske pomoći. Povezivanje različitih baza podataka (rezultata mjerenja) okolišnih uzoraka značajan je korak u procjeni utjecaja čimbenika onečišćenja iz okoliša na ljudsko zdravlje. Objedinjeni podaci nacionalnih i lokalnih praćenja okolišnih parametara, pomoći će u integraciji rezultata svih mjerenja, te u primjeni metoda procjene utjecaja na zdravlje (eng. health impact assessment – HIA) i zdravstvene procjene rizika (eng. health risk assessment – HRA) u svrhu procjene utjecaja kvalitete zraka na ljudsko zdravlje.

Rezultati ovih metoda dodatno daju vrijednost i pridonose u jačanju uloge preventivnih sudionika iz područja okoliša i zdravlja. U skladu s međunarodnim aktivnostima ključnom se pokazala uloga preventivnog dijela zdravstvenog sustava u umrežavanju i prikupljanju podataka radi posljedica toplinskih valova na zdravlje pojedinca, odnosno populacije. Uspostava integriranog Centralnog zdravstveno ekološkog informacijskog sustava zdravstvene skrbi, u svrhu praćenja zdravstvenih indikatora poput broja hitnih prijema, obolijevanja ili smrtnosti kao posljedice toplinskih valova i narušene kvalitete zraka pokazala se jednom od prioritetnih mjera tijekom pripreme nacionalne Strategije prilagodbe klimatskim promjenama.

Umrežavanje i informatizacija sustava praćenja svih ključnih onečišćujućih tvari iz zraka i okoliša uz razvoj prostorne (GIS) baze podataka također je prepoznata kao temelj pravilne procjene utjecaja na zdravlje i procjene rizika. Potrebno je raditi daljnje sveobuhvatnije evaluacije zdravstvenih posljedica i opterećenja zdravstveno-ekonomskog sustava. Međutim, ključno je kontinuirano raditi na edukaciji javnosti, te jačanju kapaciteta i svijesti struka o poveznicama između klimatskih promjena i zdravstvenih učinaka. Ključan je korak nastavak suradnje Državnog hidrometeorološkog zavoda i Hrvatskog zavoda za javno zdravstvo u sustavu upozorenja na toplinske valove te prekoračenja dozvoljenih koncentracija onečišćujućih tvari u zraku s koordiniranom preventivnom aktivnošću.

[1] Hrvatski zavod za javno zdravstvo, Rockefellerova 7, Zagreb, Hrvatska
[2] Nastavni zavod za javno zdravstvo "Dr. Andrija Štampar", Mirogojska c. 16, Zagreb, Hrvatska
[3] Sveučilište u Zagrebu, Medicinski fakultet, Škola narodnog zdravlja “Andrija Štampar”, Rockefellerova 4, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Barišin, A.[1], Capak, K.[1] Jergović, M.[2], Doko Jelinić, J.[3]

THE IMPACT OF HEAT WAVES ON AIR POLLUTION WITH HEALTH CONSEQUENCES

Keywords: *integrated health environment information system, health indicators, air quality, health impact assessment*

The concept of health, the term climate and the concept of air quality in many determinants are interlaced. Significant human and analytical capacities, crucial for preventive activities, exist in the National air quality network (network of the air quality and meteorological parameters measurements and in the emergency medical system. Connecting different environmental monitoring results is a significant step in the assessment of the impacts of environmental contamination on human health. Combined data of national and local environmental monitoring will help in the process of integration of all available results and during the future use of the Health risk assessment (HRA) and Health impact assessment (HIA) method in the assessment of the air quality impact on human health.

The results of these methods provide added value and contribute to the strengthening of key stakeholders in environment and health. In accordance with international activities, the role preventive part of the health system has been in networking and data collection in order to assess the consequences of heat waves on the health of individuals and populations. The establishment of an integrated Central Health Environment Information System for the purpose of monitoring health indicators such as the number of emergency admissions, illness or mortality as a result of heat waves and degraded air quality was proposed as one of the key measures during the preparation of the National Climate Change Adaptation Strategy.

Networking and information of all relevant air pollutants and the environmental and the development of spatial (GIS) database has also been recognized as base in proper assessment of the health impact. Further comprehensive evaluation of the health consequences and the burden of the health and economic system needs to be done. However, it is essential to continuously work on public education and to strengthen the capacity and the awareness of the profession regarding the climate change and health effects. A key step is the continuation of the activities and co-ordinating role of the Croatian Institute for Public Health in the heat health warning system. A key step is continuation of the cooperation between the Meteorological and Hydrological Service and Croatian Institute for Public Health in the heat wave warning system and exceeding the allowable concentration of pollutants in the air with coordinated preventive activities.

[1] Croatian Institute of Public Health, Rockefellerova 7, Zagreb, Croatia
[2] Andrija Štampar Teaching Institute of Public Health, Mirogojska c. 16, Zagreb, Croatia
[3] The University of Zagreb School of Medicine, School of Public Health „Andrija Štampar", Rockefellerova 4, Zagreb, Croatia

Tema 6
Zaštita zraka u sustavu prostornog uređenja, graditeljstva i zaštite okoliša

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Vađić, V.[1], Špoljar, G.[2], Hercog, P.[1], Bešlić, I.[3], Abramović, B.[1]

ANALIZA UTJECAJA MEĐUNARODNE ZRAČNE LUKE ZAGREB NA KVALITETU ZRAKA

Ključne riječi: *MZLZ, kvaliteta zraka, lebdeće čestice, okoliš*

U svibnju 2016. godine započela su mjerenja kvalitete zraka na novoj mjernoj postaji Međunarodna zračna luka Zagreb (MZLZ). Uspostavljena su mjerenja dušikovog dioksida (NO_2), ugljikovog monoksida (CO) i ozona (O_3) referentnim automatskim mjernim metodama i mjerenja PM_{10} frakcije lebdećih čestica referentnom gravimetrijskom metodom. Sva mjerenja provode se akreditiranim metodama od strane ovlaštenih laboratorija. Ekonerg laboratorij za zrak provodi mjerenja NO_2, CO i O_3 dok Institut za medicinska istraživanja i medicinu rada provodi mjerenja lebdećih čestica PM_{10}.

Mjerna postaja je po tipu područja prigradska, smještena u sjeveroistočnom dijelu Međunarodne zračne luke Zagreb vrlo blizu mogućeg izvora emisija u zrak iz zračnog prometa, bez ikakvih smetnji na protok zraka u neposrednoj blizini. U odnosu na izvor emisija to je industrijska postaja postavljena u svrhu procjene emisije u zrak iz zračnog prometa te njihov utjecaj na kvalitetu zraka. Udaljena je 300 metara od uzletno slijetne piste i nalazi se neposredno pored pročišćivača voda. Na jugu se nalazi Grad Velika Gorica, a na sjeveru i sjeverozapadu Grad Zagreb. Na oko 800 metara sjeverozapadno od postaje nalazi se i Zagrebačka obilaznica. Postaja je povezana GSM modemskom vezom s nadzornim računalom u Laboratoriju za zrak tvrtke Ekonerg od kuda se podaci svakoga sata dostavljaju na Portal Kvaliteta zraka u Republici Hrvatskoj Hrvatske agencije za okoliš i prirodu.

U analizi su prikazani rezultati praćenja kvalitete zraka za sve mjerene onečišćujuće tvari. Evaluacija rezultata za onečišćujuće tvari NO_2, CO i O_3 iskazana je za razdoblje 1.5.2016. do 31.12.2016, a gravimetrijska mjerenja PM_{10} započela su 10.5.2016. te je evaluacija rezultata za PM_{10} iskazana za razdoblje 10.5.2016. do 31.12.2016.

Iako u promatranome razdoblju nije bila obuhvaćena cijela godina može se zaključiti da su koncentracije NO_2 i CO znatno niže od granične vrijednosti (GV), a niže su čak i od donjeg praga procjene. Koncentracije O_3 prekoračile su ciljnu vrijednost 5 puta što je znatno manje od dozvoljenih 25 prekoračenja, a u obzir je uzeto skoro cijelo ljetno razdoblje kada su koncentracije O_3 najviše. Lebdeće čestice PM_{10} prekoračile su graničnu vrijednost 39 puta što je više od dozvoljenih 35 prekoračenja te je kvaliteta zraka ocijenjena drugom kategorijom.

Distribucija prekoračenja GV dnevnih koncentracija PM_{10} na mjernoj postaji MZLZ gotovo je identična onoj na mjernoj postaji Zagreb-3, a usporedba dnevnih koncentracija PM_{10} sa mjerne postaje MZLZ sa brojem letova zrakoplova u pojedinom danu pokazuje da je broj letova u ljetnim mjesecima veći nego u zimskim mjesecima u kojima su zabilježena prekoračenja GV. Iz provedene analize možemo zaključiti da Međunarodna zračna luka Zagreb nije dominantan i isključivi izvor onečišćenja zraka lebdećim česticama PM_{10} te da svojim radom ne utječe bitno na kvalitetu zraka na tom području.

[1] Ekonerg - Institut za energetiku i zaštitu okoliša, Koranska c. 5, Zagreb, Hrvatska
[2] Međunarodna zračna luka Zagreb, Ulica Rudolfa Fizira 1, Velika Gorica, Hrvatska
[3] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Vađić, V.[1], Špoljar, G.[2], Hercog, P.[1], Bešlić, I.[3], Abramović, B.[1]

IMPACT ANALYSIS OF INTERNATIONAL AIRPORT ZAGREB ON AIR QUALITY

Keywords: *IAZ, air quality, particulate matter, environment*

Air quality measurements on the new measurement station International Airport Zagreb (IAZ) started in May 2016. Measurement of nitrogen dioxide (NO_2), carbon monoxide (CO) and ozone (O_3) with automatic reference methods and measurement PM_{10} fraction of suspended particles with reference gravimetric method were established. All measurements were carried out by authorized laboratories with accredited methods. Ekonerg Air Laboratory carried out measurements of NO_2, CO and O_3 while the Institute for Medical Research and Occupational Health carried out measurements of particulate matter PM_{10}.

Measurement station is suburban, situated in the north-eastern part of International Airport Zagreb very close to potential emissions sources from air transport without any disturbance to the airflow in the vicinity. Measurement station should indicate emissions from air transport and their impact on air quality. It is located 300 meters from the landing and take-off runways and near to the water purifier. City of Velika Gorica is located on the south, while City of Zagreb is located on the north and northwest of the measurement station. Also the Zagreb ring road is located at about 800 meters northwest of the station. The station is connected with GSM modem connection with the control computer in the Ekonerg Air Laboratory from where the row data were submitted every hour to the Air Quality Portal in Croatia managed by Croatian Agency for the Environment and Nature.

In this analysis are shown all air quality monitoring results for all pollutants. Evaluation results for the pollutants NO_2, CO and O_3 were presented for the period 05.01.2016. to 31.12.2016, while gravimetric measurement of PM_{10} were started 10.05.2016. and the evaluation results for PM_{10} were presented for the period 10.05.2016. to 31.12.2016.

Although whole year were not included in this analyses it can be concluded that the NO_2 and CO concentrations were significantly lower than the limit value (LV) and even lower than the lower assessment threshold. We take in account almost whole summer period when the O_3 concentration are the highest and O_3 concentrations exceeded the target value 5 times which is less than the allowed 25 exceedances. PM_{10} concentration exceeded limit value 39 times which is more than allowed 35 exceedances and air quality were assessed the second category.

LV exceedances distribution of daily PM_{10} concentrations at the measurement station IAZ were almost identical those to the PM_{10} concentrations at the measurement station Zagreb-3. LV exceedances distribution also indicates that almost all exceedances occurred in winter period while the number of aircraft flights is higher in the summer period. From this analysis we can conclude that the International Airport Zagreb is not dominant and the sole source of particulate matter PM_{10} air pollution and that it does not significantly affect air quality in that area.

[1] Ekonerg – Energy and Environment Protection Institute, Koranska c.5, Zagreb, Croatia
[2] International Airport Zagreb, Ulica Rudolfa Fizira 1, Velika Gorica, Croatia
[3] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Alebić-Juretić, A.[1,2], Mifka, B.[1], Zatezalo, M.[1], Zubak,V.[1], Vucelić-Bokan, I.[1]

UTJECAJ GRADIJENTA OZONA NA LIŠĆE VINOVE LOZE

Ključne riječi: *ozon, gradijent, vinova loza, klorofil, karoten*

Zbog kompleksne orografije terena koja uvjetuje i kružno kretanje zračnih masa u Riječkom zaljevu, na ovom se području stvara gradijent ozona za koji je karakterističan porast koncentracije s visinom. Zbog visokih koncentracija ozona, na većini područja dolazi do prekoračenja AOT40 vrijednosti ("accumulated amount of ozone over the threshold value of 40 ppb") što bi moglo imati štetno djelovanje po vegetaciju. Uvažavajući rezultate prethodnih eksperimenata u kontroliranim uvjetima, ispitivali smo utjecaj prirodnog gradijenta ozona na listove vinove loze. Listovi vinove loze (2-5 komada) sakupljani su u razdoblju svibanj-rujan na dvije lokacije u blizini automatskih stanica za mjerenje onečišćenja zraka: Lokacija 1 je u centru grada (20 m n.m.), a Lokacija 2 (186 m n.m.) je smještena u prigradskom području. Nakon vaganja i određivanja površine, listovi (0,5 g) su ekstrahirani u 95 % etanolu te je određen sadržaj klorofila a (Chla), klorofila b (Chlb) i karotena (Car) pomoću UV-VIS spektrometrije na 3 valne duljine (664 nm, 649 nm, 470 nm). U ljeto 2016. godine gradijent ozona nije bio izrazit kao ranije te su se izmjerene koncentracije razlikovale za približno 20 %, s prekoračenjem AOT40 vrijednosti na obje lokacije (22,360 µg m^{-3} h^{1} na Lokaciji 1 i 28,061 µg m^{-3} h^{1} na Lokaciji 2). Koncentracije ostalih onečišćujućih tvari bile su ispod graničnih vrijednosti. Sadržaj Cha i Chb u listovima skupljenim krajem svibnja na Lokaciji 2 na razini je vrijednosti dobivenoj s filtriranim zrakom (bez ozona) u kontroliranom eksperimentu, tj. bez oštećenja uzrokovanih ozonom, dok je sadržaj karotena upola manji, i takav je ostao tijekom čitavog eksperimenta. Sadržaj pigmenata u srpnju ukazuje na moguće oštećenje uzrokovano ozonom, dok narednih mjeseci oštećenje može ubrzati prirodan proces starenja. Ovo je prvi dokaz mogućeg štetnog djelovanja ozona na vegetaciju u Riječkom zaljevu, usprkos manjem gradijentu ozona u odnosu na ranija razdoblja i bez vidljivog oštećenja listova vinove loze ozonom. Ovi preliminarni rezultati ukazuju na potrebu češćeg uzorkovanja, naročito u razdoblju koje je uključeno u AOT40 vrijednost (svibanj-srpanj). Nije uočena povezanost sadržaja klorofila i karotena s površinom lista.

[1] Nastavni Zavod za Javno Zdravstvo, Krešimirova 52a, Rijeka, Hrvatska
[2] Medicinski fakultet, Sveučilište u Rijeci, Braće Branchetta 20, Rijeka, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Alebić-Juretić, A.[1,2], Mifka, B.[1], Zatezalo, M.[1], Zubak,V.[1], Vucelić-Bokan, I.[1]

IMPACT OF OZONE GRADIENT ON GRAPEVINE LEAVES

Keywords: *ozone, gradient, grapevine leaves, chlorophylls, carotenoids*

Complex orography and circular air mass circulation in the Rijeka Bay area are responsible for the formation of the O_3 gradient, with concentrations rising with altitude. The AOT40 values ("accumulated amount of ozone over the threshold value of 40 ppb") were often exceeded in this coastal area and most probably resulted in harmful effects on vegetation. Based on previous controlled experiments, we examined the possible effect of atmospheric ozone on grapevine leaves under natural O_3 gradient. Grapevine leaves (2-5) were collected from May to September 2016 at two sampling points in the proximity of two AQM stations: Site 1 in the city centre (20 m asl) and Site 2 (186 m asl) in the suburban settlement. After weighing and determination of surface area, the leaves (0.5 g) were extracted in 95 % ethanol and the extract was analysed on chlorophyll a (Chla), chlorophyll b (Chlb) and carotene (Car) content by UV-VIS spectrometry at 3 wavelengths (664 nm, 649 nm, 470 nm). In summer of 2016, the O_3 gradient was not as pronounced as usual, but the concentrations still differed by approx. 20 %, exceeding the national AOT40 value at both sites (22.360 $\mu g\ m^{-3}\ h^{1}$ and 28.061 $\mu g\ m^{-3}\ h^{1}$, respectively, at Sites 1 and 2). The concentrations of other pollutants were bellow limit values (LV). The Cha and Chb in a sample of leaves collected in late May at Site 2 were equal to those with filtered O_3 in the control experiment, i.e. without damage caused by ozone, while the Car content was lower by approx. 50 % and remained at the same level. The concentrations of pigments obtained in July proved possible damage by O_3 and could have sped up natural ageing in subsequent months. This is the first evidence of O_3 damage on plants in the Rijeka Bay area, in spite of a weaker O_3 gradient and a lack of visible signs of damage. Preliminary results indicated the need for more frequent sampling, particularly in the period included in AOT40 (May-July). No correlation of pigment content with leaf area was found.

[1] Teaching Institute of Public Health, Krešimirova 52a, Rijeka, Croatia,
[2] Faculty of Medicine, University of Rijeka, Braće Branchetta 20, Rijeka, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Pavičić I.[1], Marjanović Čermak, A. M.[1]

KONCENTRACIJA UKUPNIH I AZBESTNIH VLAKANA U ZRAKU NA REZIDENCIJALNIM PODRUČJIMA GRADA ZAGREBA

Ključne riječi: *PLM, azbest u zraku, mikroskopija, membranska filtracija*

Radi određivanja koncentracije ukupnih i azbestnih vlakana u zraku provedeno je uzorkovanje zraka na mjernim mjestima rezidencijalnog područja grada Zagreba. Prikupljanje uzoraka je provedeno na području gradske četvrti Novi Zagreb-Dugave i Remetinec-Jaruščica, te u sjevernom dijelu grada na području gradske četvrti Medveščak-Ksaverska cesta. Uzorkovanja su provedena pri ugodnom, suhom i sunčanom vremenu bez oborina. Uzorci zraka su uzorkovani na visini zone disanja računajući od podloge. Koncentracija ukupnih i azbestnih vlakana određena je korištenjem metode membranske filtracije. Uzorci su analizirani korištenjem mikroskopa s polarizacijskim svjetlom (PLM). Analiza je pokazala prisustvo ukupnih vlakna respirabilne veličine u zraku kod mjernog mjesta naselje Remetinec-Jaruščica, Novi Zagreb-Dugave i Medveščak-Ksaverska cesta. Na mjernom mjestu Remetinec-Jaruščica izmjerena je koncentracija ukupnih vlakana od 0,0031 vl/cm^3 zraka, prisustvo azbestnih vlakana nije utvrđeno. Na mjernom mjestu Novi Zagreb-Dugave određena je koncentracija ukupnih vlakana od 0,0036 vl/cm^3, prisustvo azbestnih vlakana nije utvrđeno. Na mjernom mjestu Medveščak-Ksaverska cesta određena je koncentracija ukupnih vlakana od 0,0014 vl/cm^3, prisustvo azbestnih vlakana nije utvrđeno. U Hrvatskoj nisu propisane maksimalno dozvoljene vrijednosti respirabilne veličine azbestnih vlakana u zraku u općem okolišu. Međutim, Pravilnikom o zaštiti radnika od rizika zbog izlaganja azbestu NN 40/07, Zakona o zaštiti na radu (NN 59/96; 94/96, 114/03 i 100/04) Republike Hrvatske, gdje je Člankom 9 propisano da u osmosatnom vremenski prilagođenom prosjeku nijedan radnik nije izložen koncentraciji azbesta u zraku većoj od 0,1 vlakno na cm^3.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska cesta 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Pavičić I.[1], Marjanović Čermak, A. M.[1]

CONCENTRATION OF TOTAL AND ASBESTOS FIBERS IN THE AIR AT THE RESIDENTIAL AREAS OF ZAGREB

Keywords: *PLM, asbestos in air, microscopy, membrane filter method*

In order to determine concentrations of total and asbestos fibres in the air, air was sampled at measurement points of residential part of Zagreb. Samples were taken in the district of Novi Zagreb-Dugave, Remetinec –Jaruščica and in the north city area of Medveščak-Ksaverska road. The sampling was conducted during dry, stable and sunny weather without precipitation. Samples of air were taken at the height of the breathing zone starting from the ground. The concentration of total and asbestos fibres was determined using membrane filter method. Samples were analysed by means of polarized light microscopy (PLM). At the location Remetinec-Jaruščica, measured concentrations of total fibres of 0.0031 fibres/cm^3 of air, the presence of asbestos fibres in the air of respirable size was not established. At the location, Novi Zagreb-Dugave the concentration of the total fibres was 0.0036 fibres/cm^3 of air, the presence of asbestos fibres in the air of respirable size was not established. At the location Medveščak-Ksaverska road, concentration of total fibres in air was 0.0014 fibres/cm^3, the presence of asbestos fibres in the air of respirable size was not established. In Croatia, allowable values of respirable size of asbestos fibres in the air in the general environment are not prescribed. However, Croatian Occupational Safety and Health Law (NN 59/96, 94/96, 114/03 and 100/04), and the Risks related to exposure of workers to asbestos bylaw (NN 40/07), where the Article 9. instruct that the eight-hour time-adjusted average single worker is allowed to be exposed to a concentration of asbestos in the air no more than 0.1 fibres per cm^3.

[1] Institute for Medical Research and Occupational Health, Ksaverska c 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Čavlović, A.O.[1], Ćaćić, H.[1]

ONEČIŠĆUJUĆE TVARI OD IZGARANJA DRVNOG OSTATKA U DRVOPRERAĐIVAČKIM TVRTKAMA

Ključne riječi: *onečišćujuće tvari, drvni ostatak, loženje biomase, daljinsko centralno grijanje*

Sve je veća važnost uporabe obnovljivih izvora energije (OIE) s ciljem smanjenja uporabe fosilnih goriva za dobivanje toplinske i električne energije. Drvnoindustrijska i šumarska djelatnost mogu imati pozitivan utjecaj na proces kruženja ugljika zbog korištenja vlastitog drvnog ostatka kao energenta pri čemu su posljednjih 20 godina u potpunosti smanjili uporabu fosilnih goriva za dobivanje energije. No, potrebno je voditi brigu o količinama onečišćujućih tvari iz industrijskih ložišta na drvna goriva a posebno iz nekontroliranih kućnih ložišta s ciljem smanjenja emisija u okoliš.

Prema Zakonu o zaštiti okoliša (NN 110/07, 78/2015) i Zakonu o zaštiti zraka (NN 130/11) drvoprerađivačke tvrtke i energane koje koriste drvni ostatak za ogrjev i proizvodnju energije moraju pratiti i prijavljivati količine onečišćujućih tvari iz ispusta u Registar onečišćenja okoliša ukoliko te količine prelaze propisani prag. U radu je prikazana usporedba količina drvnog goriva i onečišćujućih tvari koje ispuštaju uređaji za loženje drvnog ostatka u hrvatskim drvoprerađivačkim tvrtkama i energanama na drvno gorivo prema podacima iz Registra za 2010., 2011. i 2015. godinu. Zapaža se značajno povećanje potrošnje količine drvnog goriva a time i količine onečišćujućih tvari prijavljenih u Registar za ugljikov dioksid, ugljikov monoksid, dušikov dioksid, sumporov dioksid i krute čestice PM_{10}. Tako je u 2015. godini u 61 tvrtci korišteno 252,6 kt/god drvnog ostatka kao goriva što je skoro dvostruko više u odnosu na 2010. i 2011. godinu. Uzrok tome je investicijski trend povećanja drvoprerađivačkih kapaciteta i izgradnje kogeneracijskih postrojenja za proizvodnju toplinske i električne energije iz drvnog ostatka ili šumske biomase. Broj drvoprerađivačkih tvrtki nije značajno povećan ali su postojeće tvrtke značajno povećale svoje proizvodne kapacitete te su stavljena u pogon četiri nova kogeneracijska postrojenja.

Mjere i tehnike smanjenja onečišćenja iz ispusta ložišta na drvni ostatak mogu se uspješnije primjenjivati kroz brži razvoj centralnog daljinskog grijanja u RH. Osim ekonomske prednosti, tu je i ekološka prednost jer se na jednom mjestu spaljuje drvno gorivo izbjegavajući greške gorenja i dodatna onečišćenja, te se kontrolira proces ispuštanja onečišćujućih tvari filtriranjem multiciklonima i elektrostatskim filtrima. Također se izbjegavaju toplinski gubici jer ih novije tehnike industrijskih ložišta smanjuju na 10 % u usporedbi s toplinskim gubicima iz kućnih ložišta koji iznose do 35 %.

[1] Sveučilište u Zagrebu, Šumarski fakultet, Svetošimunska c. 25, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Čavlović, A.O.[1], Ćaćić, H.[1]

POLLUTANTS FROM COMBUSTION OF WOOD WASTE IN WOODPRODUCTION COMPANIES

Keywords: *pollutants, wood waste, combustion of biomass, distance biomass heating*

There is a growing importance of renewable energy sources (RES) instead of fossil fuel use for getting thermal and electric energy. Wood processing and forestry activities may have a positive impact on the process of carbon cycle using their own wood waste for energy where in last 20 years reduced fossil fuel a lot. But, it is necessary to decrease emission of pollutant from wood waste combustion into environment from industrial furnaces but also from uncontrolled house furnaces.

According to the Environmental Protection Act (Official Gazette 110/07, 78/2015) and Air Protection Act (Official Gazette 130/11), all wood production companies and power plants with wood waste combustion devices must be monitored and reported amounts of pollution from furnaces in the Register of environmental pollution if that amounts exceeded allowed limits.

This paper presents the comparison of consumed wood fuels and quantity of pollutants emitted by combustion of wood waste in Croatian wood processing companies and power plants reported in Register in 2010, 2011 and 2015. It has been observed that significant increase of consumed wood fuel cause increase of the annual amounts (in kg/year) of reported pollutants in Register for carbon dioxide, carbon monoxide, sulphur dioxide, nitrogen dioxide and solid particles PM_{10}.

So in 2015 in 61 woodworking companies were used about 252.600 tonnes of wood fuels which is twice more than in 2010 and 2011. The cause of that is in investment trends in wood production capacities and new cogeneration power plants for thermal and electrical energy production from wood fuel and forest biomass. There is no significant increase in number of wood processing companies but the existing companies increased their capacities and a new four cogeneration plants were activated.

The measures and techniques for reducing emissions from combustion of wood waste can applied in a faster development of distance biomass heating in Croatia. Economical and ecological advantages additionally can be achieved by high level combustion control with centralized heating then avoid combustion errors with additional pollution, and by emission control using multi-cyclone and electrostatic filters and others. Also, it is needed to avoid thermal energy loss by use the new industrial technologies for combustion which reduces thermal energy loss on 10 % in comparison to house furnace which thermal energy loss amount 35 %.

[1] University of Zagreb, Faculty of Forestry, Svetošimunska c. 25, Zagreb, Croatia

Tema 7
EFCA sekcija "Air Quality in Europe – Current State and New Challenges"

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Jagusiewicz, A.[1], Murlis, J.[2]

CURRENT EFCA POLICY AND EMERGING ISSUES - INTRODUCTION TO THE EFCA SPECIAL SESSON

Keywords: *atmospheric pollution, black carbon, emissions from ships, evidence-bases policy, particulate pollution*

EFCA, the European Federation of Clean Air Associations is a body that brings together civil society environmental organizations to promote policies that will deliver clean air for all of Europe. Its mission is to help achieve policies and measures that will protect the environment, climate, and human health in Europe against the effects of pollution while fostering sustainable development. EFCA's overarching theme is "One atmosphere", encompassing the idea that, it will eventually be necessary to have a single Law of the Atmosphere to tackle all pathways of pollution. EFCA works with European institutions, notably the European Commission and the United Nations Economic Commission for Europe to promote an evidence-based approach to air policy, assessing the effectiveness of current policy and proposing improvements. EFCA works through meetings of its members, in the form of seminars, workshops, and conferences. It seeks to promote the findings of its work in a series of policy initiatives. Recent policy initiatives are:

- *improving the effectiveness of CAFE - December 2004. Recommended new approaches, in addition to the system of air quality limit values to improve health protection in Europe;*
- *linking air pollution and climate change - a challenge for European legislation - 2010. Showed inconsistencies between air quality and climate change legislation in the EU. Recommended improvements for Directives.*
- *black Carbon Particles (BCP): setting out the opportunities to strengthen policies on Air Quality and Climate Change in Europe. Contains a proposal to include Black Carbon Particles as an additional indicator for the protection of human health and connects this with the need to reduce the emissions of Black Carbon to reduce global warming.*

EFCA has a current concern about the adequacy of policies to reduce harm from particulates and is promoting a "fraction by fraction approach". In particular there has been a study of the role of UfP (Ultra-fine Particulates) which has been explored in a series of symposia and which has followed the considerable advances in recent understandings of UfP. In addition, EFCA is concerned with sources that are currently not well controlled, including shipping. Ships are significant sources of SO_2 and NO_x emissions in Europe and are also sources of fine particulates. In this special session, there will be a presentation on shipping emissions and issues in management of particulates, reflecting EFCA's current concerns.

[1] President, EFCA
[2] Vice President, EFCA

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Gregory, D.[1]

AIR POLLUTION FROM SHIPPING: CURRENT SITUATION AND OPTIONS FOR EMISSIONS REDICTIONS

Keywords: *shipping emission, regulations, abatement technology, compliance options*

As land based sources of air pollution, notably road transport, the electricity supply industry, refineries, and other large industrial plant, have come under control, with consequent reduction in emissions, the effects of pollution from ships has become more apparent. Regulatory bodies have responded by seeking reductions in air pollution emission from ships, focusing on SO_2 and NO_x from ships engines. These controls have been highly controversial within the shipping industry, yet evidence is growing that further reductions will be needed. There are effective means of achieving greater pollution reductions, targeted on the most harmful emission, but the shipping industry will find further controls challenging. This presentation intends to provide an introduction to the issue and cover the following important background considerations for regulators and industry:

1.Current position of the shipping industry, its form and size;
2.The ownership and players involved, including ship-owners, operators, charterer, PSC, FS, IMO;
3.The types of emission sources but in particular combustion sources;
4.The current regulatory framework and MARPOL;
5.Process for creating regulations at IMO;
6.Current regulations for combustion emissions.

In the second part of the presentation, compliance options will be described, including changes to fuel specification and abatement technologies. The implications of different pathways to compliance will be considered. Finally there will be a discussion of the likely form of future regulations.

[1] Exhaust Gas Cleaning Systems Association, 8 The Island, Wraysbury, Staines, TW19 5AS, United Kingdom

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Alebić-Juretić, A.[1,2]

UTJECAJ POMORSKOG PROMETA NA KVALITETU ZRAKA U RIJECI

Keywords: *pomorski promet, emisije, NO_x, PM_{10}, $PM_{2,5}$, SIA, PMF, metali*

Praćenje kvalitete zraka u Rijeci započelo je početkom sedamdesetih, i bilo je usmjereno na praćenje utjecaja velikih izvora (nova rafinerija, termoelektrana, koksara) na kvalitetu zraka. Udio tih izvora u ukupnim emisijama SO_2 iznosio je 95 %, dok je pomorski promet bio zanemaren. Prva procjena emisija iz pomorskog prometa učinjena je tek 2008. i pokazala je da su slične emisijama iz cestovnog prometa. Daljnja analiza utjecaja pomorskog prometa na kvalitetu zraka napravljena je u sklopu MED projekta POSEIDON i obuhvaćala je razdoblje 2008-2012. Referentna godina bila je 2010., kad je u zemljama EU stupila na snagu MARPOL konvencija, dok je u Hrvatskoj njena primjena počela 2013. godine. Rezultati projekta su ukazali sljedeće:

1. *U 2010. došlo je do smanjenja emisija iz pomorskog prometa, prateći na taj način ukupan pad emisija. Udio NO_x emisija u ukupnim ostao je praktički jednak kao i 2008., (17,8 % vs. 18,6 %), ali se gotovo dvostruko povećala emisija SO_2 (2,4 % vs. 4,6 %) dok je za 50 % povišena emisija PM_{10} (11 % vs. 16,5 %).*
2. *PMF analiza komponenata PM_{10} s urbane pozadinske stanice u razdoblju 2008.-2010. identificirala je pet faktora: izgaranje biomase, sekundarni ionski aerosol ("secondary inorganic aerosol", SIA), morske aerosole, prašinu i metalnu industriju. Funkcije uvjetne vjerojatnosti (cpf) dobivene iz PMF faktora za prašinu i SIA ukazuju da Ca, Fe, Zn i Cu dolaze iz smjera luke gdje se vrši pretovar fosfatnog gnojiva i metalnog otpada, dok SO_4^{2-} i NH_4^+ ukazuju na plovni put koji vodi do riječke luke.*
3. *PMF analiza sadržaja $PM_{2.5}$ s prometne stanice u luci (2012.-2015.) identificirala je 4-7 faktora, od kojih su zajednički: izgaranje biomase (dim), sekundarni sulfati, prašina s ceste (uključujući gnojivo) i emisije s brodova. Omjer V/Ni >2,5, specifičan za emisije iz brodova, dobiven je 2012., da bi se smanjio na 1,6 narednih godina. Prema koncentraciji vanadija u zraku primarna emisija $PM_{2.5}$ procijenjena je na 1,41 % u 2012. , te je nakon toga pala na 0,37 % u 2014.*

Uspoređujući dobivene rezultate s drugim lukama uključenim u projekt (Venecija, Brindizi, Patras), Rijeka ima najmanji udio pomorskog prometa u ukupnim emisijama svih onečišćujućih tvari, osim SO_2, što je posljedica najmanjeg broja brodova u luci. Veća emisija SO_2 vjerojatno je posljedica lošije kvalitete goriva koje su brodovi koristili.

[1] Nastavni Zavod za javno zdravstvo, Krešimirova 52a, Rijeka, Hrvatska
[2] Medicinski fakultet, Sveučilište u Rijeci, Braće Branchetta 20, Rijeka, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Alebić-Juretić, A.[1,2]

CONTRIBUTION OF MARITIME TRAFFIC TO AIR QUALITY IN THE PORT OF RIJEKA, CROATIA

Keywords: *maritime traffic, emissions, NO_x, PM_{10}, $PM_{2.5}$, SIA, PMF, trace metals*

The air quality monitoring program in Rijeka started in the early seventies and has focused on air pollution caused by big pollution sources (new petroleum refinery, oil burning power plant, coke plant). Their contribution to SO_2 emissions was >95 %, while maritime traffic was ignored. The first emission inventory comprising port emissions was done as late as in 2008 indicating a similar level of emissions as road traffic. Further analyses of maritime impact on air quality were done within the MED project POSEIDON that covered the 2008-2012 periods. The referent year was 2010, when the MARPOL convention came to power in EU countries, becoming obligatory in Croatia in 2013. The results of the project indicated that:

1. *Maritime emissions in 2010 decreased following the general declining trend in emissions. The contribution of NO_x remained the same (17.8 % vs. 18.6 %), but the contribution to SO_2 was doubled (2.4 % vs. 4.6 %) and to PM10 50 % higher (11 % vs. 16.5 %).*
2. *PMF receptor model analyses of PM_{10} collected from the urban background site in the 2008-2010 periods identified 5 factors: biomass burning, secondary inorganic aerosol (SIA), sea spray, dust and metal industry. Condition probability functions obtained from dust and SIA PMF factors indicated that Ca, Fe, Zn and Cu originated from a harbour area due to the reloading of fertilizers and metal waste, as well as SO_4^{2-} and NH_4^+ pointing to a maritime corridor leading to the Rijeka harbour.*
3. *PMF analyses of $PM_{2.5}$ from the traffic station in the port area (2012-2015) identified 4-7 factors, with common ones: biomass burning (smoke), secondary sulphates, road dust (including phosphate fertilizers) and ship emissions. The ratio V/Ni >2.5, characteristic for ship emission was obtained in 2012, and decreased to 1.6 in the following years. Primary $PM_{2.5}$ emission from ships estimated from the airborne concentration of vanadium was 1.41 % in 2012, and decreased to 0.37 % in 2014.*

Compared to other ports included in the project (Venice, Brindisi and Patras), Rijeka has the lowest contribution of maritime traffic to total emission for all pollutants except SO_2 due to the least intense ship traffic. Higher emission of SO_2 might be the result of poorer fuel quality.

[1] Teaching Institute of Public Health, Krešimirova 52a, Rijeka, Croatia
[2] Faculty of Medicine, University of Rijeka, Braće Branchetta 20, Rijeka, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Franić, Z.[1]

AKREDITACIJA VERIFIKACIJSKIH TIJELA ZA OCJENU PLANOVA PRAĆENJA I VERIFIKACIJU EMISIJA CO_2 U POMORSKOM PROMETU

Ključne riječi: *MRV propisi, pomorski promet, CO_2 emisije, klimatski i energetski paket*

Europska komisija (EK) u svom klimatskom i energetskom paketu zakona iz 2009. godine obrađuje problematiku CO_2 emisija u pomorskom prometu. EU MRV propisi (Monitoring, Reporting, Verification – praćenje, izvještavanje, verifikacija) stupili su na snagu 1. srpnja 2015., a efektivno će se primjenjivati od 1 siječnja 2018. godine. Propisima se zahtijeva da vlasnici i operateri brodova na godišnjoj razini izvještavaju i verificiraju CO_2 emisije za plovila veća od 5000 bruto tonaže (BT) koji pristaju u bilo kojoj EU i EFTA (Norveška i Island) luci. Prikupljanje podataka provodit će se tijekom svake plovidbe. MRV propisi dizajnirani su tako da progresivno integriraju emisije u pomorskom prometu u EU politiku reduciranja domaćih emisija stakleničkih plinova (EU uredba 2015/757) i ciljani su na kvantificiranje i smanjivanje CO_2 emisija u pomorstvu. Brodarske kompanije će najkasnije do 31. kolovoza 2017. godine za svaki od brodova koji potpadaju pod MRV propise morati pripremiti plan praćenja. Morat će pratiti i prijaviti verificiranu količinu CO_2 koju emitiraju njihovi brodovi na putovanjima do, iz i između luka u EU i EFTA, a također će morati dati informacije o parametrima energetske učinkovitosti. Prikupljanje podataka za svaku plovidbu započeti će 1. siječnja 2018. godine. Nakon verifikacije od strane akreditiranog verifikacijskog tijela, kao nezavisne treće strane, agregirani podaci o emisijama CO_2 u pomorskom prometu i podaci o energetskoj učinkovitosti će se slati u središnju bazu podataka, koju će, kako se očekuje, voditi Europska agencija za pomorsku sigurnost (EMSA), a Europska komisija će ih javno objaviti do 30. lipnja 2019., a zatim i svake sljedeće godine.

Operateri i vlasnici brodova će tijekom svake plovidbe morati pratiti slijedeće parametre:

- *polaznu i dolaznu luku, uključujući datum i sat isplovljavanja i uplovljavanja,*
- *ukupnu količinu i emisijski faktor za svaku vrstu upotrijebljenog goriva,*
- *emisiju CO_2,*
- *prevaljenu udaljenost,*
- *vrijeme provedeno u plovidbi,*
- *teret koji se prevozi i*
- *transportni rad, kao produkt prevaljene udaljenosti i mase prevezenog tereta.*

Norma prema kojoj se provodi akreditacija nezavisnih verifikacijskih tijela za područje „Ocjena planova praćenja" i „Verifikacija emisija CO_2 u pomorskom prometu" je HRN EN ISO 14065:2013 (Stakleički plinovi - Zahtjevi za tijela koja provode validaciju i verifikaciju stakleničkih plinova za potrebe akreditacije ili drugih oblika odobrenja), dok EU uredbe br. 757/2015, br. 2071/2016 i br. 2072/2016 predstavljaju EU pravni okvir.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Franić, Z.[1]

ACCREDITATION OF VERIFICATION BODIES FOR ASSESSMENT OF MONITORING PLANS AND VERIFICATION OF CO_2 EMISSIONS IN MARITIME TRANSPORT

Keywords: *MRV regulation, maritime transport, CO_2 emissions, climate and energy package*

The European Commission (EC) is bringing CO_2 emissions from shipping into its 2009 climate and energy package. The EU MRV (Monitoring, Reporting, and Verification) regulation entered into force on 1 July 2015 and will become fully effective on 1 January 2018. It requires ship owners and operators to annually monitor, report and verify CO_2 emissions for vessels larger than 5,000 gross tonnage (GT) calling at any EU and EFTA (Norway and Iceland) port. Data collection will take place on a per voyage basis. The MRV regulation is designed to progressively integrate maritime emissions into the EU's policy for reducing domestic greenhouse gas emissions (EU regulation 2015/757) and aims to quantify and reduce CO_2 emissions from shipping. Shipping companies will need to prepare a monitoring plan by 31 August 2017 at the latest for each of their ships that falls under the jurisdiction of MRV regulation. They will have to monitor and report the verified amount of CO_2 emitted by their vessels on voyages to, from and between EU and EFTA ports and will also be required to provide information on energy efficiency parameters. Data collection will start on a per-voyage basis from 1 January 2018. Once the data is verified by an accredited third-party organization and sent to a central database, presumably managed by the European Maritime Safety Agency (EMSA), the aggregated ship emission and efficiency data will be published by the EC by 30 June 2019 and then every consecutive year.

Operators and ship owners will have to monitor the following parameters on a per-voyage basis:

- *Port of departure and port of arrival, including the date and hour of departure and arrival,*
- *Amount and emission factor for each type of fuel consumed in total,*
- *CO_2 emitted,*
- *Distance travelled,*
- *Time spent at sea,*
- *Cargo carried and*
- *Transport work, defined as the product of distance travelled and cargo mass transported*

The standard for accreditation of third party verification bodies for the scope "Assessment of monitoring plans" and "Verification of CO_2 Emissions in Maritime Transport" is HRN EN ISO 14065:2013 (Greenhouse gases - requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition), while EU regulations No. 757/2015, No. 2071/2016 and No. 2072/2016 create EU-wide legal framework.

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Kiss, G.[1], Imre, K.[1], Tóth, Á.[2], Molnár, Á.[1]

DATA FROM HOURLY PM MEASUREMENTS: TRUE OR FALSE?

Keywords: *PM_{10}, $PM_{2.5}$, PM_1, hourly measurements, water adsorption/desorption*

Air pollution has a considerable impact on the quality of life and is a permanent problem in cities that leads to considerable health risks. The respirable fraction of atmospheric aerosol (particulate matter with an aerodynamic diameter <10 µm, PM_{10}) is one of the most hazardous air pollutants. In addition to its adverse health effects, particulate pollution has significant impact on visibility, which is an important issue for road transport, aviation, tourism, and landscape protection.

According to the regulations of the European Commission operative at the moment, the daily average of PM_{10} concentration should not exceed 50 µg m^{-3}, while the upper limit for the yearly average is 40 µg m^{-3}. In case the measured concentrations exceed the alert threshold, special measures are taken in order to reduce the level of pollution (smog alert), which otherwise threatens to affect the way of life of the population as well as the economy. Although the regulation is based on daily and annual average PM values, there is often need for PM data with higher temporal resolution, e.g., during air pollution episodes with high PM mass concentrations. For this reason, particulate monitors, such as the tapered element oscillating microbalance (TEOM) or instruments working on the beta-attenuation principle (BAM) were developed for the hourly measurement of PM concentration. The biggest uncertainty in the measurement of the PM mass concentration is caused by the fact that atmospheric water may significantly influence the mass and size of the aerosol particles as well as that it can be adsorbed on and desorbed from the filter material used in PM monitors. The objective of this research was the quantification of the error in the determination of PM mass concentration caused by the uptake of water vapour of the filter material. PM measurements were performed with a Thermo FH62C14 type particulate monitor working on the principle of beta attenuation. The PM_{10} inlet was changed for a HEPA filter in order to remove all particles from the gas stream sampled; therefore, only particle-free air was monitored. Consequently, any change in mass was caused by the gas phase components adsorbed on or desorbed from the glass fibre filter of the monitor. In terms of absorbable mass water, vapour is the dominant gas phase component in the atmosphere. Therefore this setup was suitable for the investigation of the effect of water vapour on PM measurements. The water uptake of the filter was examined both with a heated (40 ºC) and unheated inlet. We attempt to show that particle-free air can produce considerable apparent hourly average PM concentrations under conditions of fluctuating relative humidity. Possible solutions to reduce this error are also overviewed.

The financial support of the National Research, Development and Innovation Office – NKFIH 113059 project is gratefully acknowledged. We thank the Hungarian Air Quality Monitoring Network for the technical support and the data availability.

[1] MTA-PE Air Chemistry Research Group, Egyetem 10, Veszprém, Hungary
[2] Department of Earth and Environmental Sciences, University of Pannonia, Egyetem 10, Veszprém, Hungary

Tema 8
IUAPPA sekcija "Air Pollution in Cities: International Perspectives"

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Mills, R.[1]

AIR POLLUTION AND THE EVOLUTION OF CITIES

Keywords: *air quality management, developing countries, informal settlement, policy*

Across the world, cities have long been a pre-eminent focus of pollution policy, as a result of their particular concentration of industrial and transport emissions. This trend will continue for the foreseeable future with more than 70% of the world's population expected to live in cities by 2050. However, our understanding of the relationship between urban structure and processes and air pollution remains fragmentary and incomplete. This presentation provides an introduction to the IUAPPA session within the CAPPA 2017 Conference. It explores the origins and evolution of air pollution in cities – comparing and contrasting the experience of European cities and that of cities in the developing world. It will focus in particular on the distinctive characteristics of developing countries and their relevance to earlier European experiences. In particular, it will question whether the urban air quality management systems that now characterise western cities have, for the foreseeable future, any prospect of successful application in developing cities. European policy has grown out of its response in the 20th century to smogs generated by industrial and domestic emissions. It was based on geographical zoning and fuel switching: power stations and polluting industries were increasingly forced out of the residential areas of cities to more remote areas with lower population exposure and better dispersion; and in smoke-free zones domestic heating by coal was replaced by gas and electricity. The result was a perception that the problem of urban air pollution had been solved, a perception later confounded by emissions of particulates and NOX generated by the millions of vehicles which have subsequently flooded city streets - the unresolved policy challenge addressed by Murad Qureshi in the following presentation. For cities in developing regions the experience and issues – and hence appropriate responses – are different. The paper will argue that the there are three critical differences:

- *developing country cities face the two challenges – industrial/domestic emissions and transport emissions – at the same time;*
- *whereas European city populations have been broadly stable, cities in the developing world are still subject to massive migration pressures resulting in very large scale informal settlement, which undermines the prospect for the effective planning and regulatory policies on which European strategy has been based;*
- *in turn these have generated an unresolved problem of waste disposal which, in particular through open burning, has added a new and major dimension to the problem.*

Against this background the paper will explore whether the sorts of ambient air quality strategy developed in European cities have any prospect of success for the foreseeable future in developing cities and, if not, what alternative approaches might be relevant.

[1] International Union of Air Pollution Prevention Associations

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Qureshi, M.[1]

POLICIES FOR TACKLING THE IMPACT OF DIESEL EMISSIONS IN EUROPEAN CITIES

Keywords: *diesel emissions, EURO standards, low emission zones, diesel particulate filters & electric cars*

In Europe and particularly the EU, the air pollution problem has recently centred around diesel emissions, which have been shown to be emitted seven times[a] *the EU limits on NOx, whereas 9 out of 10 new diesel vehicles exceed the limit*[b]*. This happens while politicians admit mistake of overstating the benefits in* CO_2 *emissions at the beginning of the century when encouraging drivers to switch to diesel. So car makers are braced for a European crackdown on diesel vehicles, and this will create major problems for both manufacturers and governments.*

This review examines policies in three European cities – Paris, London, Berlin – where, according to the European Environment Agency (EEA), limits are being exceeded, with diesel vehicles the single biggest contributor to NO_2 *levels. In London, we have had a whole series of initiatives since 2008 to reduce air pollution - Low Emission Zones (LEZ) - and now the ultra-version in 2017 referred to as the ULEZ. In that time, there has been a 30 per cent increase in diesel cars, and the World Health Organisation (WHO) has defined diesel as carcinogenic. At the same time, Paris, though geographically smaller, is aiming to ban all diesel cars by 2020 with key features being pedestrianisation and the use of electric vehicles. In the meantime, Berlin has banned cars without diesel particulate filters (DPFs) and is extending their green environmental zone into a blue one.*

The impact of the Volkswagen (VW) scandal in the US and doubts about the Euro standards themselves are now cutting across these efforts in European cities. This paper will look at these general issues, and the current policies of the three cities, and consider what lessons can be learnt for future policy.

[a] *Tests conducted by International Council on Clean Transportation (ICCT) show that modern diesel cars emit 7 times EU limit for* NO_x

[b] *Green Transport "Think Tank" Transport & Environment with Emissions Analytics suggest that 9 out of 10 new diesel cars exceed limit. Of 24 cars tested survey showed that only 3 types of cars complied with EU regs (BMW -3 series, VW Golf & Audi A5) while the Audi A8 worst emissions with up to 22 time the EU limit*

[1] Qureshi Associates, London, NW1 6TD, UK

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Incecik, S.[1]

MANAGING AIR QUALITY IN ISTANBUL

Keywords: *megacities, air pollution, population growth, emission sources*

About 54 % of the world's population lives in city centers and this number is expected to grow by 1.84 per cent annually by 2030. As a result of the population increase in cities, the number of megacities (with populations over 10 million) reached 35 and 52 % in developing countries. Istanbul is the 21st largest mega city of the world with 14.7 million inhabitants and also in the 18th largest built-up urban area worldwide. Istanbul is the only city in the world on two continents. The annual growth rate for the recent decade was about 2.0 %. Istanbul city accounts for 55 % of Turkey's trade and 28% of its national production. The pressures on the growing population translate into a range of environmental problems such as air quality and natural degradation. Due to the poorly planned expansion and transport policies it led to critical air quality problems with high PM_{10} and NO_2 levels. Air pollution levels in Istanbul are the result of emission sources and their regions, meteorological conditions (e.g., wind speed, wind direction, atmospheric stability) and topographical features. An effective control strategy and techniques associated with air quality are well-defined in the literature. At this point, pollution characteristics and control systems and measures are combined with the control strategy of the city. The Air Quality Action Plan at regional and city level has been developed according to the results of preliminary assessment studies. The goals of this study are to make a review of the recent status of air quality in Istanbul and address the efforts in the field of air quality control strategy to reach better air quality in Istanbul. Key findings of emission sources, population growth, air quality levels in the country and comparisons between EU limits and efforts on air quality management such as the impact of a new underwater rail tunnel on urban transport and emission reduction and regulations are presented.

[1] Istanbul Technical University, Turkey

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Alipour S.[1]

TRAFFIC AND URBAN AIR POLLUTION

Keywords: *air pollution, air quality management, public transportation, Tehran*

Air pollution is one of the major issues and challenges of the modern era, particularly in metropolitan cities. Tehran as the capital of the Islamic Republic of Iran is not exempt from such challenges.

Tehran has more than 10 million people and a floating population incoming from satellite cities that remains in the city for days at a time, despite all efforts and actions such as the development of public transportation, improving fuel and vehicle quality, technical inspection of vehicles, etc. This problem doubles in some seasons with the increase in natural dust produced from internal and external centres.

In this study, the air pollution status in Tehran was investigated in terms of resources and types of measures taken, as well as issues and problems related to air quality management in Tehran. Solutions are proposed to reduce this trend.

[1] Department of Environment, Pardisan Park, Hakim Highway, Tehran, Iran

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Murlis, J.[1,2]

TRANSPORT POLICY OPTIONS FOR LIVEABLE CITIES

Keywords: *air quality, transport services, sustainability, liveability*

European air quality legislation provides a framework for air quality objectives, including ambient air pollution limit values designed to protect human health. Although measures taken to meet the requirements of the legislation have in many cases produced an improvement in air quality, in others ambient levels have not responded to the measures taken, to the extent that there are significant areas in the EU that do not comply with the legislation. Analysis shows that, for a large proportion of the non-compliant areas, in particular in rapidly growing urban areas, transport systems are the major source of air pollution. Although implementation of EU exhaust emission standards has reduced emission from the newer parts of transport fleets, increased demand for transport services means that there are higher vehicle numbers and that the older parts of the fleets remain in service. The failure within such urban areas to achieve EU air quality norms can be seen as an indication of priorities for town and city planners: transport systems are allowed to grow without constraint, regardless of the consequences. However, priorities are shifting as increasingly cities and other urban areas are in competition for businesses, skills and people, and for the investment needed to provide suitable accommodation and infrastructure. The pressures of competition are driving urban planning authorities to reprioritise, with quality of life for people and resource efficiency in the provision of the built environment as emerging concerns. These factors combine favourably for air quality, directly as clean air is an important part of quality of life and indirectly as more sustainable transport systems are characterised by low emissions. This paper will explore the options for linking more sustainable, low emission transport with the pressure for more sustainable and liveable urban environments. The benefits of such an approach will be considered, including overall health benefits. Whatever theoretical benefits may follow an approach based on sustainable transport strategies, however, the key issue of practical implementation remains. This paper will also consider current initiatives, including those within EU research programmes, to pioneer novel approaches to reducing harm from air pollution.

[1] EFCA, c/o Fraunhofer Institut für Chemische Technologie (ICT) P.O. Box 1240 D-76318 PFINTAL - Germany
[2] EPUK, 11 Wingle Tye Road, Burgess Hill, West Sussex, RH1 59HR

Posteri

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Brdarić, D.[1], Mihin Huskić, I.[1,2], Milas, J.[1,2], Sikora, M.[1], Egorov, A.[3], Bogdanović, T.[4], Gvozdić, V.[5], Capak, K.[6], Barišin, A.[6], Doko Jelinić, J.[7]

VLAGA I PLIJESAN U OSNOVNIM ŠKOLAMA NA PODRUČJU OSJEČKO-BARANJSKE ŽUPANIJE

Ključne riječi: *izloženost učenika, osnovne škole, vlaga/plijesan, zatvoreni prostori*

Na 5. Ministarskoj konferenciji Svjetske zdravstvene organizacije o okolišu i zdravlju održanoj 2010. godine u Parmi (Italija) usvojena je Deklaracija o okolišu i zdravlju. Jedna od obaveza Deklaracije je svakom djetetu do 2020. godine osigurati boravak u zdravim zatvorenim prostorima, tj. u objektima za skrb djece, vrtićima, školama i objektima za rekreaciju. Nakon pilot projekta iz 2012. godine i Posebnog nacionalnog istraživanja od 2012. do 2014. godine, pristupilo se proširenom projektu u 2016. godini na području Osječko-baranjske županije. Projekt je obuhvatio istraživanje izloženosti učenika na vlagu/plijesan u 15 osnovnih škola u urbanim i ruralnim područjima. Anketirani su ravnatelji škola o općim podatcima školskih zgrada, te je izvršen vizualni inspekcijski pregled zgrada. Prisutnost vlage/plijesni u građevinskom materijalu unutar školskih zgrada odredio se vizualnim inspekcijskim pregledima i pomoću profesionalnog ručnog mjerača vlažnosti. Procjena izloženosti učenika izvršena je dihotomizacijom školskih prostorija s obzirom na kontaminaciju vlagom/plijesnima. Analiza podataka provedena je pomoću posebno razvijenog Excel alata. Ukupno je inspekcijski pregledano 16115 m^2 školskog prostora. Vidljiva plijesan uočena je na 52,5 m^2 školskog prostora, dok je kontaminacija vlagom uočena na 132,6 m^2 školskog prostora. Nevidljiva kontaminacija vlagom izmjerena je ručnim mjeračem vlažnosti na 5334 m^2 školskog prostora. Rezultati istraživanja pokazuju da je ukupno 53,8 % učenika bilo izloženo na vlagu/plijesan unutar školskih zgrada, odnosno 2960 učenika. Rezultati istraživanja pokazuju da je velik broj učenika izložen vlazi i plijesni.

[1] Zavod za javno zdravstvo Osječko-baranjske županije, Drinska 8, Osijek, Hrvatska
[2] Sveučilište J. J. Strossmayera u Osijeku, Medicinski fakultet, Cara Hadrijana 10, Osijek, Hrvatska
[3] Svjetska zdravstvena organizacija, Europski centar za okoliš i zdravlje, Bonn, Njemačka
[4] Privremeno, Vijenac Republike Hrvatske 9, Valpovo, Hrvatska
[5] Sveučilište J. J. Strossmayera u Osijeku, Odjel za kemiju, Cara Hadrijana 8/A, Osijek, Hrvatska
[6] Hrvatski zavod za javno zdravstvo, Rockefellerova 12, Zagreb, Hrvatska
[7] Sveučilište u Zagrebu, Medicinski fakultet, Škola narodnog zdravlja „Andrija Štampar“, Rockfellerova 4, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Brdarić, D.[1], Mihin Huskić, I.[1,2], Milas, J.[1,2], Sikora, M.[1], Egorov, A.[3], Bogdanović, T.[4], Gvozdić, V.[5], Capak, K.[6], Barišin, A.[6], Doko Jelinić, J.[7]

MOULD AND DAMPNESS IN OSIJEK-BARANJA COUNTY PRIMARY SCHOOLS

Key-words: *indoor spaces, mould/dampness, primary school, pupils' exposure*

The World Health Organization's fifth Ministerial Conference on Environment and Health was held in Parma, Italy in 2010, at which the Declaration on Environment and Health was adopted. One of the obligations laid out is to provide healthy indoor spaces to each child in child care facilities, kindergartens, schools, and recreational facilities up to 2020. Adhering to the Pilot Project in 2012 and the Special National Research Program 2012-2014, an expanded project was launched in the Osijek-Baranja County, Croatia in 2016. The project included pupils' exposure to mould/dampness in 15 primary schools in urban and rural areas. Questionnaires for school principals and visual building inspections were carried out. The presence of mould/dampness in school buildings was determined visually and using a humidity sensor. An exposure assessment of the time that the pupils spent in indoor spaces affected by mould/dampness was calculated by method of coefficients for different types of spaces and room surface data and analysed using a specially designed MS Excel tool. A total of 16115 m^2 of school spaces were inspected. Visible mould was observed at 52.5 m^2 of school spaces, while dampness contamination was observed at 132.6 m^2 of school spaces. Invisible dampness contamination was measured by a manual humidity sensor at 5334 m^2 of school space. A total of 53.8 % of pupils (2960) were exposed to mould/dampness within the school buildings. The results of this study pointed to a large number of pupils exposed to mould/dampness.

[1] Institute of Public Health for the Osijek-Baranya County, Drinska 8, Osijek, Croatia
[2] J. J. Strossmayer University of Osijek, Faculty of Medicine, Cara Hadrijana 10, Osijek, Croatia
[3] World Health Organization, European Centre for Environment and Health, Bonn, Germany
[4] Temporary, Vijenac Republike Hrvatske 9, Valpovo, Hrvatska
[5] J. J. Strossmayer University of Osijek, Department of Chemistry, Cara Hadrijana 8/A, Osijek
[6] Croatian Institute of Public Health, Rockefellerova 12, Zagreb, Croatia
[7] University of Zagreb, Faculty of Medicine, Andrija Štampar School of Public Health, Rockfellerova 4, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Duplančić, M.[1], Tomašić, V.[1], Maduna, K.[1]

UČINKOVITO SMANJENJE EMISIJE HLAPIVIH ORGANSKIH SPOJEVA PRIMJENOM METALNOG MONOLITNOG REAKTORA

Ključne riječi: *hlapljivi organski spojevi, toluen, MnCu katalizator, metalni monolitni reaktor, katalitička oksidacija*

Emisija hlapljivih organskih spojeva u okoliš predstavljaju velik problem u zaštiti zraka, jer može dovesti do ugrožavanja ekosustava kao i do narušavanja zdravlja ljudi, te je najznačajnija vrsta emisije u atmosferu odmah nakon emisije suspendiranih čestica. Njihova emisija rezultat je svakodnevnih aktivnosti u cestovnom prometu zbog izgaranja fosilnih goriva, rada raznih industrijskih postrojenja, a najvećim je dijelom rezultat proizvodnje i uporabe organskih kemikalija, otapala, bojila i sličnih proizvoda. Dokazano je kako njihova prekomjerna emisija pridonosi nastajanju kiselih kiša, fotokemijskog smoga, učinka staklenika i drugih neželjenih pojava u okolišu. Danas postoje različite metode i tehnike kojima se može smanjiti emisija hlapljivih organskih spojeva u okoliš, a pritom se posebno izdvaja katalitička oksidacija kao jedna od najperspektivnijih, najprikladnijih i visokoučinkovitih metoda. Prisutnost katalizatora omogućava provedbu oksidacije na znatno nižim temperaturama od onih potrebnih za toplinsko spaljivanje, a monolitna izvedba reaktora, u odnosu na tradicionalne izvedbe reaktora, omogućava niski pad tlaka pri velikim protocima uobičajeno prisutnim pri različitim primjenama u zaštiti okoliša.

U ovom radu opisan je razvoj metalnog monolitnog katalizatora/reaktora za katalitičku oksidaciju toluena, a uključuje sintezu miješanog metalnog oksida MnCu u praškastom obliku, nanošenje katalitički aktivne komponente na metalni monolitni nosač, te karakterizaciju i testiranje aktivnosti pripremljenih katalizatora. Toluen je izabran kao modelna komponenta s obzirom da je uobičajeni predstavnik aromatskih hlapljivih organskih spojeva koji se ispuštaju u okoliš. U cilju usporedbe, katalitička oksidacija toluena provedena je u cijevnom reaktoru s nepokretnim slojem katalizatora (0,05 g praškastog katalizatora) i u metalnom monolitnom reaktoru (0,0024 g katalizatora nanesenog na metalni monolitni nosač), pri konstantnoj ulaznoj koncentraciji toluena (210,43 ppm), različitim temperaturama (100–275°C) i ukupnim protocima reakcijske smjese (23–138 cm^3/min).

Utvrđeno je da se konverzija toluena povećava s porastom temperature i smanjenjem ukupnog volumnog protoka reakcijske smjese, odnosno povećanjem prostornog vremena zadržavanja. Potpuna konverzija toluena postignuta je, ovisno o vremenu zadržavanja, uz praškasti MnCu katalizator pri temperaturama manjim od 275ºC, a uz monolitni katalizator, Al/Al_2O_3-MnCu, pri temperaturama manjim od 215ºC. Iz navedenoga se može zaključiti da obje konfiguracije pripremljenih miješanih metalnih oksida mangana i bakra pokazuju izvanrednu aktivnost pri oksidaciji toluena, pri čemu se primjenom metalnog monolitnog reaktora postiže potpuna konverzija toluena pri značajno nižim temperaturama sa značajno manjom masom katalizatora uz isti ukupni protok reakcijske smjese.

[1] Sveučilište u Zagrebu, Fakultet kemijskog inženjerstva i tehnologije, Marulićev trg 19, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Duplančić, M.[1], Tomašić, V.[1], Maduna, K.[1]

EFFICIENT VOLATILE ORGANIC COMPOUNDS ABATEMENT USING METAL MONOLITHIC REACTOR

Keywords: *volatile organic compounds, toluene, MnCu catalyst, metal monolithic reactor, catalytic oxidation*

Volatile organic compounds (VOCs) emission in the environment represents a major problem in air protection because it can lead to serious endangerment of the ecosystem and human health and it is the most significant type of emission in the atmosphere immediately after the emission of suspended particles. VOCs emission is the result of daily traffic activities due to combustion of fossil fuels, the work of various industrial plants, and most of all the result of the production and use of organic chemicals, solvents, dyes and similar products. It has been proven that their excessive emission can contribute to the emergence of acid rain, photochemical smog, greenhouse effect and other adverse effects in the environment. Today there are different methods and techniques that can be used to reduce VOCs emission in the environment, and catalytic oxidation is one of the most promising, most suitable and highly efficient methods. The presence of the catalyst allows the oxidation to be performed at significantly lower temperatures than those required for thermal incineration, and the monolithic form of the reactor, in comparison with the traditional reactor designs, contributes to a low pressure drop for the large flows commonly present in various environmental protection applications.

This paper describes the development of metal monolithic catalyst/reactor for the catalytic oxidation of toluene and includes the synthesis of MnCu mixed metal oxide in powder form, loading of active component on a monolithic carrier, characterization and activity testing of the prepared catalysts. Toluene was chosen as a model component since it is an aromatic volatile organic compound commonly released into the environment. For comparison, the catalytic oxidation of toluene was carried out in a tubular fixed bed reactor (0.05 g of the powder catalyst) and in a metal monolithic reactor (0.0024 g of the catalyst applied to a metal monolithic carrier), at a constant inlet concentration of toluene (210.43 ppm) and at different reaction temperatures (100–275°C) and different total flow rates of the reaction mixture (23-138 cm^3/min).

It was found that toluene conversion increases with increasing the temperature and decreasing the total volume flow of the reaction mixture, i.e. increasing the space time. The complete oxidation of toluene was achieved, depending on the space time, at temperatures less than 275°C for MnCu mixed metal oxide in powder form, and at temperatures lower than 215°C for the multiphase monolithic catalyst, Al/Al_2O_3-MnCu. From this it can be concluded that both configurations of the prepared manganese and copper mixed metal oxides exhibit remarkable activities in toluene oxidation. It is important to emphasize that in the metal monolithic reactor, Al/Al_2O_3-MnCu, the complete conversion of toluene was achieved at significantly lower temperatures with significantly lower catalyst mass at the same total flows of the reaction mixture.

[1] University of Zagreb, Faculty of Chemical Engineering and Technology, Department of Reaction Engineering and Catalysis, Marulićev trg 19, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Gluščić, V.[1], Čačković, M.[1], Pehnec, G.[1], Mihaljević, A.[1]

KISELE KOMPONENTE U UKUPNOJ TALOŽNOJ TVARI U ZRAKU ZAGREBA

Ključne riječi: *UTT, kloridi, nitrati, sulfati, mjerna postaja*

Prikazani su rezultati prostorne razdiobe kiselih komponenti klorida, nitrata i sulfata u ukupnoj taložnoj tvari (UTT) u zraku Zagreba. Mjesečni uzorci ukupne taložne tvari sakupljani su tijekom 2016. godine Bergerhoff-ovim sakupljačem na šest mjernih postaja. Mjerne postaje klasificirane su kao:

- *RS - mjerna postaja smještena u sjevernom rezidencijalnom dijelu grada,*
- *CC - mjerna postaja u centru grada s gustim prometom,*
- *RI - mjerna postaja u industrijskom istočnom dijelu grada,*
- *RJ - mjerna postaja u gusto naseljenom južnom dijelu grada s gustim prometom,*
- *RZ - mjerna postaja u zapadnom gusto naseljenom dijelu grada*
- *RZI – mjerna postaja u rubnom zapadnom dijelu grada s industrijskim objektima.*

Ukupna taložna tvar određena je gravimetrijski dok su kloridi, nitrati i sulfati određeni ionskom kromatografijom. Rezultati pokazuju značajnu ovisnost količine mjerenih onečišćujućih tvari o položaju mjerne postaje. Za promatrano razdoblje mjerenja srednje godišnje vrijednosti količine UTT kretale su se u rasponu od 60 mg/(m^{2}d) do 111 mg/(m^{2}d), količine kiselih komponenti u UTT od 0,97 mg/(m^{2}d) do 2,55 mg/(m^{2}d) za kloride, od 2,15 mg/(m^{2}d) do 3,95 mg/(m^{2}d) za nitrate i od 2,25 mg/(m^{2}d) do 3,60 mg/(m^{2}d) za sulfate.

Uredba o razinama onečišćujućih tvari u zraku (NN 117/2012) propisuje graničnu vrijednost (GV) razina ukupne taložne tvari, dok za razine mjerenih iona u UTT granične vrijednosti nisu propisane, stoga ocjenu kvalitete zraka s obzirom na količinu kiselih komponenti u UTT nije moguće dati. Za promatrano razdoblje mjerenja količina ukupne taložne tvari u gradu Zagrebu nije prelazila propisanu graničnu vrijednost te je zrak bio na razini I kategorije kvalitete.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska cesta 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Gluščić, V.[1], Čačković, M.[1], Pehnec, G.[1], Mihaljević, A.[1]

ACIDIC COMPONENTS IN TOTAL DEPOSITED MATTER IN ZAGREB AIR

Keywords: *TDM, chlorides, nitrates, sulphates, sampling site*

This investigation focuses on the influence of the sampling site on levels of major acidic species chlorides, nitrates and sulphates in total deposited matter (TDM) in Zagreb air. Monthly samples of total deposited matter were taken continuously throughout 2016 at six sampling sites. Sampling sites were classified as:

- *RN - northern residential part of the town with moderate traffic density;*
- *CC - city centre with high traffic density;*
- *RE - residential-industrial area in eastern part of the town*
- *RS - residential densely populated area in southern part of the town with high traffic density;*
- *RW - residential area in western part of the town with high traffic density;*
- *RWI - residential-industrial area in western part of the town with high traffic density.*

Samples of total deposited matter were collected using the Bergerhoff sampler. Total deposited matter was determined gravimetrically. Acidic anions were analysed using ion chromatography. Significant differences in annual average values of all measured pollutants were found between all sampling sites. The annual average levels of measured pollutants ranged from 60 mg/(m^{2}d) to 111 mg/(m^{2}d) for TDM, from 0.97 mg/(m^{2}d) to 2.55 mg/(m^{2}d) for chlorides, from 2.15 mg/(m^{2}d) to 3.95 mg/(m^{2}d) for nitrates, and from 2.25 mg/(m^{2}d) to 3.60 (mg/(m^{2}d) for sulphates, respectively.

The national regulations the Air Protection Act (OG No.130/11, 47/14), and the Regulation on Levels of Pollutants in Ambient Air (OG No. 117/12), defined limit values for TDM, while the limit values for acidic components in TDM were not defined. Regarding to the regulations the Air quality in Zagreb with respect to TDM was the first category of quality.

[1] Institute for Medical Research and Occupational Health, Zagreb, Ksaverska c. 2, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Herceg Romanić, S.[1], Klinčić, D.[1]

RAZINE POLIKLORIRANIH BIFENILA (PCB) U ZRAKU, ZAGREB, HRVATSKA

Ključne riječi: *onečišćenje atmosfere, PCB*

PCB su skupina od ukupno 209 izomera i homologa različitih po broju i položaju klorovih atoma na benzenskim prstenovima. Razlikuju se po strukturi, svojstvima, učestalosti u okolišu i toksičnom potencijalu. Najtoksičniji kongeneri PCB-a (PCB-77, PCB-126, PCB-169) su ne-ortho supstituirani kongeneri, zatim kongeneri koji imaju samo jedan klorov atom supstituiran u ortho-položaju (tzv. mono-ortho supstituirani kongeneri). Zbog toga imaju strukturu sličnu 2,3,7,8-tetraklordibenzo-p-dioksinu (2,3,7,8-TCDD) i s njim dijele isti mehanizam toksičnosti.

Zrak je najčešće prvi i najveći primatelj onečišćenja iz kojeg se ono dalje prenosi u druge dijelove okoliša. Na temelju masenih koncentracija određenih u uzorcima zraka i poznatih faktora ekvivalentne toksičnosti (TEF) mono- i ne-ortho supstituiranih kongenera PCB-a određeni su ekvivalenti toksičnosti (TEQ). Uzorci zraka skupljani na dvije lokacije u Zagrebu: Ksaver (N=47) i Siget (N=38). Analitički postupak opisan je u disertaciji „Onečišćenje zraka i bioindikatori izloženosti ljudi i morskih organizama postojanim organoklorovim spojevima" Darije Klinčić iz 2012.

Masene koncentracije pojedinačnih PCB kongenera u pozitivnim uzorcima zraka skupljenim na lokaciji Ksaver bile su u rasponu od 0,1 pg m^{-3} do 39,8 pg m^{-3} te od 0,1 do 40,5 pg m^{-3} na lokaciji Siget. Niti u jednom uzorku s obje lokacije nije detektiran PCB-169. Ne-ortho supstituirani kongeneri u uzorcima skupljenim na lokaciji Ksaver slijede niz: PCB-77>PCB-126. Učestalost i medijani masenih koncentracija PCB-77 i PCB-126 u uzorcima skupljenim na lokaciji Siget su podjednaki.

Rasponi izračunatih TEQ-ova širi su za uzorke zraka skupljene na Ksaveru nego u uzorcima skupljenim u Sigetu (Tablica 1). Medijan vrijednosti TEQ-a za uzorke skupljene na Ksaverskoj cesti otprilike je 3 puta veći od medijana vrijednosti TEQ-a za uzorke skupljene na drugoj lokaciji. Iako se PCB-126 ne pronalazi u visokim masenim koncentracijama i po učestalosti je među posljednjim toksikološki značajnim kongenerima PCB-a u uzorcima zraka, ovaj kongener zbog najveće vrijednosti TEF-a od 0,1, u najvećoj mjeri pridonosi vrijednostima TEQ-a. U uzorcima u kojima je detektiran, PCB-126 čini od 89 % do 100 % ukupne vrijednosti TEQ-a. *Sudjelovanje proizašlo iz projekta "OPENTOX", potpora Hrvatske zaklade za znanost (HrZZ).*

Tablica 1. Raspon TEQ-ova

	Ksaver		Siget	
	TEQ / fg m^{-3}			
	medijan	raspon	medijan	raspon
$TEF_{1998.}$	15,5	0,2 do 96,8	5,9	0,09 do 18,5
$TEF_{2005.}$	14,1	0,03 do 94,0	5,8	0,04 do 18,4

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c.2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Herceg Romanić, S.[1], Klinčić, D.[1]

POLYCHLORINATED BIPHENYL (PCB) LEVELS IN AIR, ZAGREB, CROATIA

Keywords: *PCBs, atmospheric pollution*

PCBs are a group of 209 isomers and homologs that differ according to the number and position of chlorine atoms in benzene rings. They vary according to structure and therefore their properties, incidence in the environment, and toxicity. The most toxic congeners are PCB-77, PCB-126 and PCB-169 (non-ortho congeners), followed by mono-ortho congeners.

Air is often the first recipient for pollution and a vector for transport into other environmental compartments. Toxicity is estimated using mass concentrations and toxic equivalent factors (TEF) for non- and mono-ortho PCBs. In our study, air samples were collected at two sites in Zagreb: Ksaver (N=47) and Siget (N=38) according to an analytical procedure described in the PhD thesis Air pollution and bioindicators of human and marine organism exposure to persistent organochlorine compounds by Darija Klinčić in 2012.

PCB mass concentrations in the positive air samples collected ranged 0.1-39.8 pg/m^3 at Ksaver and 0.1-40.5 pg/m^3 at Siget. No sample contained PCB-169. The profile of non-ortho PCBs was PCB-77>PCB-126 at Ksaver, while at Siget they were equal.

The range of toxic equivalents (TEQ) was wider at Ksaver than at Siget (Table 1). The TEQ median at Ksaver was three times higher than at Siget. PCB-126 had the biggest TEF (0.1), and consequently in samples which contained PCB-126, this congener contributed to the TEQ with between 89 and 100%. Participation supported by project "OPENTOX", Croatian science foundation.

Tablica 1. Raspon TEQ-ova

	Ksaver		**Siget**	
	TEQ / fg m^{-3}			
	Median	Range	Median	Range
$TEF_{1998.}$	15,5	0,2 - 96,8	5,9	0,09 - 18,5
$TEF_{2005.}$	14,1	0,03 - 94,0	5,8	0,04 - 18,4

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Hwang, I.J.[1], Lee, D.[1], Kim, S.[1], Ju, J.[1], Song, J.[2]

ESTIMATION OF EC AND OC CONCENTRATION TRENDS AND SOC TRENDS FOR AMBIENT $PM_{2.5}$ IN THE KOREA

Keywords: *organic carbon, elemental carbon, secondary OC, TOR method, $PM_{2.5}$*

To establish the relationship between $PM_{2.5}$ concentrations and public health impacts, to understand $PM_{2.5}$ temporal and spatial variations, it is necessary to intensive monitoring and analysis for $PM_{2.5}$ (aerodynamic diameters < 2.5 μm) for a number of years, and establish systematic protocol of sampling methods. Carbonaceous compounds such as elemental carbon (EC), organic carbon (OC), and a small quantity of carbonate carbon (CC) constitute a significant portion (approximately 10 ~ 70 % of the PM mass) of the atmospheric aerosol mass in the various areas. Carbonaceous compounds play a major role in serious atmospheric pollution such as visibility degradation and climate chance, and these compounds have adverse human health effects. Elemental carbon originates from incomplete combustion processes of fossil fuel. On the other hand, organic carbon directly emitted in particulate matter (primary OC) or formed in the atmosphere from products of gas phase photochemical reactions (secondary OC; SOC). The objective of this study is to estimate the trend and characteristics for carbonaceous compounds concentration of $PM_{2.5}$ in the sampling area during the sampling period. In this study, $PM_{2.5}$ samples were collected by $PM_{2.5}$ sampler from September 2010 to December 2014 at the Daegu University, Gyeongsan-si, Korea. The $PM_{2.5}$ samples were collected on Teflon, nylon, and quartz filters every 3 days. The quartz filters were used for analysis of OC/EC by TOR method. TOR method following the IMPROVE protocol using the DRI analyser (DRI Model 2001 Thermal/Optical carbon analysis). This study showed the average concentration of total carbon (OC+EC) estimated 5.97 μg/m^3. Also, the average OC concentration was 4.79 μg/m^3 (79.6 %) and EC concentration was 1.22 μg/m^3 (20.4 %) in TC concentration. Detailed estimation of SOC and concentration trends of carbonaceous compounds for $PM_{2.5}$ will be presented.

[1] Department of Environmental Engineering, Daegu University, Gyeongsan, Gyeongbuk, Korea
[2] Department of Civil and Environmental Engineering, Sejong University, Gwangjin-gu, Seoul, Korea

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Marić, M.[1], Grgec, D.[1], Orsag, Z.[1]

MJERENJE ODLAGALIŠNOG PLINA

Ključne riječi: *odlagalište, odlagališni plin, metan, analizator odlagališnog plina*

Na odlagalištu otpada može doći do mikrobioloških i kemijskih reakcija što rezultira formiranjem plinova. Sastav i brzina stvaranja odlagališnih plinova vremenski se mijenjaju. Ako tehničkim ili strukturnim mjerama nije omogućeno njegovo sakupljanje, tako formirani odlagališni plin se emitira u atmosferu i može predstavljati opasnost za ljude, floru i faunu, kao i za zgrade i tehničku opremu. Kod mjerenja odlagališnog plina treba razlikovati mjerenja od strane operatora odlagališta i mjerenja od strane vanjskih organizacija. Kod mjerenja od strane operatora odlagališta mogu se koristiti interne metode i operativni postupci dok mjerenja od strane vanjskih organizacija moraju biti izvedena prema standardnim mjernim metodama (npr. normni niz VDI 3860). Ciljani spojevi koji se mjere su prije svega ugljikov dioksid (CO_2), metan (CH_4), kisik (O_2) i dušik (N_2) koji čine glavne komponente odlagališnog plina. Također, osim glavnih komponenata mjere se i manje zastupljene komponente kao što su sumporovodik (H_2S) i amonijak (NH_3) i komponente u tragovima kao što su BTEX i organski silicijski spojevi. Opasnosti od odlagališnog plina uglavnom dolaze zbog njegove glavne komponente metana, koji je zapaljiv kada se u smjesi sa zrakom nalazi u volumnim koncentracijama od 5 % do 15 %. Mjerenje odlagališnog plina može se podijeliti u pet kategorija: mjerenje u sustavu otplinjavanja, mjerenje odlagališnog plina blizu površine, mjerenje odlagališnog plina ispod površine, praćenje kvalitete okolnog zraka i praćenje kvalitete unutarnjeg zraka. U ovom radu obrađeno je mjerenje odlagališnog plina ispod površine. Podaci dobiveni iz ovih mjerenja korisni su za procjenu rizika od eksplozije i za dobivanje informacije o migraciji odlagališnog plina izvan tijela odlagališta. Kako bi se izbjegla interakcija s okolnim zrakom, mjerenja se provode na dubini od najmanje dva metra ispod razine tla. Mjerenja glavnih komponenata odlagališnog plina provode se prijenosnim analizatorom odlagališnog plina s integriranom pumpom i zapisivačem podataka (engl. data logger). Kako razvoj odlagališnog plina prolazi kroz devet karakterističnih faza, tako i koncentracije glavnih komponenata ovise o fazi u kojoj se odlagališni plin trenutno nalazi. Jednu do tri godine nakon odlaganja otpada, dolazi do stanja gdje se sastav odlagališnog plina više ne mijenja. Odlagališni plin se tada sastoji isključivo od metana 45 % do 60 % i ugljikovog dioksida 40 % do 60 %.

[1] Nastavni zavod za javno zdravstvo „Dr. Andrija Štampar“, Mirogojska cesta 16, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Marić, M.[1], Grgec, D.[1], Orsag, Z.[1]

MEASUREMENT OF LANDFILL GAS

Keywords: *landfill, landfill gas, methane, landfill gas analyser*

In a landfill body, microbiological and chemical reactions may occur which result in the formation of gases. Both the composition and the formation rate of the landfill gases change in time. Unless the landfill gases are collected by technical or structural measures, they are emitted into the atmosphere and can cause hazards to humans, fauna and flora as well as buildings and technical equipment. For landfill gas measurements a distinction must be made between measurements for self-monitoring of the landfill by the landfill operator and measurements for external monitoring by external organisations. Self-monitoring measurements are generally governed by internal work instructions and operating procedures; external monitoring measurements should be carried out according to standardized measurement methods. Target compounds are primarily the permanent gases carbon dioxide (CO_2), methane (CH_4), oxygen (O_2) and nitrogen (N_2) which constitute the main components of landfill gas. Reference is made to minor components such as hydrogen sulphide (H_2S) and ammonia (NH_3) and trace components such as BTEX and organic silicon compounds. Possible uses and hazards of landfill gas mainly involve the main component methane, which is combustible and forms explosive mixtures with air in a concentration range from 5 % to 15 %. Measurement of landfill gas can be divided into five categories: measurement in the gas collection system, near surface gas measurement, subsurface measurement, ambient air monitoring and indoor air monitoring. This paper deals with subsurface measurement of landfill gas. The data obtained from these measurements are generally useful for evaluating risks of explosion and for getting a qualitative sense of whether landfill gases are migrating in the soils to off-site locations. In order to avoid interaction with the ambient air, the depth of a landfill gas monitoring point shall be at least 2 m below ground level. Measurements of the main components of landfill gas are carried out by a mobile gas analyser with integrated pump and data logger. As the development of landfill gas passes through nine characteristic phases, the concentrations of the main components depend on the stage at which the landfill is currently located. One to three years after the storage of the waste, a condition is reached where the composition of the landfill gas no longer changes. The landfill then consists almost exclusively of methane 45 % to 60 % and carbon dioxide 40 % to 60 %.

[1] Andrija Štampar Teaching Institute of Public Health, Mirogojska 16, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Marović, G.[1], Franić, Z.[1], Šega, K.[1], Senčar, J[1], Bešlić, I.[1]

UKUPNA BETA AKTIVNOST ZRAKA I OBORINA

Ključne riječi: *onečišćenje atmosfere, radioaktivne tvari, ukupna beta aktivnost zraka, ukupna beta aktivnost oborina*

Onečišćenje atmosfere radioaktivnim tvarima dio je ukupnih onečišćenja u atmosferi. Radioaktivne su tvari sastavni dio atmosfere, bilo da su terestrijalnog ili kozmogenog podrijetla, ili se radi o radioaktivnosti koja je ispuštena u atmosferu djelovanjem ljudi. Praćenje i određivanje radioaktivnih tvari u zraku u Hrvatskoj je započelo 1961. godine i provodi se neprekidno do danas. Prisutnost radioaktivnih tvari u zraku i oborinama određuje se mjerenjem ukupne beta aktivnosti kao početnog podatka. Ukoliko se želi saznati koji je od radionuklida prisutan u uzorku, provodi se ispitivanje pojedinih radionuklida posebnim radiokemijskim analizama te alfa, beta i gamaspektrometrijskim metodama. Cilj rada je prodiskutirati prisutnost radioaktivnih tvari u zraku u atmosferi nad Zagrebom i njihovo taloženje na zemljinu površinu.

U okviru Državne mreže za trajno praćenje kakvoće zraka na mjernoj postaji Zagreb-1, smještenoj na raskrižju Miramarske ulice i Avenije Vukovar u Zagrebu, sakupljani su uzorci PM_{10} frakcije lebdećih čestica. Za mjerenja ukupne beta aktivnosti korišteni su alikvotni uzorci filtra na kojima su sakupljene lebdeće čestice. Na lokaciji Instituta za medicinska istraživanja i medicinu rada (IMI) u Zagrebu se neprekidno na visini jedan metar iznad tla prosisava zrak kroz filter papir Schneider-Poelman (plavi). U dane s oborinama provodi se njihovo sakupljanje pomoću Helmanovog pluviometra u dnevni zbrojni uzorak koji se potom propušta kroz ionoizmjenjivačku smolu na filtar papiru. U sakupljenom uzorku zraka i pripremljenom uzorku oborine najmanje 120 sati nakon uzorkovanja mjeri se ukupna beta aktivnost u beta brojaču niskih aktivnosti Low-level beta Geiger–Müller multicounter system; model RISØ GM-25-5. Kalibracija efikasnosti provedena je standardima Češkog metrološkog instituta.

U ovom su radu prikazani rezultati određivanja ukupne beta aktivnosti zraka i radioaktivnih oborina (fallout) na uzorcima sakupljenima u periodu studeni 2016. – siječanj 2017. Odabrana su tri mjeseca u nizu koja se znatno razlikuju po režimu oborina kako bi se prikazale razlike u prisutnosti radionuklida u nižim slojevima atmosfere kao i njihovo taloženje na zemljinu površinu. Količina oborina u studenom 2016. godine iznosila je 113,2 Lm^{-2} (11 dana s oborinom), u prosincu 2,5 Lm^{-2} (u samo jednom danu s oborinama), a u siječnju 2017. godine 35,5 Lm^{-2} (devet dana s oborinama) Rezultati su međusobno uspoređeni u vremenskom slijedu; vrijednosti ukupne beta aktivnosti zraka izmjerene na postaji Zagreb-1 bile su u rasponu od 0,3 $mBqm^{-3}$ do 7,7 $mBqm^{-3}$, uz prosjek 1,7 ± 0,9 $mBqm^{-3}$. Na lokaciji IMI ukupna beta aktivnosti zraka bila je u rasponu od 0,3 $mBqm^{-3}$ do 4,8 $mBqm^{-3}$ uz prosjek 1,3 ± 0,8 $mBqm^{-3}$. Vrijednosti ukupne beta aktivnosti oborina na lokaciji Instituta kretale su se u rasponu od 9,0 $mBqm^{-2}$ do 1,3 Bqm^{-2}, uz prosjek od 0,3 ± 0,3 Bqm^{-2}.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Marović, G.[1], Franić, Z.[1], Šega, K.[1], Senčar, J[1], Bešlić, I.[1]

TOTAL BETA ACTIVITY IN AIR AND FALLOUT

Keywords: *atmosphere pollution, radioactive matter, total beta radioactivity in the air, total beta activity in the fallout*

Contamination of the atmosphere with radioactive substances is part of the total pollution in the atmosphere. Radioactive substances are permanent features of the atmosphere, whether they are of terrestrial or cosmogenic origin or the radioactivity was released into the atmosphere due to anthropogenic activity. In Croatia, the monitoring and determination of radioactive matter in the air has been continuously performed ever since 1961. The presence of radioactive matter in air and fallout is determined by measuring total beta activity. More complex analyses, like radiochemical analysis, alpha, beta and gamma spectrometric methods can give more information about the activity concentrations of particular radionuclides. The aim of this paper was to investigate and discuss the presence of radioactive matter in the atmosphere in the city of Zagreb and their deposition on Earth's surface.

Within the State Network for Continuous Air Quality Monitoring at Zagreb-1 Station, located at the intersection of Miramarska Street and Vukovar Avenue in the city of Zagreb, samples of PM_{10} fraction of particulate matter were collected. Aliquot samples of filters used for PM_{10} collection were used to measure total beta activity. At the location of the Institute for Medical Research and Occupational Health (IMI), the air is continuously pumped at one meter above ground through Schneider-Poelman filter paper (blue). On days with precipitation, they are collected with the Helman pluviometer into a daily sample, which is subsequently passed through the ion-exchange resin attached on the filter paper. In the collected samples, i.e., air sample and precipitation sample, at least 120 hours after sampling, total beta activity was measured in the Low-level beta Geiger–Müller multicounter system; Model RISØ GM-25-5. Efficiency calibration was carried out using the standards of the Czech metrology institute.

This paper presents the results of the determination of total beta activity in air and fallout in samples collected from November 2016 to January 2017. The series of these three months, which significantly differed in precipitation amount, were selected in order to show differences in the presence of radionuclides in lower atmosphere layers as well as their deposition on Earth's surface. In November 2016, the amount of precipitation was 113.2 Lm^{-2} (11 days with precipitation), in December 2.5 Lm^{-2} (with only one day with rainfall), and in January 2017 35.5 Lm^{-2} (with nine days of rainfall). The results were compared with each other in time-series: the values of the total beta activity in air measured at Zagreb-1 station ranged from 0.3 $mBqm^{-3}$ to 7.7 $mBqm^{-3}$, with an average of 1.7 ± 0.9 $mBqm^{-3}$. At location IMI, total beta activity in air ranged from 0.3 $mBqm^{-3}$ to 4.8 $mBqm^{-3}$ with an average of 1.3 ± 0.8 $mBqm^{-3}$. Values of total beta activity in fallout at IMI ranged from 9.0 $mBqm^{-2}$ to 1.3 Bqm^{-2}, with an average of 0.3 ± 0.3 Bqm^{-2}.

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Mihajlović, D.[1], Ružman, K.[1] i Kraljević, L., Mrvoš, L.[1]

KONTROLA KVALITETE MJERILA ZA MJERENJE KONCENTRACIJA SUMPOROVA DIOKSIDA, DUŠIKOVA MONOKISDA I UGLJIKOVA MONOKSIDA U VANJSKOM ZRAKU

Ključne riječi: *kontrola kvalitete, terensko ispitivanje mjerila, državna mreža za trajno praćenje kvalitete zraka*

Mjeriteljske norme za mjerenje koncentracija sumporova dioksida, dušikova monoksida i ugljikova monoksida u vanjskom zraku (HRN EN 14212, HRN EN 14211 i HRN EN 14626) definiraju aktivnosti kontrole kvalitete mjerila tijekom rada na mjernoj postaji za mjerenje kvalitete zraka. Osnovna aktivnost kontrole kvalitete mjerila tijekom godine jest periodično ispitivanje mjerila u dvije točke, na čisti zrak i na plin koncentracije oko 80% raspona mjerenja koncentracija na pojedinoj mjernoj postaji. Rezultati kontrole kvalitete mjerila se koriste za kontrolu ispravnosti mjerila, za validaciju vremenskog niza mjerenja i za proračun proširene mjerne nesigurnosti koncentracije mjerenja pojedinog plina u vanjskom zraku. Tijekom ožujka i travnja 2017. godine, djelatnici Državnog hidrometeorološkog zavoda, su napravili terenska ispitivanja mjerila za mjerenje koncentracija sumporova dioksida, dušikova monoksida i ugljikova monoksida na urbanim mjernim postajama državne mreže za trajno praćenje kvalitete zraka (Zagreb-1, Zagreb-2, Zagreb-3, Sisak-1, Kutina-1, Rijeka-2, Karlovac, Varaždin, Slavonski Brod-1, Slavonski Brod-2 i Osijek-1). Ispitivanje pojedinog mjerila jest provedeno na mjernoj postaji i to u dvije točke, na čisti zrak pomoću uređaja Teledyne API T701 i na plin određene koncentracije (sumporov dioksid, dušikov monoksid i ugljikov monoksid; 304 nmol mol^{-1}, 321 nmol mol^{-1} i 12,032 µmol mol^{-1}) iz pojedinačnih boca. Osnovni statistički rezultati ispitivanja jesu standardna ponovljivost mjerenja (na čisti zrak i na plin), te koeficijenti odmaka i nagiba koji prikazuju odnos između referentne vrijednosti i mjerenja pojedinog mjerila. U ovom radu će biti prikazana metodologija provedbe terenskog ispitivanja, te rezultati ispitivanja mjerila za mjerenje koncentracije sumporova dioksida, koncentracije dušikova monoksida i koncentracije ugljikova monoksida tijekom proljeća 2017.

[1] Državni hidrometeorološki zavod, Grič 3, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Mihajlović, D.[1], Ružman, K.[1] i Kraljević, L., Mrvoš, L.[1]

QUALITY CONTROL OF MEASURING INSTRUMENTS FOR MEASUREMENT OF SULPHUR DIOXIDE, NITROGEN MONOXIDE AND CARBON MONOXIDE IN AMBIENT AIR

Keywords: *quality control, field testing of measurement units, state network for air quality measurement*

Croatian and European standards for continuous measurement methods for determination of the concentrations of sulphur dioxide, nitrogen monoxide and carbon monoxide (HRN EN 14212, HRN EN 14211 and HRN EN 14626) define the quality control activities for measurement units during regular work on the air quality station. The main procedure in the quality control is periodic calibration of the analyser in two points, on zero air and on gas with concentration value of 80% in the measuring range. The results of quality control are used to ensure the state of the measuring unit, for validation of the measurements in time and for calculation of expended measurement uncertainty for specific gas in ambient air. During March and April of 2017, the personnel of meteorological and hydrological service of Croatia, made field testing of the air quality measurement units for the measurement of the sulphur dioxide concentration, nitrogen monoxide concentration and carbon monoxide concentration on urban air quality stations in state air quality network in Croatia (Zagreb-1, Zagreb-2, Zagreb-3, Sisak-1, Kutina-1, Rijeka-2, Karlovac, Varaždin, Slavonski Brod-1, Slavonski Brod-2 i Osijek-1). The testing of the measurement units wad done on the air quality stations in two points, on zero air using zero air generator Teledyne API T701 and on gas with specific concentration (sulphur dioxide, nitrogen monoxide and carbon monoxide; 304 nmol mol^{-1}, 321 nmol mol^{-1} i 12.032 µmol mol^{-1}) from individual gas bottles. The main statistical results are standard repeatability (at zero gas and at gas concentration) and data adjustment function coefficients that are used for a correction of measurement time series. In this work, the methodology of field testing with be demonstrated and the testing results of measurement units will be shown for measurement of sulphur dioxide concentration, nitrogen monoxide concentration and carbon monoxide concentration during spring 2017.

[1] Meteorological and Hydrological Service, Grič 3, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Mihaljević, A.[1], Žužul, S.[1]

USPOREDBA RAZLIČITIH POSTUPAKA PRIPRAVE UZORAKA ZA ODREĐIVANJE UKUPNE TALOŽNE TVARI U ZRAKU

Ključne riječi: *Bergerhoffov sakupljač, priprava uzoraka, ukupna taložna tvar*

Ukupna taložna tvar (UTT) uključuje sve tvari u čvrstom, tekućem ili plinovitom stanju koje nisu sastavni dio zraka, a talože se gravitacijom ili ispiranjem s padalinama iz atmosfere na tlo. Najčešće su veće od 20 µm i prekrupne su da bi mogle udisanjem ući u organizam čovjeka, ali narušavaju kakvoću okoline te mogu posredno nepovoljno djelovati i na čovjeka. Pravilnikom o praćenju kvalitete zraka (NN 3/2013) propisana je metoda mjerenja ukupne taložne tvari u zraku te se ukupna taložna tvar sakuplja i određuje prema Bergerhofovoj metodi opisanoj u VDI 4320 Part 2:2012.

Uspoređena su dva postupka priprave uzoraka za određivanje ukupne taložne tvari u zraku. Uzorci ukupne taložne tvari sakupljeni su tijekom četiri mjeseca, od 1. prosinca 2016. do 31. ožujka 2017., na četiri mjerne postaje u gradu Zagrebu. Na svakoj mjernoj postaji postavljena su dva odvojena Bergerhoffova sakupljača kojima su uzorkovana dva paralelna mjesečna uzorka ukupne taložne tvari u vremenskom periodu od 30 ± 2 dana. Količina ukupne taložne tvari u svim sakupljenim uzorcima određena je gravimetrijski na analitičkoj vagi razlučivosti 10^{-5} g i izražena u mg m^{-2} d^{-1}. U prvom postupku uzorci su pripravljeni prema referentnoj metodi opisanoj u VDI 4320 Part 2:2012 i količina ukupne taložne tvari određena je uparivanjem cijeloga uzorka. U drugom postupku, svi sakupljeni uzorci su profiltrirani kroz membranski filtar veličine pora 8 µm i izmjeren je volumen filtrata. Filtri su osušeni i izvagani prije i nakon filtracije te je određena masa netopljivih tvari u ukupnoj taložnoj tvari. Alikvot filtrata svakog uzorka uparen je do suhoga u prethodno izvaganoj čaši te je određena masa topljivih tvari u uzorku. Količina ukupne taložne tvari izračunata je iz sume dobivenih masa topljivih i netopljivih tvari u uzorku. Mjesečne vrijednosti količine ukupne taložne tvari kretale su se od 14,6 mg m^{-2} d^{-1} do 69,3 mg m^{-2} d^{-1}. Statističkom obradom dobivenih rezultata uočeno je da je u uzorcima pripravljenim drugim postupkom dobivena nešto viša vrijednost količine ukupne taložne tvari u odnosu na paralelne uzorke pripravljene referentnom metodom prema VDI 4320 Part 2:2012, ali T-testom je utvrđeno da razlika između rezultata dobivenih navedenim postupcima priprave nije statistički značajna.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Mihaljević A.[1], Žužul S.[1]

COMPARISON OF DIFFERENT SAMPLE PREPARATION PROCEDURES FOR THE DETERMINATION OF TOTAL DEPOSITED MATTER IN AIR

Keywords: *Bergerhoff collector, sample preparation, total deposited matter*

Total deposited matter (TDM) includes all solids, liquids and gasses that are not components of air but are deposited to the ground by gravity or rain from the atmosphere. They are mainly bigger than 20 μm so they are too large to enter the human respiratory tract; however, they do disturb the quality of the environment so they may have an indirect adverse effect on humans. The Ordinance on Air Quality Monitoring (NN 3/2013) defines the Bergerhoff method (VDI 4320 Part 2:2012) for sampling and measuring total deposited matter.

Two procedures for preparing samples for the determination of total deposited matter in air are compared. Samples of total deposited mater were collected at four sampling sites over a period of four months, from December 1 2016, to March 31 2017. Two separate Bergerhoff collectors were set up at each sampling site so two parallel monthly samples of total deposited matter were collected in a sampling period of 30 ± 2 days. Total deposited matter was determined gravimetrically with an analytical balance with 10^{-5} g resolution. Results are expressed in mg m^{-2} d^{-1}. In the first procedure, samples were prepared according to the reference method (VDI 4320 Part 2:2012). Total deposited matter was determined by weighing dry residue after evaporating the whole sample volume. In the second procedure, all samples were filtered through 8 μm pore size membrane filters and filtrate volume was measured. Filters were dried and weighed before and after filtration to determine the water-insoluble fraction of total deposited matter. The filtrate aliquot of each sample was reduced to dryness in a tare-weighed beaker to determine the water-soluble fraction in sample. Total deposited matter was determined as a sum of dissolved matter mass and undissolved matter mass. Monthly results of total deposited matter ranged from 14.6 mg m^{-2} d^{-1} to 69.3 mg m^{-2} d^{-1}. Statistical evaluation of data showed that results of total deposited matter in samples prepared according to the second procedure of preparation were higher than the others prepared according to the reference method. T-test showed that there was no statistically significant difference between the results obtained by the said preparation procedures.

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Sever Štrukil, Z.[1], Jakovljević, I.[1], Pehnec, G.[1]

MASENE KONCENTRACIJE PAU U PM_{10} FRAKCIJI LEBDEĆIH ČESTICA U ZAGREBU

Ključne riječi: *PAU, benzo(a)piren, dijagnostički omjeri, kancerogena aktivnost*

Policiklički aromatski ugljikovodici (PAU) pripadaju skupini toksičnih spojeva nastalih nepotpunim sagorijevanjem fosilnih goriva i drugih organskih materijala. Zdravstveni rizici povezani s inhalacijom PAU iz zraka određuju se najčešće na temelju koncentracije benzo(a)pirena (BaP) u zraku kojeg je Međunarodna agencija za istraživanje raka (IARC) svrstala u prvu grupu karcinogena. Masene koncentracije PAU određivane su u PM_{10} frakciji lebdećih čestica na tri lokacije u Zagrebu s različitim utjecajem izvora onečišćenja (promet, industrija, kućanstva). Tijekom sezone grijanja (studeni i prosinac 2016. godine), neprekidno 36 dana, sakupljani su 24-satni uzorci PM_{10} frakcije lebdećih čestica. Analiza PAU je provedena kromatografijom visoke djelotvornosti (HPLC) s fluorescentnim detektorom promjenjivih valnih duljina ekscitacije i emisije. Ukupne srednje koncentracije deset mjerenih PAU iznosile su: 42,01 ng m^{-3} na postaji u stambenom dijelu grada, 41,29 ng m^{-3} na postaji u blizini prometnice, te 60,64 ng m^{-3} na postaji u neposrednoj blizini industrije. Nije utvrđena statistički značajna razlika između masenih koncentracija pojedinih PAU-a na mjerenim postajama, osim za dibenzo(a,h)antracen čija je izmjerena vrijednost statistički značajno veća na lokaciji u blizini industrije. Masene koncentracije benzo(a)pirena na tri mjerene postaje izmjerene su u rastućem rasponu: kućanstva < promet < industrija. Najviša srednja koncentracija BaP-a izmjerena je na lokaciji u blizini industrije (5,96 ng m^{-3}), dok je najniža (4,39 ng m^{-3}) zabilježena u stambenom dijelu grada. Izračunati su dijagnostički omjeri PAU-a kako bi se utvrdio mogući izvor onečišćenja. Utjecaj ispušnih plinova automobila vidljiv je na svim lokacijama, dok je na lokaciji u blizini prometnice značajan izvor PAU dizelsko gorivo. Također, potencijalni izvor PAU u blizini kućanstava u stambenom dijelu grada je izgaranje ugljena ili drva. Kancerogena aktivnost PAU može se odrediti preko ekvivalenta BaP (BaPeq). Ekvivalent BaP dobije se tako što se izmjerena koncentracija pojedinog PAU u vanjskom zraku pomnoži s toksičnim ekvivalentnim faktorom (TEF). Najveća kancerogena aktivnost izračunata je za lokaciju u blizini industrije (8,62 ng m^{-3}), dok su ostale dvije lokacije imale slične kancerogene aktivnosti (6,51 ng m^{-3} u blizini prometnice, 6,07 ng m^{-3} u stambenom djelu). Doprinos kancerogene aktivnosti BaP-a iznosio je više od 70 % u ukupnoj kancerogenoj aktivnosti na svim lokacijama. Uz benzo(a)piren, značajan doprinos imali su benzo(b) fluoranten, indeno(1,2,3-cd)piren, benzo(a)antracen i dibenzo(a,h)antracen.

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Sever Štrukil, Z.[1], Jakovljević, I.[1], Pehnec, G.[1]

MASS CONCENTRATIONS OF PAHS IN PM_{10} PARTICLE FRACTION IN ZAGREB

Keywords: *PAHs, benzo(a)pyrene, diagnostic ratios, carcinogenic activity*

Polycyclic aromatic hydrocarbons (PAHs) are toxic pollutants released by the incomplete combustion or pyrolysis of fossil fuels and other organic materials. Health risk assessments associated with PAH uptake by inhalation are often made on the basis of benzo(a)pyrene (BaP) concentrations in air. Concerning carcinogenicity, the International Agency for Research on Cancer (IARC) has classified BaP as a Group 1 agent (carcinogenic to humans). Mass concentrations of PAHs were measured in the PM_{10} particle fraction at three locations with potentially different pollution sources (traffic, industry, and households) in Zagreb. Samples of PM_{10} particles were collected during 24 h in the heating season (November and December 2016), continuously for 36 days. The analysis was performed using liquid chromatography (HPLC) with a fluorescence detector and programmed changes in excitation and emission wavelengths. Total average PAH concentrations (ten measured compounds) were: 42.01 ng m^{-3} at the urban residential site, 41.29 ng m^{-3} at the site near highways, and 60.64 ng m^{-3} close to the industrial zone. The measured PAH concentrations were not statistically different between the three locations with the exception of dibenzo(a,h)anthracene, which showed a statistically higher concentration near the industrial zone. The mass concentrations of BaP on the three locations were in the following ascending range: urban households < traffic < industry. The highest average BaP concentration was measured at the site near the industrial zone (5.96 ng m^{-3}), while the lowest average BaP concentration (4.39 ng m^{-3}) was registered in the urban residential area. Diagnostic ratios of PAHs were calculated in order to estimate possible pollution sources. The contribution of car exhausts was significant at all three of the locations, the urban traffic site having a particularly high contribution to PAHs with gasoline and diesel. Also, a potential PAH source in the residential area is coal or wood combustion. The total carcinogenic activity is defined as the sum of BaP equivalents (BaPeq). BaPeq was calculated by multiplying each PAH concentration by its individual toxic equivalency factor (TEF). The highest total carcinogenic activity was calculated for the industrial site (8.62 ng m^{-3}), while the other two locations had similar total carcinogenic activities (6.51 ng m^{-3}; 6.07 ng m^{-3}). Contribution of carcinogenic activity of BaP alone was more than 70 % of the activity of all of the measured PAHs at all of the measured sites. Besides benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, benzo(a)anthracene, and dibenzo(a,h)anthracene also had a major role in total activity.

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Šimić, I.[1], Godec, R.[1], Čačković, M.[1], Šega, K.[1], Bešlić I.[1]

PROSTORNA RASPODJELA MASENIH KONCENTRACIJA UGLJIKA U ZRAKU GRADA ZAGREBA

Ključne riječi: *EC, OC, OC/EC omjer, $PM_{2,5}$, TC*

U ovom radu proučavane su masene koncentracije elementnog (EC) i organskog (OC) ugljika u $PM_{2,5}$ frakciji lebdećih čestica (čestice s ekvivalentnim aerodinamičkim promjerom manjim od 2,5 μm) u zraku tijekom 2016. godine u svrhu utvrđivanja prostorne i vremenske raspodjele. Mjerna mjesta nalazila su se u različitim dijelovima Zagreba:

- *A – zapadni dio grada opterećen onečišćenjima iz industrije s umjerenim prometom*
- *B – južni stambeni dio grada s povećanim prometom*
- *C – centar grada opterećen onečišćenjima iz prometa*
- *D – sjeverni stambeni dio grada s umjerenim prometom.*

24-satni uzorci frakcije lebdećih čestica $PM_{2,5}$ sakupljeni su prosisavanjem malih volumena zraka (≈ 55 m^3) na filtre od kvarcnih vlakana. Prije uzorkovanja filtri su žareni na 900°C tijekom tri sata kako bi se smanjio sadržaj organskog ugljika u njima. Masene koncentracije $PM_{2,5}$ frakcije lebdećih čestica određene su gravimetrijski sukladno normi HRN EN 12341:2014. Sadržaj OC i EC u lebdećim česticama određen je metodom termičko-optičke transmisije (TOT) na analizatoru ugljika s plameno ionizacijskim detektorom uz korištenje NIOSH-like temperaturnog protokola. Rezultati su pokazali statistički značajne razlike u masenim koncentracijama lebdećih čestica i ugljika u njima između različitih mjesta sakupljanja. Prosječne godišnje masene koncentracije $PM_{2,5}$ slijede niz: A > B > C > D što je za očekivati zbog prisutnosti industrije, veće gustoće prometa te resuspendirane prašine. Najniže dnevne masene koncentracija EC izmjerene su u ljetnim mjesecima na mjernim mjestima C i D zbog smanjene frekvencije prometnih vozila, dok su na mjernim mjestima A i B najniže vrijednosti bile u proljeće. Najviše dnevne masene koncentracije OC izmjerene su zimi na svim mjernim mjestima osim na mjernom mjestu D. Prosječni godišnji omjeri masenih koncentracija OC/EC na svim mjernim mjestima veći su od 3 što ukazuje na prisutnost sekundarnog organskog aerosola u zraku Zagreba. Ukupni ugljik na svim mjernim postajama čini značajan udio u $PM_{2,5}$ lebdećim česticama (≈ 40 %).

[1] Institut za medicinska istraživanja i medicinu rada, Ksaverska c. 2, Zagreb, Hrvatska

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Šimić, I.[1], Godec, R.[1], Čačković, M.[1], Šega, K.[1], Bešlić I.[1]

SPATIAL DISTRIBUTION OF CARBON MASS CONCENTRATIONS IN ZAGREB AIR

Keywords: *EC, OC, OC/EC mass ratio, $PM_{2.5}$, TC*

The spatial and temporal distribution of carbon species in $PM_{2.5}$ (particles with an equivalent aerodynamic diameter below 2.5 μm) were investigated over 2016. The sampling sites were located in different parts of Zagreb:

- *A – western part of the town with moderate traffic burdened with pollutions which originated from industry;*
- *B – southern residential part of the town with heavy traffic;*
- *C – city centre burdened with pollution which originated from traffic;*
- *D – northern residential part of the town with moderate traffic.*

24-hour $PM_{2.5}$ samples were collected from approximately 55 m^3 of ambient air on quartz fibre filters fired at 900°C for 3 hours before sampling in order to minimize the carbon content in the filters. $PM_{2.5}$ mass concentrations were determined gravimetrically according to the standard HRN EN 12341:2014. Analyses were performed by the thermal-optical transmittance method (TOT) using a carbon analyser with a flame ionization detector, operating according to a NIOSH-like temperature program. Our results showed statistically significant variations of particle and carbon mass concentrations between the monitoring stations. The annual average mass concentrations of $PM_{2.5}$ varied in the order of A > B > C > D due to the presence of industry, higher traffic density and resuspended dust. The lowest daily mass concentrations of EC were observed in summer at sampling sites C and D because of the reduced frequency of motor vehicles. At sampling sites A and B, the lowest daily mass concentrations of EC were observed in spring. The highest daily mass concentrations of OC were obtained in winter for all of the sampling sites except for sampling site D. The annual average mass ratio of OC/EC was higher than 3, which demonstrated an abundance of secondary organic aerosols in Zagreb. Total carbon (sum of OC and EC) at all of the sampling sites constituted a significant part of $PM_{2.5}$ aerosol fraction (≈ 40 %).

[1] Institute for Medical Research and Occupational Health, Ksaverska c. 2, Zagreb, Croatia

DESETI HRVATSKI
ZNANSTVENO-STRUČNI SKUP
ZAŠTITA ZRAKA 2017
Primošten, 03.-07. listopada 2017.
CAPPA

Todorović, M.[1], Knežević, J.[2], Radenković, M.[3]

MORTALITET KAO POSLEDICA IZLOŽENOSTI STANOVNIŠTVA PM_{10}, NO_2 I SO_2 U AMBIJENTALNOM VAZDUHU BEOGRADA

Ključne riječi: *zdravstveni efekti, AirQ, mortalitet*

Kvalitet vazduha predstavlja jedno od najvažnijih ekoloških pitanja vezanih za ljudsko zdravlje širom sveta. Tokom poslednje dve decenije, pokazano je da izloženost zagađenom vazduhu uzrokuje kardiovaskularna i respiratorna oboljenja, koja se mogu završiti i smrtnim ishodom. Zbog visokog zagađenja, posebna pažnja se posvećuje urbanim sredinama zemalja u razvoju. U ovom radu, izvršena je procena efekata zagađenja ambijentalnog vazduha na zdravlje stanovnika Beograda kao jednog od najvećih gradova na Balkanskom poluostrvu. Procena kratkoročnih efekata zagađenja vazduha na zdravlje lokalnog stanovništva urađena je na osnovu dnevnih koncentracija azot dioksida (NO_2), sumpor dioksida (SO_2) i čestica sa dijametrom manjim od 10 μm (PM_{10}), izmerenih tokom 2011.-2015. godine u osam odabranih opština u beogradskom regionu. Procena ukupnog mortaliteta i mortaliteta uzrokovanog kardiovaskularnim i respiratornim oboljenjima koja predstavljaju posledicu izloženosti zagađenom vazduhu urađena je pomoću AirQ+ modela. Osnovne stope ukupnog mortaliteta i mortaliteta uzrokovanog kardiovaskularnim i respiratornim oboljenjima dobijene su iz Republičkog zavod za statistiku, a kao granična koncentracija za sve zagađujuće materije odabrana je vrednost od 20 μg m^{-3}. Mortalitet usled izloženosti povećanim koncentracijama PM_{10}, NO_2 i SO_2 u vazduhu kretao se u intervalima koji su predstavljali 0,2 % (2013. god.) - 3,4 % (2011. god.), 0 % (2013. god.) - 1.3 % (2015. god.) i 0,03 % (2013. god.) - 1.1 % (2012. god.) od ukupnog broja smrtnih slučajeva, respektivno. Najveći broj smrtnih slučajeva na 100000 stanovnika (45, 20 i 15 usled izloženosti PM_{10}, NO_2 i SO_2) procenjen je za centralne opštine beogradskog regiona, tj. opštine koje su bile pod najjačim uticajem emisija iz saobraćaja, i emisija iz gradskih toplana i individualnih grejnih jedinica. Među ispitivanim polutantima, PM_{10} su pokazale najveći efekat na zdravlje stanovništva u ovoj oblasti, dok je udeo mortaliteta usled kardiovaskularnih oboljenja ukazao na njegovu značajnu ulogu u ovom problemu. Pošto su procenjene stope mortaliteta direktno povezane sa koncentracijama ispitivanih zagađujućih materija, rezultati ukazuju na to da je neophodno preduzeti mere smanjenja emisije radi poboljšanja kvaliteta ambijentalnog vazduha, a samim tim i kvaliteta života stanovništva u Beogradu. U daljem radu će biti predložene potrebne mere redukcije i potencijalni izvori zagađenja na koje treba obratiti pažnju.

[1] Institut za fiziku Beograd, Univerzitet u Beogradu, Pregrevica 118, Beograd, Republika Srbija
[2] Agencija za zaštitu životne sredine, Ruže Jovanovića 27a, Beograd, Republika Srbija
[3] Institut za nuklearne nauke „Vinča“, Univerzitet u Beogradu, Vinča, Beograd, Republika Srbija

TENTH CROATIAN
SCIENTIFIC AND PROFESSIONAL ASSEMBLY
AIR PROTECTION 2017
Primošten, October 03-07, 2017
CAPPA

Todorović, M.[1], Knežević, J.[2], Radenković, M.[3]

STUDY ON MORTALITY DUE TO EXPOSURE TO PM_{10}, NO_2, AND SO_2 IN BELGRADE URBAN AREA

Keywords: *health effects, AirQ, mortality*

Air quality represents one of the most important environmental issues related to human health worldwide. In the past two decades, it has been shown that criteria pollutants cause cardiovascular illness and reduced lung function, with potentially fatal consequences. Considering the severity of air pollution in urban areas of developing countries, they have been recognized as areas of special concern. The aim of this study was to evaluate health effects of outdoor air pollution on the citizens of Belgrade, one of the major cities of the Balkan Peninsula. Daily concentrations of criteria pollutants - nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulate matter with less than 10 microns in diameter (PM_{10}) - obtained in 2011-2015 were used to estimate short term health effects due to the inhabitants' exposure to their ambient levels. AirQ+ model developed by the WHO European centre for Environment and Health was used in order to calculate total mortality and mortality related to cardiovascular (CVD) and respiratory diseases (RD) in eight selected municipalities within the city area. The baseline incidence rates for total, CVD, and RD mortality were obtained from the Statistical Office of the Republic of Serbia. The cut-off level for all pollutants was 20 μg m^{-3}. Total mortality due to the exposure to PM_{10}, NO_2 and SO_2 was estimated to be between 0.2 % (2013) - 3.4 % (2011), 0 % (2013) - 1.3 % (2015), and 0.03 % (2013) - 1.1 % (2012) of total number of cases, respectively. Highest numbers of excess deaths per 100,000 residents (45, 20, and 15 due to increased concentrations of PM_{10}, NO_2, and SO_2) were found in the central municipalities of the Belgrade area, which were under the strongest influence of traffic emissions and emissions from district heating and individual heating units. Among the investigated pollutants, increased levels of PM10 had the strongest influence on the health of Belgrade residents. The CVD and RD mortality estimates indicated that CVD could play a major role in mortality due to inhabitants' exposure to PM_{10}, NO_2, and SO_2.

Since the estimated health effects are directly related to the concentrations of investigated pollutants, these results indicated that abatement measures are necessary to raise the quality of ambient air and therefore the quality of life of Belgrade residents. Some of them will be suggested in a forthcoming paper.

[1] Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, Belgrade, Republic of Serbia
[2] Serbian Environmental Protection Agency, Ruže Jovanovića 27a, Belgrade, Republic of Serbia
[3] Vinca Institute of Nuclear Sciences, University of Belgrade, Vinča, Belgrade, Republic of Serbia

INSTITUT ZA MEDICINSKA ISTRAŽIVANJA I MEDICINU RADA

Ksaverska cesta 2
p.p. 291
HR 10001 ZAGREB
Tel.: + 385 1 46 82 500
Fax.: + 385 1 46 73 303
http:// www.imi.hr

DJELATNOST

- Istraživački rad
- Stručna djelatnost
- Nastava
- Izdavačka djelatnost

JEDINICE

- Jedinica za analitičku toksikologiju i mineralni metabolizam
- Jedinica za molekulsku toksikologiju
- Jedinica za analitičku i fizičku kemiju
- Jedinica za toksikologiju
- Jedinica za mutagenezu
- Jedinica za laboratorijske životinje
- Jedinica za biokemiju i organsku analitičku kemiju
- Jedinica za zaštitu od zračenja
- Jedinica za higijenu okoline
- Jedinica za dozimetriju zračenja i radiobiologiju
- Jedinica za medicinu rada i okoliša
- Centar za kontrolu otrovanja

INSTITUT ZA MEDICINSKA ISTRAŽIVANJA I MEDICINU RADA

Ksaverska cesta 2
p.p. 291
HR 10001 ZAGREB
Tel.: + 385 1 46 82 500
Fax.: + 385 1 46 73 303

Jedinica za higijenu okoline

- Mjerenja imisija
- Razvoj i provjera metoda
- Modeliranja izloženosti i razina rizika
- Pomoć pri pripremi i razradi zakonskih propisa i normi

- Ispitni laboratorij s dozvolom Ministarstva zaštite okoliša i energetike za obavljanje djelatnosti praćenja kvalitete zraka

- Referentni laboratorij za određivanje masene koncentracije i sadržaja frakcija lebdećih čestica PM_{10} i $PM_{2,5}$

Akreditirane metode:

- HRN EN 12341:2014 (EN 12341:2014)
- HRN EN 14212:2012 (EN 14212:2012); HRN EN 14212:2012/Ispr.1:2014(EN 14212:2012/AC:2014)
- HRN EN 14625:2012 (EN 14625:2012)
- HRN EN 14211:2012 (EN 14211:2012)
- HRN EN 14626:2012 (EN 146256:2012)
- HRN EN 14902:2007 (EN 14902:2005); HRN EN 14902/ AC:2007 (EN 14902/AC:2006)
- HRN EN 15549:2008 (EN 15549:2008)
- SIST – TP CEN/TR 16243:2011 (CEN/TR 16243:2011)
- HRI – CEN/TR 16269:2017 (CEN/TR 16269:2011)
- VDI 4320 Part 2:2012 (VDI 4320 Part 2:2012)
- HRS CEN/TS 16645:2016 (CEN/TS 16645:2014)

DHMZ

1947. – 2017.

MISIJA

DHMZ podžava održivi i gospodarski razvoj države te zaštitu života, dobara i okoliša informacijama o vremenu, klimi, klimatskim varijacijama i promjenama, vodama i zraku te upozorenjima na opasne vremenske, hidrološke i ekološke pojave i klimatske ekstreme u cilju ublažavanja njihovih posljedica, sukladno preporukama Svjetske meteorološke organizacije i direktivama Europske Unije.

DHMZ upravlja meteorološkom i hidrološkom infrastrukturom te infrastrukturom za motrenje kvalitete zraka te nacionalnom arhivom meteoroloških, hidroloških i njima srodnih podataka.

DHMZ provodi pouzdano i prepoznatljivo međunarodno partnerstvo, posebno na području jugoistočne i srednje Europe.

Djelatnosti DHMZ-a

- Proizvodnja informacija te usluživanje korisnika informacijama iz područja meteorologije, hidrologije i kvalitete zraka (upozorenja, analize, prognoze, studije, elaborati) primjenom znanstvenih metoda uz pomoć snažnih računala i sofisticiranih softvera - numeričkih modela
- Izgradnja infrastrukture i mjernih sustava te planiranje i održavanje svih vrsta meteoroloških i hidroloških postaja te postaja za mjerenje kvalitete zraka
- Izgradnja i održavanje baza podataka (meteorološka, hidrološka, kvaliteta zraka)
- Primijenjeno znanstveno istraživanje i razvoj metoda za povećanje kvalitete informacija koje DHMZ nudi korisnicima
- Obrana od tuče (operativna provedba)

REPUBLIKA HRVATSKA / REPUBLIC OF CROATIA
DRŽAVNI HIDROMETEOROLOŠKI ZAVOD
METEOROLOGICAL AND HYDROLOGICAL SERVICE
www.meteo.hr

EKONERG Institut za energetiku i zaštitu okoliša

Ispitni laboratorij - mjerenje kvalitete zraka i emisija u zrak

Umjerni laboratorij - analizatori za kvalitetu zraka i emisije u zrak

Laboratorij za ispitivanje sposobnosti - mjerenja kvalitete zraka

Referentni laboratorij RH za plinovite onečišćujuće tvari

Najava: **Akreditacija prema normi HRN EN ISO/IEC 17043 za organizaciju ispitivanja sposobnosti u području mjerenja emisije plinovitih onečišćujućih tvari.**

www.ekonerg-laboratorij.com

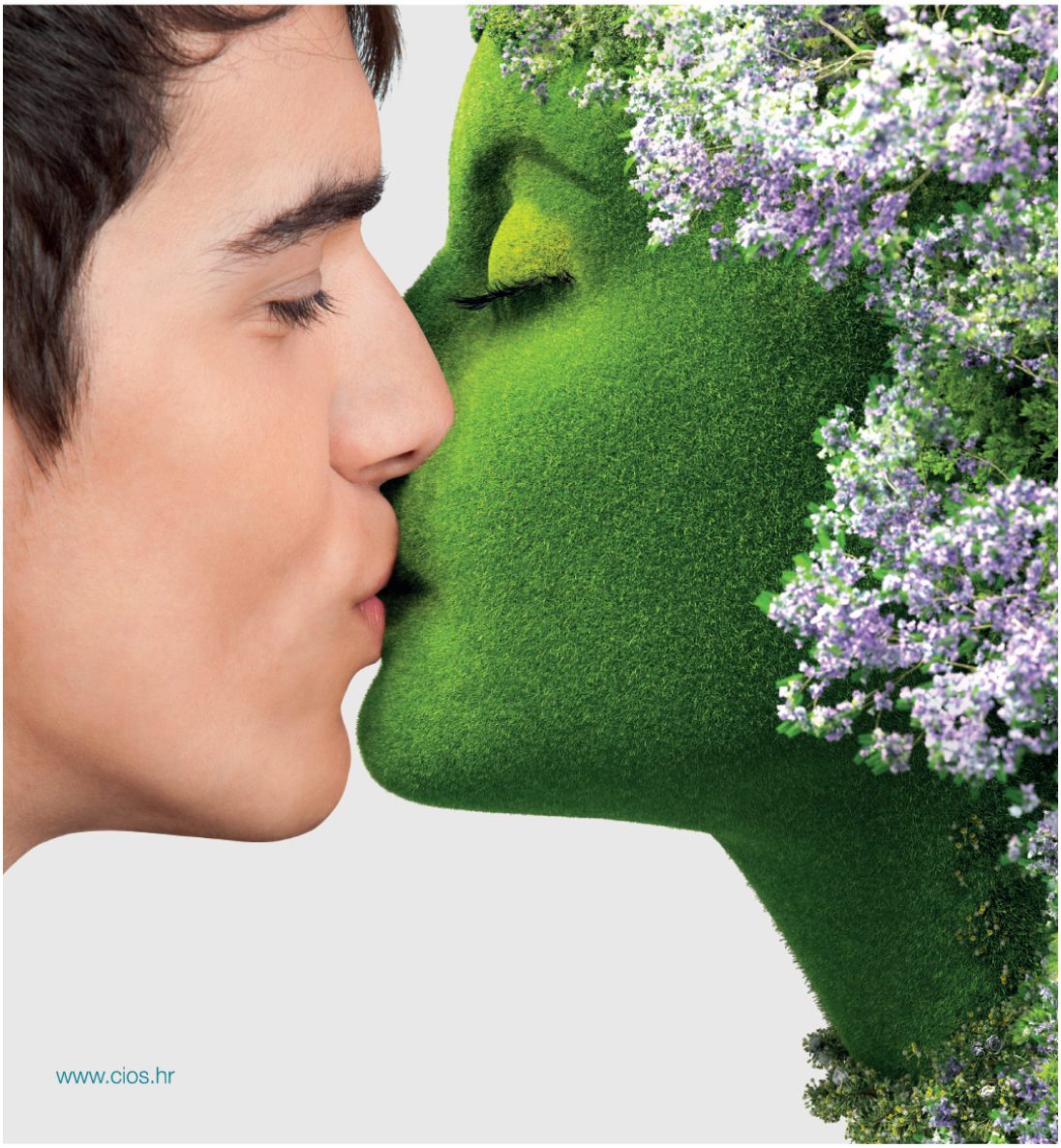
17025 · HAA 1194 TEST

17025 · HAA 2471 CAL

17043 · HAA 8414

SVI KAŽU
DA VOLE PRIRODU
LJUBAV DOKAŽITE
RECIKLIRAJUĆI

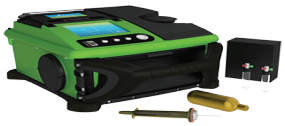
C.I.O.S.
GRUPA
Vaš partner u očuvanju okoliša



www.cios.hr

Atomic Spectroscopy

Consumables



Chromatography

HEBE d.o.o.

And more!

Let's create solutions for the future together!

01/2001-767

info@hebe.hr

PerkinElmer For the Better

SCIEX

BECKMAN COULTER Life Sciences

SPEX Europe

Selnica Ščitarjevska 113, 10410 Velika Gorica

www.hebe.hr

Gmajnje 24
HR-10000 Zagreb
OIB: 68373453442
IBAN: HR9424020061100036827

t +385 1 3457 969
f +385 1 3457 967
labomar@zg.t-com.hr
www.labomar.hr

1nm Scanning Mobility Particle Sizer Spectrometer 3938E77

MASS FLOWMETER 4040 -UMJERNICA-CERTIFIKAT

Mjerač trenutne koncetracije lebdećih čestica veličine do 100 um

koncetracije lebdećih čestica s priključcima-(kontinuirano bilježenje promjene koncetracije)

770-300K SPLIT2 DUST Direct Reading Dust Monitorr - KIT

CECIL INSTRUMENTS LIMITED,CAMBRIDGE,UK- CE Aquarius UV/Visible double beam scanning spectrophotometer,190-900 nm

Cascade impactor

Kontakt:Matija Marić,Mg B.Sc.,matija@labomar.hr,Viktor Marić,B.Sc 10000 Zagreb Sjedište: Gmajnje 24, 10090 Zagreb

Tel. 01 / 34 57 969 - Fax. 01 / 34 57 967,Email. labomar@zg.t-com.hr,www.labomar

AnAs
ANALYTICAL ASSISTANCE

T. Maretića 6
HR-10010 Zagreb
Tel: 01 6625606, 6625607
Fax: 01 6625608
www.anas.com.hr

Temeljna djelatnost tvrtke **AnAs d.o.o.** je snabdijevanje analitičkom opremom i pripadajućim priborom brojnih znanstvenih i sveučilišnih institucija, zavoda za javno zdravstvo i industrijskih pogona u Hrvatskoj.

Široka paleta proizvoda koje nudimo, u kombinaciji s našim znanjem i iskustvom stečenim radom u laboratoriju, omogućuje nam da ponudimo najbolje rješenje za sve vaše analize.

Naši partneri:

analytikjena, RESTEK, scion INSTRUMENTS, CEM, BRUKER, VICI DBS, Starna, VWR HITACHI, PSS, Rigaku, TELEDYNE ISCO, TELEDYNE TEKMAR, aj BLOMESYSTEM, CPAchem, GL Sciences, INORGANIC VENTURES, Kinesis Scientific Experts, MEINHARD, Specac, VICI

KEFO®

SINCE 1949

"ZNAM DA JE MOJ UZORAK DOBAR!"

Carlos Rivera
Laboratorijski tehničar

Bezbrižno vaganje
Slijedite zeleno svijetlo

"Nova METTLER TOLEDO XPE analitička vaga omogućuje mi vaganje uzoraka bez razmišljanja. Vaga dolazi sa pametnim sustavom za detekciju elektrostatike koji automatski detektira i neutralizira naboj na uzorcima i spremnicima. Čini moj svakodnevni rad puno jednostavnijim. Samo slijedim zeleno svijetlo za bezbrižno vaganje."

www.mt.com/green-light

METTLER TOLEDO

Bilješke

Bilješke

Bilješke

ISSN 1848-185X