Program

3rd Workplace and Indoor Aerosols Conference
AEROSOLS 2014
13th – 16th May, 2014
Wrocław, Poland

Organizes: Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Wrocław, Poland and the Wrocław Branch of the Polish Academy of Sciences
COMMITTEES

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Prof. Dainius Martuzevicius, Kaunas University of Technology, Lithuania
Prof. Lidia Morawska, Queensland University of Technology, Australia
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Dr. Bernard Polednik, Lublin University of Technology, Poland
Dr. Michael Riediker, Institute of Work and Health, Switzerland
Prof. Kai Savolainen, Finnish Institute of Occupational Health, Finland
Dr. Otmar Schmid, German Research Center for Environmental Health, Germany
Dr. Bogumiła Szponar, Institute of Immunology and Experimental Therapy, Poland
Dr. Pawel Wargocki, Department of Civil Engineering DTU, Denmark
Dr. Aneta Wierzbicka, Institute of Immunology and Experimental Therapy, Poland
Dr. Oliver Witschger, Institute National de Recherche et de Securite, France

**Organizing Committee**
Dr. Bogumiła Szponar, Assoc. Prof., Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Wrocław
Prof. Marzenna R. Dudzińska, Department of Indoor Environment Engineering, Lublin University of Technology, Lublin
Prof. Rafał Górny, Central Institute for Labour Protection (CIOP-PIB), Warszawa
Dr. Piotr Grzybowski, Faculty of Chemical and Process Engineering, Warsaw University of Technology, Warszawa
Prof. Beata Gutarowska, Institute of Fermentation Technology and Microbiology, Łódź University of Technology, Łódź
Dr. Elżbieta Jankowska, Central Institute for Labour Protection (CIOP-PIB), Warszawa
Dr. Jerzy Sowa, Faculty of Environmental Engineering, Warsaw University of Technology, Warszawa
Prof. Irena Szadkowska-Stańczyk, Department of Environmental Health Hazards, Nofer Institute of Occupational Medicine, Łódź
Prof. Lidia Wol ska, Dept of Environmental Toxicology, Faculty of Health Sciences with Subfaculty of Nursing and Institute of Maritime and Tropical Medicine, Medical University of Gdańsk

under the honorary patronage of
Dr. Rafał Dutkiewicz
Mayor of Wrocław
Dear Colleagues and Friends,

Welcome to the 3rd Workplace and Indoor Aerosols Conference in Wroclaw!

We greatly appreciate that we can host this prestigious international meeting, and we hope that our efforts yield the last two conferences in series, in Karlsruhe and in Lund.

The conference aim is providing a forum for aerosol researchers and students to meet, to integrate scientific research community and to create opportunities to update and improve knowledge behind observed health effect due to exposure to airborne particles, as well as development of prevention strategies in public places, homes and working environments.

This conference will continue and build on experience of previous Conferences on Workplace and Indoor Aerosols, organised by Association for Aerosol Research (Gesellschaft für Aerosolforschung e.V., GAeF) in Karlsruhe, Germany in June 2010, and Lund University, Division of Ergonomics and Aerosol Technology in Lund, Sweden, in April 2012.

This time we will meet in Wroclaw, the main city of the historical region of Silesia in south-western Poland, situated on the Odra River. We thank you for attending the Aerosols 2014 and for all your contributions. We wish you the great time in sharing the knowledge, experience and a joy.

Welcome to Wroclaw – the meeting place!

on behalf of the Organizing Committee
Bogumila Szponar
## CONFERENCE PROGRAM

### TUESDAY, May 13th

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>15:00 - 18:00</td>
<td>Conference registration at Campanile-Centrum hotel</td>
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<tr>
<td>18:30 - 20:00</td>
<td>Opening &amp; Welcome party, in the <strong>Ossolineum baroque garden</strong>, Grodzka street 10, near the Odra river banks</td>
</tr>
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### WEDNESDAY, May 14th

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>9:30 - 9:45</td>
<td>Welcome address</td>
</tr>
<tr>
<td>9:45 - 10:20</td>
<td><strong>Keynote lecture - Prof. Lidia Morawska</strong>, Queensland University of Technology, Brisbane, Australia Do indoor exposures matter?</td>
</tr>
<tr>
<td>10:20 - 11:00</td>
<td><strong>Keynote lecture - Prof. Chris Chao</strong>, Hong Kong University of Science and Technology, Hong Kong From source to exposure: study of indoor aerosol transport</td>
</tr>
<tr>
<td>11:00 - 11:30</td>
<td>Coffee &amp; Posters &amp; Sponsors</td>
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**Session 1 - Workplace and indoor aerosols, levels and exposure**  
*Chairpersons: E. Jankowska, M. Jicha*

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>11:30 - 11:45</td>
<td>T. Moreno, Inst. of Environmental Assessment &amp; Water Research (IDAA-CSIC), Barcelona, Spain Underground rail platform air quality: why is there so much variation?</td>
</tr>
<tr>
<td>11:45 - 12:00</td>
<td>M. Viana, Inst. of Environmental Assessment &amp; Water Research (IDAA-CSIC), Barcelona, Spain Nanoparticle exposure during laser irradiation of ceramic tiles in an industrial setting</td>
</tr>
<tr>
<td>12:00 - 12:15</td>
<td>Ch. Asbach, Inst. of Energy and Environmental Technology (IUTA), Duisburg, Germany Means for personal nanoparticles exposures assessment: a review</td>
</tr>
<tr>
<td>12:15 - 12:30</td>
<td>TSI sponsored talk</td>
</tr>
<tr>
<td>12:30 - 13:00</td>
<td>Lunch</td>
</tr>
<tr>
<td>13:00 - 13:30</td>
<td>Coffee &amp; Posters &amp; Sponsors</td>
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**Session 2 - Mitigation strategies of indoor exposures**  
*Chairpersons: D. Martuzevičius, P. Grzybowski*

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<tbody>
<tr>
<td>13:45 - 14:00</td>
<td>I. Chaban, Kyiv National University of Construction and Architecture, Ukraine Combined shock-foam-type air handling unit for air conditioning systems</td>
</tr>
<tr>
<td>14:00 - 14:15</td>
<td>P. Markowicz, Dept. of Laboratory Medicine, Lund University, Sweden Improving the indoor air quality in a school building by using surface emission trap</td>
</tr>
<tr>
<td>14:15 - 15:15</td>
<td>Panel discussion</td>
</tr>
<tr>
<td>15:15 - 15:55</td>
<td><strong>Coffee &amp; Cake &amp; Posters</strong></td>
</tr>
<tr>
<td>19:00</td>
<td><strong>Biesiada social event, at the Letnia restaurant, Wroclaw ZOO</strong></td>
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### THURSDAY, May 15th

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<tbody>
<tr>
<td>9:30 - 9:45</td>
<td>Introduction</td>
</tr>
<tr>
<td>9:45 - 10:20</td>
<td>Keynote lecture – Prof. Tiina Reponen, University of Cincinnati, USA</td>
</tr>
<tr>
<td></td>
<td>Microbial fragments - exposure and health effects</td>
</tr>
<tr>
<td>10:20 - 11:00</td>
<td>Keynote lecture – Prof. Detlef Schmechel, BioGenes, Berlin, Germany</td>
</tr>
<tr>
<td></td>
<td>The development of immunodiagnostics and monitoring techniques for fungal bioaerosols</td>
</tr>
<tr>
<td>11:00 - 11:30</td>
<td>Coffee &amp; Posters &amp; Sponsors - 30’</td>
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**Session 3 - Aerosols and bioaerosol in occupational and dwellings indoor environment**

*Chairperson: B. Szponar, L. Larsson*

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker and Institution</th>
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<tbody>
<tr>
<td>11:30 - 11:45</td>
<td>A. Włodarczyk, School of Biosciences, Cardiff University, UK</td>
</tr>
<tr>
<td></td>
<td>The genotoxicity of PM10 collected from indoor air in Barcelona schools</td>
</tr>
<tr>
<td>11:45 - 12:00</td>
<td>M. Cyprowski, Dept. of Chemical, Aerosol and Biological Hazards, Central Institute for Labour Protection - National Research Institute, Warsaw, Poland</td>
</tr>
<tr>
<td></td>
<td>Assessment of bacterial aerosols in waste sorting plant</td>
</tr>
<tr>
<td>12:00 - 12:15</td>
<td>B. Polednik, Faculty of Environmental Engineering, Lublin University of Technology, Lublin, Poland</td>
</tr>
<tr>
<td></td>
<td>Aerosols in a dental office</td>
</tr>
<tr>
<td>12:15 - 12:30</td>
<td>Sponsored talk</td>
</tr>
<tr>
<td>12:30 - 13:00</td>
<td>Lunch</td>
</tr>
<tr>
<td>13:00 - 13:30</td>
<td>Coffee &amp; Posters &amp; Sponsors</td>
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**Session 4 - Human immunology and pathology in relations to aerosol exposure**

*Chairperson: G. Buonanno, A. Gamian*

<table>
<thead>
<tr>
<th>Time</th>
<th>Invite and Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:30 - 14:00</td>
<td>Invited lecture – Prof. Marek Jutel MD, Wroclaw Medical University, Poland</td>
</tr>
<tr>
<td></td>
<td>Immunological response to bioaerosols</td>
</tr>
<tr>
<td>14:00 - 14:30</td>
<td>Invited lecture – Prof. Joanna Domagała-Kulawik MD, Warsaw Medical University, Poland</td>
</tr>
<tr>
<td></td>
<td>Acute and chronic respiratory risks triggered by aerosols</td>
</tr>
<tr>
<td>14:30 - 15:30</td>
<td>Panel discussion</td>
</tr>
<tr>
<td></td>
<td>Aerosols in indoor environment and occupational settings with impact on human health</td>
</tr>
<tr>
<td>15:30 - 16:00</td>
<td>Coffee &amp; Cake &amp; Posters</td>
</tr>
<tr>
<td>19:00</td>
<td>Conference dinner, at the Campanile Centrum hotel, Ślężna street 26</td>
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### FRIDAY, May 16th

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>8:00 - 9:30</td>
<td>Breakfast at hotels</td>
</tr>
<tr>
<td>9:30 - 13:00</td>
<td>Guided city sightseeing</td>
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<tr>
<td></td>
<td>Wrocław - city on islands and The Baroque Wroclaw</td>
</tr>
<tr>
<td>13:00</td>
<td>Lunch (for participants of excursions)</td>
</tr>
</tbody>
</table>
**POSTER SESSION**

**Session 1**

*Workplace and indoor aerosols, levels and exposure*

**Sub-session 1 - Exposure assessment and instrumentation**

1. **M. Kistler**, *Institute of Chemical Technologies and Analytics, Vienna University of Technology, Vienna, Austria*
   Chemical and physical characterization of size resolved particles collected in a chemical engineering laboratory

2. **E. Krugly**, *Department of Environmental Technology, Kaunas University of Technology, Kaunas, Lithuania*
   The impact of residential solid fuel burning on outdoor and indoor concentrations of PAHs

3. **K. S. Patel**, *School of Studies in Chemistry, Pt. Ravishankar Shukla University, Raipur, India*
   Indoor emission exposure in India

4. **P. Tint**, *Tallinn University of Technology, Tallinn, Estonia*
   Model for risk assessment of dust and chemicals in the work environment

5. **C. V. Trassierra**, *Department of Civil and Mechanical Engineering - University of Cassino and Lazio Meridional, Italy*
   On the interaction between radon and particles generated by incense

6. **A. Wierzbicka**, *Ergonomics and Aerosol Technology, Lund University, Sweden*
   Can information gathered from questionnaires be used to estimate concentrations of particles in dwellings?

7. **P. Sobczyński**, *Ecologistics Group, Biology and Ecology Group, Institute of Environmental Protection Engineering, Wroclaw University of Technology, Poland*
   Evaluation of odour and sanitary air quality in the vicinity of the selected wastewater treatment plant

**Sub-session 2 - Nanoparticles, nanosafety, nanotechnology**

8. **A. S. Fonseca**, *Institute of Environmental Assessment and Water Research, Barcelona, Spain*
   Indoor emissions monitoring during tile sintering in a high-temperature continuous laser furnace

9. **U. Mikolażycky**, *Nofer Institute of Occupational Medicine, Lodz, Poland*
   Emission of nanosized particles during abrasion of dental material

10. **N. Prokopciuk**, *State Research Institute Center for Physical Sciences and Technology, Vilnius, Lithuania*
    Submicron particle emission in controlled environment during the laser ablation process

11. **E. Jankowska**, *Central Institute for Labour Protection – National Research Institute, Department of Chemical, Aerosol and Biological Hazards, Warsaw, Poland*
    Exposure to nano-objects and their agglomerates and aggregates during mixing of engineered nanomaterials

12. **D. Wojcieszak**, *Faculty of Microsystem Electronics and Photonics, Wroclaw University of Technology, Wroclaw, Poland*
    Comparison for photocatalytic activity of nanoparticles and thin films based on titania

13. **M. Jicha**, *Brno University of Technology, Brno, Czech Republic*
    Automatic Image Analysis of Micron-sized Particles: Validation and Application for Fiber Deposition in Human Airways
# Session 2

**Mitigation strategies of indoor exposures**

## Sub-session 3 - Advanced air distribution and exposure control

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<tr>
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<th>Author(s)</th>
<th>Affiliation</th>
<th>Presentation Title</th>
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</thead>
<tbody>
<tr>
<td>14</td>
<td>K. Jeżak</td>
<td>Department of Environmental Health Hazards, Nofer Institute of Occupational Medicine, Lodz, Poland</td>
<td>Factors significantly related to dampness and mold symptoms in urban dwellings – multi regression analysis</td>
</tr>
<tr>
<td>15</td>
<td>D. Martuzevicius</td>
<td>Department of Environmental Technology, Kaunas University of Technology, Kaunas, Lithuania</td>
<td>Dynamics of Aerosol Emissions from Common Indoor Pollution Sources as Characterised in the Ventilation Exhaust</td>
</tr>
<tr>
<td>16</td>
<td>L. Mendes</td>
<td>Environmental Radioactivity Laboratory, N.C.S.R. “DEMOKRITOS”, Athens, Greece</td>
<td>Application of the volatility TDMA technique for human exposure studies in indoor/outdoor residential microenvironment</td>
</tr>
<tr>
<td>17</td>
<td>Ł. Pachurka</td>
<td>Ecologistics Group, Institute of Environmental Protection Engineering, Wroclaw University of Technology, Wroclaw, Poland</td>
<td>Influence of the type and method of distribution of essential oils on odour air quality inside of the car cabin</td>
</tr>
<tr>
<td>18</td>
<td>K. Pietrzak</td>
<td>Institute of Fermentation Technology and Microbiology, Lodz University of Technology, Lodz, Poland</td>
<td>Disinfection at workplaces</td>
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</tbody>
</table>

## Sub-session 4 - Ventilation, air filtration, protective equipment

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<tr>
<th>No.</th>
<th>Author(s)</th>
<th>Affiliation</th>
<th>Presentation Title</th>
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</thead>
<tbody>
<tr>
<td>19</td>
<td>F. Chata</td>
<td>Institut national de recherche et de sécurité (INRS), Vandoeuvre-lès-Nancy, France</td>
<td>Numerical and experimental characterization of dust emission profiles for hand held wood working machines</td>
</tr>
<tr>
<td>20</td>
<td>J. Skóra</td>
<td>Lodz University of Technology, Institute of Fermentation Technology and Microbiology, Lodz, Poland</td>
<td>Evaluation of the antimicrobial activity of nonwovens for respiratory protective equipment</td>
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</tbody>
</table>

## Sub-session 5 - Particulate matter, measurement, field studies

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<tr>
<th>No.</th>
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<th>Affiliation</th>
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<tr>
<td>21</td>
<td>Ch. Asbach</td>
<td>Institute of Energy and Environmental Technology (IUTA) e.V., Air Quality &amp; Filtration, Germany</td>
<td>Characterisation of fine and ultrafine particulate matter from indoor activities</td>
</tr>
<tr>
<td>22</td>
<td>J. G. Bartzis</td>
<td>University of Western Macedonia (UOWM), Department of Mechanical Engineering, Environmental Technology Laboratory, Kozani, Greece</td>
<td>Particulate matter size distribution measurements in modern offices in Athens, Greece (OFFICAIR PROJECT)</td>
</tr>
<tr>
<td></td>
<td>Author(s)</td>
<td>Institution(s)</td>
<td>Title</td>
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<tr>
<td>23</td>
<td>M. Fortuna</td>
<td>Ecologistics Group, Institute of Environmental Protection Engineering, Wroclaw University of Technology, Wroclaw, Poland</td>
<td>Measurements of school indoor and outdoor PM1, PM2.5 and PM10 concentrations complemented with single particle analysis</td>
</tr>
<tr>
<td>24</td>
<td>V. Martins</td>
<td>IDAEA-CSIC (Institute of Environmental Assessment and Water Research - Spanish National Research Council), Barcelona, Spain</td>
<td>Characterisation of particulate matter in the Barcelona subway system</td>
</tr>
<tr>
<td>25</td>
<td>L. Mašková</td>
<td>Institute of Chemical Process Fundamentals of the ASCR, Prague, Czech Republic</td>
<td>Aerosol particles in the indoor environment of different types of archives</td>
</tr>
<tr>
<td>26</td>
<td>T. Moreno</td>
<td>Inst. of Environmental Assessment &amp; Water Research (IDÆA-CSIC), Barcelona, Spain</td>
<td>Chemistry of PM2.5 in the urban school playgrounds and classrooms</td>
</tr>
<tr>
<td>27</td>
<td>T. Prasauskas</td>
<td>Department of Environmental Technology, Kaunas University of Technology, Kaunas, Lithuania</td>
<td>Characterization of multifamily buildings by representative indicators of indoor PM</td>
</tr>
<tr>
<td>28</td>
<td>E. Schreiner</td>
<td>Institute of Chemical Technologies and Analytics, Vienna University of Technology, Vienna, Austria</td>
<td>Chemical characterization of particulate matter samples collected within and outside of two Schools in Vienna, Austria</td>
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<tr>
<td>29</td>
<td>E. C. Cetintas</td>
<td>Institute of Chemical Technologies and Analytic, Technical University of Vienna, Vienna, Austria</td>
<td>Indoor air concentrations of particulate matter in different environments in Vienna, Austria</td>
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### Session 3

**Aerosols and bioaerosols in occupational and dwellings indoor environment**

#### Sub-session 6 - Bioaerosols in indoor environment and occupational settings

<table>
<thead>
<tr>
<th>No.</th>
<th>Author(s)</th>
<th>Institution(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>J. Adamiak</td>
<td>Institute of Fermentation Technology and Microbiology, Faculty of Biotechnology and Food Sciences, Lodz University of Technology, Lodz, Poland</td>
<td>Molecular methods for evaluation of microbial diversity of indoor air and historic objects in the museum environments</td>
</tr>
<tr>
<td>31</td>
<td>M. Bartoszewicz</td>
<td>Medical University of Gdańsk, Department of Environmental Protection, Department of Environmental Toxicology, Gdansk, Poland</td>
<td>Generation and transport of bioaerosol exemplified by the waste disposal site in Gdansk Szadolki</td>
</tr>
<tr>
<td>32</td>
<td>A. Kozajda</td>
<td>Department of Environmental Health Hazards, Nofer Institute of Occupational Medicine, Lodz, Poland</td>
<td>The levels of the mold air contamination related to selected home characteristics in urban area</td>
</tr>
<tr>
<td>33</td>
<td>A. Ławniczek-Walczyk</td>
<td>Department of Chemical, Aerosol and Biological Hazards, Central Institute for Labour Protection – National Research Institute, Warsaw, Poland</td>
<td>Assessment of airborne microbial contamination at office workplaces</td>
</tr>
<tr>
<td>34</td>
<td>S. Saari</td>
<td>Tampere University of Technology, Finland</td>
<td>Effects of various factors on the fluorescence properties of fungal spores</td>
</tr>
<tr>
<td>35</td>
<td>J. Skóra</td>
<td>Lodz University of Technology, Institute of Fermentation Technology and Microbiology, Lodz, Poland</td>
<td>Indoor air quality at the workplaces</td>
</tr>
<tr>
<td>36</td>
<td>A. Stobnicka</td>
<td>Biohazard Laboratory, Department of Chemical, Aerosol, and Biological Hazard, Central Institute for Labour Protection – National Research Institute, Warsaw, Poland</td>
<td>Biological contamination of filter mats from ventilation system of airport building</td>
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<tr>
<td>37</td>
<td>I. Szadkowska-Stańczyk</td>
<td>Department of Environmental Health Hazards, Nofer Institute of Occupational Medicine, Lodz, Poland</td>
<td>Subjective and objective assessment of residential mold contamination</td>
</tr>
<tr>
<td>38</td>
<td>R. Czernych</td>
<td>Department of Environmental Toxicology, Faculty of Health Sciences, Medical University of Gdańsk</td>
<td>Phthalates in an indoor dust samples: children health risk assessment</td>
</tr>
<tr>
<td>39</td>
<td>M. Paściak</td>
<td>Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Wroclaw, Poland</td>
<td>Harmful actinobacteria in a compost facility bioaerosol</td>
</tr>
</tbody>
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### Sub-session 4

**Human immunology and pathology in relations to aerosol exposure**

### Sub-session 7 - Relation between aerosol properties and health effects

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<td>40</td>
<td>Characterization of Organic &amp; Inorganic species of Delhi Aerosols (Diwali Festival 2013): Possible Health Effects</td>
<td>S. K. Mishra, National Physical Laboratory, New Delhi</td>
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<tr>
<td>41</td>
<td>Aerosol particles during Masses in a church</td>
<td>B. Polednik, Faculty of Environmental Engineering, Lublin University of Technology, Lublin, Poland</td>
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<td>42</td>
<td>The air quality assessment using tissue cultures</td>
<td>G. Gałęzowska, Medical University of Gdansk, Faculty of Health Sciences with Subfaculty of Nursing, and Institute of Maritime and Tropical Medicine, Department of Environmental Toxicology, Gdansk, Poland</td>
</tr>
<tr>
<td>43</td>
<td>Inhaled nanoparticle tracking and oxidative stress biomarkers in apprentice welders</td>
<td>H. Graczyk, Institute for Work and Health, Lausanne-Epalinges, Switzerland</td>
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<tr>
<td>44</td>
<td>Particulate matter (PM10, PM2.5, PM1) impact assessment on short-term changes in lung function parameters in children</td>
<td>K. Kwiecińska, Ecologistics Division, Institute of Environmental Protection Engineering, Wroclaw University of Technology, Poland</td>
</tr>
<tr>
<td>45</td>
<td>Physico-chemical properties and potential health effects of aged brake wear aerosol</td>
<td>J. Zhao, Institute for Work and Health, University of Lausanne, Switzerland</td>
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<td>46</td>
<td>Microorganisms threatening the people’s health in the work enviroment and their virulence factors</td>
<td>J. Skóra, Lodz University of Technology, Institute of Fermentation Technology and Microbiology, Lodz, Poland</td>
</tr>
</tbody>
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ORAL SESSION

SESSION I

Workplace and indoor aerosols, levels and exposure
Underground rail platform air quality: why is there so much variation?

T. Moreno¹, V. Martins¹, N. Pérez¹, C. Reche¹, E. de Miguel², M. Capdevila², S. Centelles², MC. Minguillón¹, F. Amato¹, A. Alastuey¹, X. Querol¹ and W. Gibbons³

¹ Institute of Environmental Assessment and Water Research, IDAEA, CSIC, C/Jordi Girona 18-24, 08034 Barcelona, Spain

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Commuting by underground rail is a transport mode used daily by over one hundred million people worldwide and in large cities is a key to efficient urban development. There is however a major air quality problem, with PM levels in subway systems worldwide commonly far above the limit values applied to outdoor air. Curiously, there is also striking variability in underground ambient PM levels, both in time and space, as we have demonstrated during a series of ongoing experiments in the Barcelona Metro, where concentration ranges of <10 to >100 µg/m³ for PM₁₀, <20 to >200 µg/m³ for PM₃, and <30 to >300 µg/m³ for PM₁₀ are found. The air quality of a given subway platform involves a complex interplay of the ventilation system, station depth and design, train speed, frequency, wheel materials and braking mechanisms, and number of passengers being transported. Air movements on the platform show constantly repeated cycles involving three-dimensional turbulent flow through some combination of mechanically forced ventilation systems, blast shafts, and platform access points, driven to a large extent by the piston effect of the trains moving through the tunnels. It can be observed that narrow platforms with single-track tunnels are strongly dependent on forced tunnel ventilation and cannot rely on the train piston effect alone to reduce platform PM concentrations. In contrast in wider stations with spacious double-track tunnels ambient PM levels can actually improve when tunnel ventilation is switched off. In those subway systems worldwide that regularly use forced ventilation, this observation offers the possibility of significant energy savings without damaging air quality. Underground platform PM size ratios remain similar (0.3 for PM₁/PM₁₀ and 0.7 for PM₃/PM₁₀) whether or not forced tunnel ventilation is applied. Another variable is that occurring spatially along the platform, with the greatest accumulation of particulates usually occurring at one end, depending on station design. Access tunnels can help dilute particulate concentrations by introducing cleaner air from outside, although lateral accesses are less effective than those at the train entry point. Finally, the commuters themselves influence air quality, as demonstrated by the regular rise and fall of carbon dioxide levels during the build-up and exchange of passengers with each passing train.

Acknowledgements.

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Keywords: Underground rail platform air quality; piston effect; subway particulate matter; carbon dioxide
Nanoparticle exposure during laser irradiation of ceramic tiles in an industrial setting

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Nanoparticle formation and emission mechanisms were assessed at pilot plant scale during irradiation of commercial ceramic tiles using a state-of-the-art continuous laser furnace. Laser irradiation of ceramic tiles is a novel technique for tile sintering developed within the framework of LIFE project LASERFIRING (www.laserfiring.eu), with numerous advantages regarding the sintering process (speed, temperature), durability and coating layer of the tiles. As a result, the implementation of higher powered CO₂ lasers for commercial industrial processes is currently being assessed under LIFE project CERAMGLASS (www.ceramglass.eu). However, nanoparticle emissions during laser irradiation of tiles have so far never been evaluated. The aim of this work was to characterise nanoparticle formation and emission mechanisms, as well as their impact on exposure, during this industrial process. To this end, nanoparticle number, size distribution, mass concentration, surface area and size-resolved chemical composition were monitored using two sets of instruments (TSI water-CPC, TSI NanoScan, Grimm particle counter 1108, DiscMini, and PCIS impactors) located simultaneously at the emission source and the worker breathing zone. The sintering of six different types of commercial tiles was assessed, undergoing maximum temperatures of 1200°C. The tiles consisted of porcelain and red clays, and in each case the tiles were raw, frit coated and frit and decoration coated.

Results evidenced that nanoparticle formation takes place during tile sintering through SO₂-induced nucleation processes, and that primary nanoparticles are also emitted during laser irradiation of the tiles. As a result, nanoparticle concentrations reached a maximum of 9.7*10⁵ #/cm³ (mean size =18 nm) at the emission source over the 2-hour periods during which each of the tiles underwent the thermal treatment. For all tiles, concentrations at the emission source were in the range of 10⁵ #/cm³, with mean sizes ranging between 8 and 18 nm. When emissions were transported toward the area where the workers were exposed, and at breathing zone level, particle number concentrations decreased by approximately one order of magnitude (maximum mean N concentration = 1.1*10⁵ #/cm³) and particle diameter increased from 18 to 26 nm, thus remaining at extremely high concentrations with very low and potentially toxic particle sizes. In terms of mass, an increase was detected from the emission source towards the breathing zone, as expected due to particle ageing. The chemical characterisation of the nanoparticles collected on filter samples displayed high contents of toxic metals (mainly Zn, Pb, Cr and As), especially in the PM0.25 particle size fraction (the lowest fraction collected by the impactors).

Results evidenced the need for protective actions and equipment in ceramic industries using laser irradiation during tile sintering.

Keywords: Ceramic, nucleation, toxic metals, tiles, laser, breathing zone
Means for personal nanoparticle exposure assessment: A review

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The inhalation exposure to airborne particles can best be assessed by taking samples in the breathing zone, which is defined as a 30 cm hemisphere around mouth and nose. In occupational hygiene, particles up to the micron size range are traditionally sampled onto filters and weighed to determine their particle mass concentration. Nanoscale particles usually contribute only negligibly to these mass concentrations and hence the conventional samplers and corresponding evaluation routines are not sufficiently sensitive to assess the personal exposure to airborne nanoparticles. Only in the recent years, dedicated miniaturized samplers and monitors have been developed to measure exposure concentrations in the breathing zone.

The SIINN Eranet project nanoIndEx aims at reviewing these novel personal samplers and monitors and to evaluate their accuracy, comparability and field applicability. Eventually the personal exposure of workers to nanoparticles will be assessed using these samplers and monitors in workplaces where these materials are produced or handled. Around one dozen suitable instruments have been identified. The personal monitors include instruments that determine the particle number, lung deposited surface area or total carbon concentration with high time resolution. The personal samplers deposit particles onto filters, flat substrates or TEM grids for consecutive analysis of the particle morphology, chemical composition, (substance specific) mass concentration and/or the particles’ ability to generate reactive oxygen species as a health-relevant indicator. The samplers and monitors have been subject to intensive laboratory experiments with monodisperse particles and round robin tests with well-defined polydisperse particles. The combination of these tests allows for evaluating the instruments’ accuracy and comparability and to scrutinize the limits of the instruments concerning particle sizes and concentrations.

A review of the existing commercial instruments and some prototypes will be presented along with their experimental evaluation results. Acknowledgement nanoIndEx is supported by the French National Funding Agency for Research (ANR), the German Federal Ministry of Education and Research (BMBF), the British Technology Strategy Board (TSB) and the Swiss TEMAS AG, under the frame of SIINN, the ERA-NET for a Safe Implementation of Innovative Nanoscience and Nanotechnology. IDÆA-CSIC received funding from FP7 Marie Curie ITN “HEXACOMM”.

Keywords: nanoparticle exposure, personal exposure, personal sampler, personal monitor, diffusion charger
POSTER SESSION

SESSION I

Workplace and indoor aerosols, levels and exposure
Chemical and physical characterization of size resolved particles collected in a chemical engineering laboratory

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Size classified aerosol samples were collected at a test stand for chemical engineering and fuel technology, located in the basement floor of a University building.

The aim of the experiment was to link the bulk analysis with chemical imaging for more precise understanding of mixing and variations among indoor particles. Sampling was conducted continuously over five days (120 h). One sampling line was equipped with a five stage low pressure impactor with size cuts between 0.015 and 12.8 µm, another with PM10 low volume separation device (1 m³/h, Digitel). Quartz fiber and Polycarbonate filters were used as sample substrates for the impactor stages, while PM10 was collected on a quartz fiber filter. Additional impactor sampling was conducted over a shorter time period (24 h) on aluminium foils. Particle mass was analyzed gravimetrically (Microbalance Sartorius MP-5). Main PM constituents were determined from quartz and polycarbonate filter aliquots. Carbon parameters (OC, EC) were measured using a thermal-optical method (Sunset Lab. Inc.). Inorganic ions (Cl⁻, NO₃⁻, SO₄²⁻, Na⁺, NH₄⁺, K⁺, Mg²⁺, Ca²⁺) were determined after elution in Milli-Q water (anions) or diluted acid (MSA, cations) using two ion chromatography systems (Dionex). Main and trace elements were determined using ICP-OES (Thermo Scientific) after acidic digestion of the filter aliquot.

The aluminium foils were analyzed using chemical imaging and electron microscopy providing molecular and elemental information at a high lateral resolution. A Horiba LabRam 800HR Raman microscopy was used for vibrational mapping of an area of about 100 µm x 100 µm of the foils at a resolution of about 1 µm. The same area was analyzed using a Quanta FEI 200 electron microscope, acquiring the elemental composition using energy-dispersive X-ray spectroscopy. Both optical images and the related chemical images were combined and a chemometric investigation of the datasets was done using the software package ImageLab (Epina Software Labs). This allowed a comparison of deposited particles with information about their chemical composition obtained from bulk analysis.

First results show a good agreement between both approaches. Main aerosol constituents like sulfates, black carbon and mineral particles were identified. The chemical imaging with subsequent chemometric investigation provided for small sample amount and practically without sample preparation fast information about particle structure. This helps to estimate the formation pathway and health relevance of the particles and therefore reveal a potential for implementation in recognition of hazards related to indoor air quality.

Acknowledgements

The experiment was conducted in the frames of student course LVA 164.311 UPA. The authors thank Dr. Stefan Müller and Prof. Hermann Hofbauer from the Institute of Chemical Engineering for admission to their laboratory. The help of all working groups involved in the course is acknowledged.
Keywords: particulate matter, cascade impactor, bulk analysis, Raman microspectroscopy, electron microscopy, chemometry
The impact of residential solid fuel burning on outdoor and indoor concentrations of PAHs

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Introduction

Solid biomass burning for heat energy production is one of the most important sources of renewable energy. However, biomass combustion can be a major source of emissions of polycyclic aromatic hydrocarbons which cause negative short and long-term health effects. The aim of the research was to report indoor and outdoor concentrations of polycyclic aromatic hydrocarbons (PAHs) in order to define their indoor-outdoor (I/O) ratio from residential wood burning.

Methods

Six sampling locations (L1- L6) in the city of Kaunas, Lithuania, were chosen. Four locations may be classified as “urban” and two locations as “suburban” sampling sites. The measurements have been performed during winter period. Size-resolved outdoor ambient aerosol samples were taken using the low pressure electric impactor ELPI+ (Dekati Inc., Finland). ELPI+ divided aerosol particles to 15 fractions (10 µm – 0.017 µm). Indoor ambient aerosol samples were taken using a micro orifice uniform deposition impactor MOUDI (MSI, USA), which collected ten fractions of the particles (0.056 µm - 18 µm), at an air intake flow rate of 30 l min⁻¹. The I/O ratio of PAHs was calculated by for three pooled fractions (0.056 - 0.32 µm; 0.32 - 1.8 µm; 1.8 – 18 µm).

Results

The analysis of I/O ratios of the individual PAHs indicated several patterns of indoor sources of PAHs. Two patterns of the I/O ratio could be distinguished: a) a uniform distribution of I/O ratios among various PAHs (L1, L2, and L4) at a level <0.5; b) varying I/O ratios of PAHs (L3, L5, L6, including summer measurements) in a broad range from 0.2 to 1 and above (L3). These two patterns of I/O distributions appeared to be associated with the presence of indoor PAH sources. L3 and L5 had operating wood-fired heating system inside, although one storey away. L6 had a wood fireplace, which was operated once during sampling campaign, thus affected the results. The I/O ratio has revealed the influence of the indoor boilers in L5 and L6, although the concentration of PAHs was lower than outdoors. Moreover, an increase of chrysene and fluoranthene was noticeable in each of the three buildings. In the buildings where no indoor PAH source was present, the I/O ratio may indicate a crude estimate of the amount of outdoor combustion-related pollution that penetrated to indoor environment. This ratio ranged from 0.11 to 0.36 at L1, 0.08 to 0.33 at L2, 0.05 to 0.23 at L4.

Acknowledgement

This work was supported by Research Council of Lithuania under grant “Pollution Control in Biomass Combustion: from Pollutant Formation to Human Exposure (BioMassPoll), project No. ATE05/2012.

Keywords: Biomass, Indoor/Outdoor, combustion, PAH
Indoor emission exposure in India

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The incense materials (IM) and mosquito coils (MC) are used for ceremonial purposes and for repelling of mosquito insects in Indian houses. Their fuming are responsible for the indoor air pollution hazards due to emission of ultrafine PM, black carbon (BC), organic carbon (OC), polycyclic aromatic hydrocarbons (PAHs), etc. In this work, the segregation and fluxes of PM and their chemical constituents (i.e. BC, OC, ions and PAHs) emitted during fuming of SM and MC is described. The large fraction (≥90%) of PM falls in the ultrafine modes, ≤1.1 µm. The PM10 emission fluxes for the IM- and MC-PM were ranged from 2422 – 10775 and 19107 – 33797 mg kg⁻¹ with mean value of 6935±3250 and 29191±6644 mg kg⁻¹, respectively. The BC and OC fraction (n = 4) for the IM-PM was ranged from 3.9 – 8.8 and 49.5 – 73.4% with mean value of 5.9±2.3 and 61.4±9.9%, respectively. Similarly, the BC and OC fraction (n = 4) for the MC-PM was ranged from 5.5 – 7.2 and 49.5 – 73.4% with mean value of 6.0±0.8 and 49.5 – 73.4%, respectively. The BC and OC fraction (n = 4) for MC-PM was ranged from 5.5 – 7.2 and 49.5 – 73.4% with mean value of 6.0±0.8 and 27.5±2.9%, respectively. The sum of total fraction of ions i.e. Cl⁻, NO₃⁻, SO₄²⁻, NH₄⁺, Na⁺, K⁺, Mg²⁺ and Ca²⁺ (n = 4) for IM- and MC-PM was ranged from 12.0 – 12.9 and 129 – 349 g kg⁻¹ with mean value of 12.4±0.4 and 232±89 g kg⁻¹, respectively. The total ΣPAH13 content in

Keywords: Indoor air pollution, incense materials, mosquito coils, India
The paper concentrates on the influence of dust and chemicals from the manufacturing of wood, metals, and textiles on human health. The health damages: allergy, more sensitive to the bacteria and viruses from the environment; decreased work-life etc. The measurements in the work and outdoor environment of chemicals, aerosols and dust were carried out around the Estonian Republic. The portable HAZ-DUST EPAM-5000 particulate monitor was used for measurements of dust. Portable FTIR/FT-NIR spectrometer Interspec 301-X with open optical path was used (allows to determine 400 different chemical compounds in the indoor air qualitatively and in restricted cases also quantitatively).

The risk assessment model for determination of health damages in the environment is presented (Fig.1) and the health risk is assessed according to this model (Table 1).

![Model for health risk assessment in the environment](image-url)

### Table 1. The results of measurement of dust and chemicals in the enterprises and the nearest dwellings

<table>
<thead>
<tr>
<th>Measurement point</th>
<th>Measured value</th>
<th>The result</th>
<th>Exposure limit, TVL</th>
<th>Risk level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country-place</td>
<td>dust</td>
<td>0.016 mg/m³</td>
<td>0.050 mg/m³</td>
<td>I</td>
</tr>
<tr>
<td>Wood souvenirs making factory</td>
<td>dust</td>
<td>0.09 mg/m³</td>
<td>5 mg/m³</td>
<td>II</td>
</tr>
<tr>
<td>Outside, close to the factory</td>
<td>dust</td>
<td>0.011-0.014 mg/m³</td>
<td>0.050 mg/m³</td>
<td>I</td>
</tr>
<tr>
<td>Office-rooms (2)</td>
<td>dust</td>
<td>0.012-0.014 mg/m³</td>
<td>0.050 mg/m³</td>
<td>I</td>
</tr>
<tr>
<td>Room for copies</td>
<td>dust</td>
<td>0.02 mg/m³</td>
<td>0.050 mg/m³</td>
<td>II</td>
</tr>
<tr>
<td>In the library</td>
<td>dust</td>
<td>0.012 mg/m³</td>
<td>0.050 mg/m³</td>
<td>I</td>
</tr>
<tr>
<td>Offices, closed to the atrium</td>
<td>dust</td>
<td>0.012 mg/m³</td>
<td>0.050 mg/m³</td>
<td>I</td>
</tr>
<tr>
<td>In the smoking room</td>
<td>dust</td>
<td>0.1 mg/m³</td>
<td>III</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
<td>------------</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>Outside of the office house (in town)</td>
<td>dust</td>
<td>0.005 mg/m³</td>
<td>0.050 mg/m³</td>
<td>II</td>
</tr>
<tr>
<td>Welding in metal industry</td>
<td>CrO₃, O₃, Phenol, Styrene, H₂S, Dust, Swirling Welding</td>
<td>&lt;0.1±0.05 mg/m³, &lt;0.05±0.0075ppm, &lt;1±0.15 ppm, &lt;10±0.15 ppm, &lt;0.2±0.02 ppm, 0.064...0.668 mg/m³, 0.049...0.25 mg/m³, 0.038...0.497 mg/m³</td>
<td>2 mg/m³, 1 ppm, 4 ppm, 20 ppm, 5 ppm, 5 mg/m³, 5 mg/m³, 5 mg/m³</td>
<td>II</td>
</tr>
<tr>
<td>Office-room (15), openable windows</td>
<td>CO₂</td>
<td>779....1549 ppm</td>
<td>492*+800=1292 ppm</td>
<td>II</td>
</tr>
<tr>
<td>Office rooms (15), with unopenable windows</td>
<td>CO₂</td>
<td>866.....1986 ppm</td>
<td>492*+800=1292 ppm</td>
<td>III</td>
</tr>
<tr>
<td>Glass-wool manufacturing</td>
<td>dust</td>
<td>3.7-20.0 mg/m³</td>
<td>10 mg/m³-overall dust</td>
<td>IV</td>
</tr>
<tr>
<td>Textile manufacturing</td>
<td>dust</td>
<td>0,083 -0.52 mg/m³</td>
<td>5 mg/m³-inhalable dust</td>
<td>I</td>
</tr>
<tr>
<td>Shale fuel oil handling, gaseous phase</td>
<td>Benzene, Toluene, o-Xyylene, Phenol</td>
<td>3.2 mg/m³, 23.0 mg/m³, 35.0 mg/m³, 34.0 mg/m³</td>
<td>1.5 mg/m³, 192 mg/m³, 200 mg/m³, 8.0 mg/m³</td>
<td>III, II, II, III</td>
</tr>
<tr>
<td>Rubber manufacturing for car parts</td>
<td>Mercaptane</td>
<td>50 ppm</td>
<td>1.0-10 ppm</td>
<td>IV</td>
</tr>
</tbody>
</table>

* Concentration of CO₂ outdoors, ppm

In the wood processing industry soft and hardwood species were investigated. The size of particles was measured with the measurement equipment Frisch Particle Sizer “analysette 22”.

The conclusion is that softwoods give smaller particles than hardwoods in polishing with different sandpapers. FTIR/FT-NIR spectrometer enables to determine some of the chemicals in the gaseous mixtures that are not possible to identify with other measurement methods (chromatography).
On the interaction between Radon and particles generated by incense

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Radon (Rn) and airborne particles are two of important pollutants in the indoor environment, where most people spend nearly 90% of their life (Buonanno et al., 2011a; Buonanno et al., 2012a). Indoor combustion sources like incense sticks and mosquito coil can produce high particle concentrations (Stabile et al., 2012). Regarding, the risk associated with exposure to Rn, it is due to the inhalation of short-lived progeny. These are particles of heavy metals with diameters from 0.5 to 5 nm called cluster or “unattached” radionuclide. The Radon daughter products are highly mobile and readily attach to aerosol in the surrounding gas by forming a radioactive aerosol in sizes ranging between 10 and 1000 nm.

In order to deepen the interaction between Rn progeny and airborne particles, an experimental study was performed by generating aerosol from combustion of incense inside a Radon chamber. This chamber is at the INMRI (National Institute of Ionizing Radiation Metrology, Italy) and is located at the ENEA Casaccia Research Centre. In the chamber the Radon in air comes naturally from first soil and ambient conditions are controlled. To characterize the incense aerosol condensation particle, counters and scanning mobility particle sizer were used. Radon concentration in the air was measured through a AlphaGUARD Professional Radon Monitor, whereas the measurement of Radon decay product in the air was performed with the Tracelab BWLM Plus-2S Radon daughter Monitor. It was found an increase of the potential alpha energy concentration (PAEC) due to the radon decay products attached to aerosol for higher particle number concentrations as well as of the equilibrium factor (EF). Such growth still continued for long time after the combustion, consequently increasing the exposure risk.

Reference:
Buonanno G., Giovinco G., Morawska L., Stabile L., 2011a. Tracheobronchial and alveolar dose of submicrometer particles for different population age groups in Italy, Atmospheric Environment, 45 (34), 6216-6224.


Keywords: indoor air quality, indoor aerosol, radon, exposure risk, equilibrium factor, Potential Alpha Energy Concentration
Can information gathered from questionnaires be used to estimate concentrations of particles in dwellings?

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In private homes we spend about 65% of our time, where contribution of particles from indoor sources can be significant i.e. accounting to ~60% of exposure to submicrometer particles by number (Bekö et al, 2013). In epidemiological studies contribution of indoor sources is not accounted for, the estimates are based solely on outdoor concentrations. There is a need to include contribution of indoor sources in the exposure estimates. Conducting measurements in a large number of residences remains a challenge. In this study we suggest an alternative approach. The aim was to develop a model that allows estimation of indoor number concentrations. The estimates obtained with this model could be used as input data to improve exposure assessment in epidemiological studies.

A simplified version of the indoor aerosol model (MC-SIAM, Hussein and Kumala, 2008), based on the mass balance equation and with a simplified implementation of the aerosol dynamics, was developed. Input data consisted of: frequency, time and duration of particle-generating activities (on the basis of activity logbooks/questionnaires); emission factors for indoor sources/activities (in particles/h) with geometric mean diameters of emitted particles; residence characteristics (volume, air exchange rate), penetration factor, and outdoor number concentrations (from monitoring station in Copenhagen). Modelled number concentrations were compared to forty-eight-hour measurements conducted in two residences in Copenhagen during the winter season 2011/12.

Modelled indoor number concentrations in comparison to measured values showed 6 and 30% higher average concentrations over the total 48h measurement period in two residences. The average concentrations during occupied time periods, relevant for exposure assessment indoors, were 9 and 35% higher in the model compared to measurements, whereas the estimated median values were 33 and 35% lower than the measured ones.

Information acquired through questionnaires together with outdoor concentrations, used in a simple indoor aerosol model may be a promising tool to estimate proxy submicrometer particle concentrations in dwellings. Inclusion of these estimates in epidemiological studies, would allow better assessment of exposure by accounting for contribution of particles from indoor sources which so far have been neglected.

Acknowledgement

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References

and source apportionment in 56 Danish homes. *Environmental Science and Technology, 47*, 10240-10248.


**Keywords:** Particle concentrations, Residential exposure, Modelling, Indoor activities
Evaluation of odour and sanitary air quality in the vicinity of the selected wastewater treatment plant

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Ecologistics Group, Biology and Ecology Group, Institute of Environmental Protection Engineering, Wrocław University of Technology, Poland; National Research Institute, Institute of Meteorology and Water Management, Poland

The results of field studies in terms of olfactory and microbiological air pollution carried out in the vicinity of a mechanical-biological treatment plant with an intensified nutrient removal and complete sludge treatment sludge are presented. Field inspections allowed to determine the frequency and intensity of odours as well as indicate the number of microorganisms in the air in the area of the investigated wastewater treatment plant. Analysis of the results showed that the workers and residents of area located approximately 200 m east of the plant are most exposed to the odors (zone no. 1). Number of microorganisms detected in the air near the emitters confirmed that the primary settling tank and a bioreactor are most impactful sources of microbiological contamination of the air.

Keywords: field inspections, odour, microorganisms
Exposure to nano-objects and their agglomerates and aggregates during mixing of engineered nanomaterials

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Risk assessment arising from exposure to nano-objects and their aggregates and agglomerates (NOAA) is a difficult issue due to the limited number of studies as a basis for conducting routine measurements in the working environment and the lack of generally accepted limit exposure values determined on the basis of the admitted unequivocally proven negative health effects. Currently, works are carried out aiming to harmonize approaches for assessing exposure and occupational risks associated with the production and use of nanomaterial’s [1-3].

The aim of the performed studies was to investigate of parameters characterizing exposure workers to the NOAA during mixing of commercially available engineered nanomaterial’s comprising particles having a different chemical composition and particle shape - nanotubes (halloysite nanoclay), nanoplates (nanomer I.34MN) and nanoparticles (silicon oxide: SiO2 form Sigma-Aldrich and SiOx from Nanostructured & Amorphous Materials). In the breathing zone of the workers simultaneously in real-time were measured size distribution (SMPS, CPC 3022A and DMA 3080L), number concentration (P-Trak, 8525) and surface concentration (Aero-Trak, 9000). During processes of mixing nanomaterial’s powders air samples with the NAS (Nanometer Aerosol Sampler, model 3089) were taken for their future analysis with electron microscope SEM with EDS detector. Received data confirmed the need for comprehensive, multi-parameter approach to the measurements carried out to assess exposure to NOAA that can be emitted into the working environment during processes with nanomaterial’s. Very importance is of proper assessment of the impact of the “background” on the results. As an effect of processes of mixing nanomaterial’s powders significant increase of number and surface concentrations compared to "background" were observed. Changes were also observed in the size distribution of particles - significant increase of emission of particles with smaller diameter compared to "background". Confirmation of emissions of NOAA to the working environment are results of SEM/EDS analysis.

This study was prepared on the basis of the results of projects I.B.03 and 2.Z.04 carried out within the scope of the National Programme “Safety and working conditions improvement”, funded in the years 2011-2016 by the MNiSW and MPiPS. Main co-ordinator CIOP-PIB.

1. Tiered approach to an exposure measurement and assessment of nanoscale aerosols released from engineered nanomaterials in workplace operations (2011).

Keywords: NOAA, exposure, size distribution, concentration, SEM/EDS analysis
Emission of nanosized particles during abrasion of dental material

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This work was supported under the grant agreement nr 5052/B/P01/2010/38 and 7PR/236215/2011

Background

Abrasion of dental materials may release nanoparticles. Inhalation of nanosized particles can cause respiratory symptoms in the exposed people. Our aim was to assess number, surface area and mass concentrations of nanoparticles released during abrasion of dental materials.

Method

Determinations of the number, mass and surface area of nanoparticles were performed in a laboratory room before, during, and after grinding of abrasive dental material. The number concentrations of <1000nm and <100nm nanoparticles were determined by a condensation particle counter (CPC), mass concentration was determined using a DustTrak airborne aerosol concentration monitor, and the surface concentrations of the particles capable of being deposited in the alveolar (A) and tracheo-bronchial (TB) regions were assessed with an AeroTrak nanoparticle monitor.

Results

Mean number concentrations of <1000nm and <100nm nanoparticles determined prior to the start of the process was 2882.8 particles/cm³ and 2054.5 particles/cm³ of air; during the abrasion process the corresponding numbers were 3025.9 particles/cm³ and 2193.5 particles/cm³ of air, and after finishing of the process the corresponding values were 2269.8 particles/cm³ and 1547.5 particles/cm³ of air, respectively. The surface area of the 10-1000nm particles capable of deposition in the area A was 17.49 μm²/cm³ before starting the abrasion process, 37.50 μm²/cm³ during, and 18.27 μm²/cm³ after the process. For the TB fraction, the corresponding values were 4.18 μm²/cm³ before, 4.36 μm²/cm³ during, and 3.57 μm²/cm³ after the process. The mass concentration of <1000nm nanoparticles was 0.03 mg/m³ before, 0.06 mg/m³ during, and 0.02mg/m³ after the abrasion process.

Conclusion

The number of concentration <1000nm and <100nm nanoparticles released in the abrasion process increased 1-fold, while the surface area of the particles capable of settling in the area A increased 2-fold and 1-fold in the TB region. The mass concentration of the particles increased 2-fold. In summary, particles smaller than 1000nm represent about 68% of the total inhalable particles. Results of the analysis of particles counts showed than the proportion of the particles with a diameter 100nm was 72%, indicating a significant increase. Particles surface area of the alveolar fraction (A) was 8-fold greater than of the particles capable of being deposited in the region of the trachea and bronchi.

Keywords: emission, nanosized particles, abrasion, dental material
Submicron particle emission in controlled environment during the laser ablation process

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Laser ablation of metals is widely applied in the material processing industry. It is also an intense source for generating submicron and nanoparticles (Gonzalez et al., 2007; Barcikowski et al., 2002), which become airborne in the working environment. Such particles may have adverse effect on occupational health conditions. The establishment of appropriate safety standards and regulations with regard to nanoparticles depends on reliable measurement techniques to assess air quality and workplace exposure (Luther, 2004).

In order, to evaluate the metal particle emission as a by-products of the ablation process, experiments in a sealed chamber were conducted. Particle-free ambient air flowed into the chamber at the rate of 5 l/min at atmospheric pressure. The relative humidity of air was in the range of 25% - 30%, while the average air temperature equaled 25 C. Samples of common industry metals: Al, Fe and Cu were used. Nanosecond pulse laser (Baltic HP, λ=532 nm, τ=8 ns) was applied for particle generation. Particle size distribution and a number concentration were measured with a scanning mobility particle sizer (SMPS; working range: from 9 to 840 nm). The ablation lasted as long as the up and down scan of the SMPS. The highest particle number concentration values in the diluted flow were observed in the range from 100 nm to 200 nm for stainless steel - 80000 particles/cm³, aluminium stainless steel - 15000 particles/cm³ and copper 30000 particles/cm³. Ultrafine particle mode (less than 20 nm) was observed only in the cases of stainless steel and copper, the concentration did not exceed 35000 particles/cm³. For aluminium the particle number concentration was declining rapidly after each consequent scan of the surface. The measured particle number concentration of all size range particles was higher in the laboratory indoor air than in the experiment chamber with the same laser operating parameters.

This research has shown that laser ablation increases the submicron and nanoparticle concentration in indoor environment. The concentration of the particles depends on the target material and laser energy.


Keywords: laser ablation, nanoparticles, aerosol formation, aerosol size distribution
Indoor emissions monitoring during tile sintering in a high-temperature continuous laser furnace

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Laser technology offers a modern tool not yet exploited in ceramic tile manufacturing. The implementation of CO2 lasers on industrial processes is being investigated, such as (i) tile sintering in a high-temperature furnace (continuous laser furnace), currently studied under LIFE project CERAMGLASS (www.ceramglass.eu) and (ii) ceramic materials ablation. In order to characterise nanoparticle formation and emission mechanisms during both industrial processes, quantitative NP levels at the emission source (ES) and the breathing zone (BZ) were studied by monitoring real-time size-resolved aerosol concentrations in the size range of 5 nm - 20 μm. Offline techniques such as transmission electron microscopy (TEM) and Energy-Dispersive X-ray (EDX) spectroscopy were used to characterize the particles collected and determine their corresponding elemental composition. Additionally, major and trace elements were determined on the collected filters by inductively coupled plasma mass spectrometry (ICP-MS) and atomic emission spectroscopy (ICP-AES).

Six typical industrial tiles were selected and subjected to the standard thermal cycles used at the companies, with peak temperatures of about 1200°C. The tiles were porcelain and red clay and in each case correspond to (i) raw, (ii) frit coated and (iii) frit and decoration coated.

The results evidenced that:
- NP emissions in terms of mass were 57.6 times higher during ablation than melting process;
- The red clay tiles (especially frit coated) emitted higher particle number and mass concentrations in comparison with porcelain tiles during the laser melting process;
- The maximum nanoparticle concentration monitored for red clay frit coated tile was 9.7x10^5 # cm^-3 (mean diameter =18 nm) over full sampling 2-hours, at the emission source;
- Emissions in terms of particle number concentration from tiles with frit were higher than raw tiles or with decoration (especially red clay with frit which is 3.6 times higher than red clay raw);
- Two different emission behaviors were detected, between porcelain and red clay tiles, strongly linked to T and composition;
- New particle formation processes (SO2-induced nucleation) were detected during thermal sintering of the tiles;
- Primary nanoparticle emissions were detected during laser melting of the tiles;
- Spherical particles originated from fusion were observed by TEM images;
- The highest concentrations of potentially harmful metals (mainly Zn, Pb, Cu, Cr and As) were found in the ultrafine fraction < 0.25 μm.

It is recommended that precautionary and protective actions should be undertaken based on the high NP concentrations recorded during tile sintering using laser.

Keywords: industrial ceramic tiles, CO2 laser, sintering, ablation, nanoparticle emissions
Comparison for photocatalytic activity of nanoparticles and thin films based on titania

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In this paper structural, optical and photocatalytic properties of TiO₂ and TiO₂:Nd nanopowders and thin films have been compared. Titania nanoparticles with 1, 3 and 6 at. % of Nd-dopant were synthesized by sol gel method. Additionally, thin films with the same material composition were prepared with the aid of spin coating method. Properties of the samples were characterized with the aid of such methods as SEM, EDS, XRD, TEM, absorbance, optical transmission and optical profilometry. Moreover, their photocatalytic activity was determined based on the results of methyl orange (MO) degradation. The analysis of structural investigations revealed that all as-prepared nanopowders were nanocrystalline and had TiO₂-anatase structure. The average size of crystallites was ca. 4-5 nm and the correlation between the amount of neodymium and the size of TiO₂ crystallites was observed. Moreover, the dopant content influenced on agglomeration of the nanoparticles. The results of photocatalytic decomposition of MO showed that doping with Nd (especially in the amount of 3 at. %) increased self-cleaning activity of TiO₂. Similar effect was received in case of thin films, but due to its smaller active surface area the decomposition rate was lower. However, as-prepared TiO₂:Nd photocatalyst in the form of thin films and nanopowders seems to be very attractive material for various application. Application of this material in a form of thin film does not have any negative impact on microorganisms or human body, that could not be overcome. In case of nanoparticles the situation is different. Their high activity may caused nanotoxicity.

Keywords: titania, nanoparticles, thin films, nanocrystalline, neodymium, nanotoxicity, nanorisk
Automatic Image Analysis of Micron-sized Particles: Validation and Application for Fiber Deposition in Human Airways

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Determination of particle number concentration in air is common procedure in the occupational hygiene. Particles of different shape are present in the environment and their shape determines the choice of a method for particle analysis. Sampling using filters is the dominant method for air quality evaluation recently. Several methodologies were established for manual optical counting of fibers deposited on filters. These methods are time consuming as well as sensitive to subjective effects. For these reasons automatic image analysis (AIA) methods are being developed. We introduce novel AIA software for an estimation of the fiber number concentration. The software is applied to filter samples acquired during in vitro measurement of deposition of fibers in human airways. The AIA procedure is briefly described and Illustrative examples of AIA are represented including several specific cases of fiber distribution on the sample. An analysis of effect of the particle number concentration on the ability of the automatic method to detect the particles is documented and a suitable range of concentrations is recommended. The AIA results are compared with fiber counting according WHO methodology and the AIA software is adjusted for our specific experimental case. Also an example of application of the AIA method for spherical particle analysis is shown. The AIA method is proved to be successful for samples with low number of impurities, however its usability reduces for low quality samples.

Keywords: fiber deposition, image analysis, phase-contrast microscopy, automatic counting
Performance tests of particle filters in indoor air purifiers

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INTRODUCTION

In order to support consumers in selecting long-term efficient and reliable indoor air purifier, standards are needed that quantify air purifier performance. Current air purifier standards do not address tests over longer periods of time. The American ANSI/AHAM (2006) and the Japanese JEM 1467 (1995) standard only quantify the initial particle removal efficiency of air purifiers. The Japanese standard additionally quantifies the effectiveness of cigarette smoke removal in a small (1 m³) box, which can yield misleading high reduction values, even for devices that show rather poor performance when operating in a typical residential environment. A DIN standard (44973-100) for testing air cleaners and air humidifiers for household and similar applications is currently still only in a draft state. Finally, the Chinese GB/T 18801-2008 (2006) standard specifies testing procedures to quantify the particle and VOC removal of air purifiers in both initial and aged state. A procedure for testing the long-term efficiency is described but rarely used. Unfortunately, requirements on the VOC testing procedures are often not reached and the long-term testing procedures are rather complicated for practical use.

The presentation will cover the testing procedures according to the aforementioned standards and point out differences, advantages and disadvantages. Furthermore, an improved test procedure for testing the short and long-term efficiency, using cigarette smoke is used as the target aerosol will be proposed. This procedure can be considered as an alternative test to the Chinese GB/T 18801-2008 (2008). In this test, a new filter is installed in the purifier that is centrally placed in a 30 m³ chamber. The chamber is flushed with smoke from 5 cigarettes before the purifier is turned on. The subsequent exponential decay of the particle concentration is used to calculate the clean air delivery rate (CADR). In a second step, the filters are loaded with smoke from 50, 100, 200 and 400 cigarettes, respectively. For that purpose, the filter is installed in another specimen of the same purifier, located in a chamber with a tailored device to simultaneously burn several cigarettes.

RESULTS AND DISCUSSION

The tested filters show significant aging upon loading with cigarette smoke. To simplify and accelerate a long-term performance test of portable indoor air purifiers, it is recommended to determine the CADR from a purifier both in new state and after a defined aging of the filter, e.g. after loading with 400 cigarettes.

CONCLUSIONS

Portable air purifiers can show a significant decrease in the particle removal efficiency after filter aging with cigarette smoke. In order to help consumers selecting an air purifier that offers reliable long-term protection against air borne particulates, new and improved standards are needed that quantify the purifier performance after well-defined aging.

Keywords: air purifier, clean air delivery rate, standards, filter aging
Combined shock-foam-type air-handling unit for air conditioning systems

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The problem of microclimate in museum premises is a complex task. On the one hand it is creation of such conditions that would ensure long term of preservation of museum specimen, on the other hand creating a comfort conditions for visitors and employees of the museum.

At the present time, the optimal parameters of the microclimate in the premises of the museum are usually created using central or self-contained air conditioning systems with air-handling and air-conditioning equipment. Besides of the exhibition halls, in museums are present workrooms, laboratories, research premises, museum depositories and other. There is own, specific requirements for microclimate parameters in each of these areas, that demand instrumentation of self-contained air conditioning units, to perform the air-handling process under each of the specific areas. In addition to well-known action of changes in temperature and relative humidity, the gas composition of the air has a great influence on museum specimen and well-being of people. In the museum except of external sources there are a wide range of internal sources of pollution. The main impurities are microscopic gaseous particles, sulfur dioxide, nitrogen oxide and ozone oxide, dust, aerosols, etc. So the aim of the research was to create air-handling unit that would be a compact, lightweight, energy efficient, independent of spatial location and could maintain optimal microclimate parameters in wide ranges and purified air from pollution.

We have developed and patented a new combined shock-foam-type air-handling unit with a block of thermoelectric modules. The unit belongs to surface trickling heat exchangers, which combine a contact and surface heat-exchangers in one design. An air-handling unit works on the principle of the creation dynamic foam layer that flow over the surface of heat exchangers. Strong turbulence of gas-liquid system provides a heavy increase of interacting phases of contact surface which lead to intensification of heat-mass-exchange between air and water and for efficiency upgrading of air purification from pollution. Dust and aerosols are refined, using mechanical separation of suspended particles, through their wetting and dissolution by water. The effectiveness of treatment range from 98.5% to 99.8% and depends on foam height and air velocity in the cross-section of the air-handling unit.

Along with air purification from dust take place a purification from gaseous and vaporous contaminants by dissolving in water or condensation in a foam layer or chemical interaction with water. Therefore combined shock-foam-type air-handling unit provides an optimal microclimate parameters over a wide range and ensures efficient air purification from various types of pollution, however is compact, lightweight, energy efficient and make possible a temperature and cooling capacity variable control.

Keywords: museum specimen, aerosols, air-handling unit, heat exchanger, air purification, suspended particles, foam height
Improving the Indoor Air Quality in a School Building by Using a Surface Emissions Trap

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INTRODUCTION

Unsatisfactory indoor air quality can result from emissions e.g. of particulate matter (PM) or volatile organic compounds (VOCs) from the materials in a building. Recently a new device, the surface emissions trap (cTrap), was developed for stopping emissions from building material surfaces indoors e.g following a water damage, the goal being to prevent such emissions from reaching individuals residing inside the building. Here we studied the ability of a cTrap prototype to improve the air quality of a water-damaged school building by reducing emissions from the floor.

METHODS

A school built in the 1970:s, with a long history of complaints on air quality resulting in high absenteeism, headache, fatigue etc. among the pupils and the school staff, was studied. 2-Ethyl-1-hexanol, a moisture driven VOC, originating from the degradation of components in the glue or/and PVC flooring, was used as a marker of dampness. Increased ventilation and use of air purifiers in the rooms had not resulted in any major improvements in the perceived air quality. A cTrap prototype (cTrap Ltd, Lund, Sweden), which is a laminate with one adsorption and one polymer layer, was attached on the existing PVC flooring, by using a double sided adhesive tape, in several classrooms comprising a total surface area of approximately 500 m². Over the device was installed a laminate flooring. Air samples (Tenax) as well as samples of the cTrap cloth were taken from the floor (immediately replaced with new pieces of cTrap) at different time periods (up to 13 months) for measuring the amounts of 2-ethyl-1-hexanol in the air and adsorbed on the cTrap cloth, respectively. The samples were analyzed by gas chromatography mass spectrometry.

RESULTS

Already a few days after the cTrap had been installed a clear improvement in the perceived air quality was noticed. Some classrooms which had been unoccupied due to the bad air quality could now again be used. Air concentrations of 2-ethyl-1-hexanol decreased from 6-7 µg/m³ to 2 µg/m³; the concentrations of 2-ethyl-1-hexanol in the installed cTrap rose from 0 (unused cTrap) to 280.3 µg/g after 13 months of use.

CONCLUSIONS

Emissions of VOCs (including odors) and PM from a surface may be stopped efficiently by applying the cTrap cloth on the surface while at the same time allowing ready passage of water vapor. In the present study, attaching the cTrap on a PVC flooring in a school with air complaints led to a clear improvement in the perceived air quality as well as decreased 2-ethyl-1-hexanol air concentrations. The device may constitute a cost-efficient and effective way of restoring the indoor air quality e.g. after water damage leading to unwanted emissions indoors.

Keywords: Indoor air purification, Volatile organic compounds, Building dampness, School environment
POSTER SESSION

SESSION II

Mitigation strategies of indoor exposures
Factors significantly related to dampness and mold symptoms in urban dwellings – multi regression analysis

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Environment of residence is the place where a person spends a large part of life. Therefore, ensuring proper air quality in dwellings is one of the important health related problem. Research carried out in European countries and the United States indicates that on average about 20% of residential buildings and dwellings have characteristics associated with dampness and molds growth. Molds can be both infectious and allergic agents, and prolonged exposure to high concentrations of this kind of microorganisms can cause upper respiratory tract symptoms and respiratory diseases like asthma.

Aim

The aim of this study was to identify the factors determining occurrence the signs of dampness and moldiness in dwellings.

Material and methods

The study was carried out in the city of Lodz in 754 dwellings selected as random sample from the official register of the territorial division of Poland, led by the Central Statistical Office. The random selection process was performed by the Faculty Disclosure Statistical Office in Lodz. Description of randomly selected dwellings was conducted by questionnaire. For this purpose, a questionnaire was developed, which was a compilation of standardized questionnaires used in studies of exposure to harmful factors in the living environment, and our own project. The questionnaire was divided into four thematic blocks of information: about the building, the dwelling and the way it is use, flooding incidents, signs of dampness and moldiness in dwelling. Questionnaire survey was conducted by professional interviewers.

For the purpose of analysis flats with a visible mold growth on surfaces and flats with a strong water vapor condensation on surfaces were isolated from all dwellings. In order to indicate the factors significantly determining the dampness and moldiness symptoms, the data were analyzed using logistic regression model with the function of penalty. For this analysis, the R package version 3.0.2. was used.

Results

Statistical analysis showed that dampness in dwellings is affected among other things by: type of building, age of building, way of dwelling heating, water heating system, place where the laundry is dried, reduction of the heat consumption during the heating season. Moldiness in dwelling is affected by characteristics such as: age of building, occurrence of water vapor condensation during the heating season (windows, window sills or walls), number of people living in the dwelling, way of heating, water heating system, cover the external walls of the building and occurrence of flooding incident and/or dampness in the dwelling in the past 12 months preceding the survey.
Conclusions

Both the dampness and moldiness were affected by a number of characteristics of the building and the dwelling such as: age of the building, way of home heating and the water heating system affect both dampness and moldiness in the dwellings.

The project was carried out under grant 1754/B/P01/2010/39 and was financed by the National Science Center. Project leader: Prof. Irena Szadkowska-Stańczyk

Keywords: dampness, mold, questionnaire survey, dwelling
Dynamics of Aerosol Emissions from Common Indoor Pollution Sources as Characterised in the Ventilation Exhaust

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Introduction

The increasing energy efficiency in housing sector is one of the most feasible means to reduce emissions of greenhouse gases. In low-energy homes the high tightness and thermal insulation of building envelope must be accompanied with engineering means to supply suitable microclimate and air quality. Living indoor environments contain many various sources of air pollution. Ventilation exhaust provides concentrated flow of pollutants from living areas, thus providing an opportunity for the real-time characterization and management of IAQ. This study aims at the characterization of aerosol in the exhaust ventilation, generated by common indoor pollution sources.

Methods

Experiments were carried out in 36 m³ full scale insulated test chamber representing a usual living room. The chamber was equipped with air handling unit. The supply air was delivered through HEPA11 filter, assuring air exchange of 0.5 ach. Inside of the chamber, a pollution episode was generated and the UFP concentration was monitored in the exhaust ventilation by the Nanoscan SMPS (TSI Inc, USA), measuring particle concentration from 0.01 to 0.42 µm in mobility diameter. The coarse portion of the aerosol was monitored by OPC (3016, Lighthouse Inc, USA) in six channels from 0.3 to 10 µm. The following pollution sources were researched: cooking related sources (electric stove; water boiling; oil heating, Teflon pan heating); other thermal sources (cigarette, candle, incense); personal hygiene and wellbeing related sources (air-freshener, hair spray; hair dryer); household maintenance sources (furniture polisher; floor vacuuming; electric air heater; ironing). Each source was initiated by its usual household operation time. The dynamics of particle concentration was monitored for 15 minutes.

Results

Hair drying yielded the highest concentration of particles (8.6x10⁵ - 4.3x10⁶ #/cm³), followed by the Teflon pan related cooking operations (1.8x10⁶ - 2.5x10⁶ #/cm³), aromatic candle (9.6x10⁵ #/cm³), cigarette smoke (5.4x10⁵ #/cm³), paraffin candle (4.0x10⁵ #/cm³) and electrical stove (3.2x10⁵ #/cm³). The OPC responded to the oil heating (1.8x10³ #/cm³), as well as cigarette (1.3x10³ #/cm³) and incense (1.0x10³ #/cm³) smoke. The dynamics of particle concentration throughout the 15 min monitoring period was very diverse. In some cases, a lag of up to 4 minutes was recorded for the transportation of particles to the measurement location. Moreover, in cases particle growth were observed throughout the course of the experiment, as well as nucleation events in case of VOC emitting sources (hair spray, air freshener). The 15 min period was insufficient for the removal of UFP in most cases, suggesting that a rapid adjustment of ventilation strategies is necessary to ensure good status of IAQ.
Acknowledgement

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Keywords: ultrafine particles, emissions, indoor sources, ventilation
Application of the volatility TDMA technique for human exposure studies in indoor/outdoor residential microenvironment

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The penetration of ultrafine particles in the lungs depends on their size and physico-chemical properties, like hygroscopicity, volatility and solubility (Schulz et al, 2000; Wehner et al, 2004). The volatility of the aerosol can provide valuable information on the aerosol composition and mixing state (Vilani et al, 2007), which supports exposure and source apportionment studies.

This work aims to study the volatility of indoor and outdoor aerosol after thermal treatment. The measurements took place in a suburban house in Athens, Greece, by means of a Volatility Tandem Differential Mobility Analyzer (VTDMA). It includes three thermodenuder channels with temperature regulated at 110, 200 and 330 °C and one channel at ambient temperature. Monodisperse aerosol of 30, 60, 80 and 120 nm was selected by the 1st DMA, it was thermally processed and the resulting size distribution recorded. A three way valve allowed one hour long measurement cycles to alternate between indoor and outdoor aerosol. Few activities took place in the house during the measurement period, like cooking or use of the fireplace. The outdoor aerosol was characterized mostly by internally mixed modes, shrinking to smaller sizes after heating. The reduction in particle number was not significant, which may indicate that most particles have a nonvolatile core. The refractory volume ranged between 63% and 12%, after heating at 110 and 330 °C respectively, with bigger particles having a higher nonvolatile fraction. Outdoor aerosol concentrations were higher in the end of the afternoon, which can be related to emissions by fireplaces for residential heating.

The indoor aerosol concentrations followed the general trend of outdoor aerosol, however, differences in concentration and volatile fractions were observed, when indoor sources were active. Several indoor emission events were found to coincide with cases where a bimodal size distribution was observed after thermal treatment. On average indoor particles had a more significant reduction in number (14% at 330 °C), however the refractory volume was similar to outdoor aerosol. Despite the fact that the current setup only allows time resolution in the range of hours, the measurements conducted can provide quantitative results of the temporal variability of aerosol volatile fractions and mixing state with respect to indoor/outdoor aerosol size in the ultrafine particle size range.

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References


Keywords: aerosol, mixing state, volatility, VTDMA
Influence of the type and method of distribution of essential oils on odour air quality inside of the car cabin

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The paper presents the results of measurements of odor concentration in correlation with the concentration of total amount of volatile organic compounds (VOC) and function of dry weight loss during sample of natural and synthetic essential oils used inside of the car cabin by different internal conditions (temperatures, dynamic sampling conditions).

Analysis of test results showed that the highest concentration of odours occurred in samples of gases with aromatherapeutic effect oil influencing on the improvement of human concentration (oil No. 29) and with the oil of scent of tea tree (oil No. 1) and was 2312 and 567 ouE/m³, respectively. Introduction of different and dynamic conditions of sampling (simulation of real conditions) resulted in an effect of reduction of odour concentration in samples of odour gases by more than 99% (oil No. 29) and 95% (oil No. 1). Obtained odour test results were not coincided with the physicochemical characteristics of VOC emissions. This may indicate a need for differentiation method for dispensing of essential oil to the interior of the vehicle.

Keywords: odour, car, volatile organic compounds
Disinfection at workplaces
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The risk of harmful biological agents at workplaces concerns employees of many industries. The microorganisms inhabiting the workplaces in museums, libraries, tanneries and composting plants can cause severe health issues. The protection of workers can be fulfilled by cleaning and disinfection.

The purpose of the study was to assess the effectiveness of air and surface disinfection in museum, library, tannery and composting plant. Disinfection was performed using UV radiation, photocatalytic ionisation and chemical misting with quaternary ammonium compounds (QACs). Processes were carried out by three methods, at about 1-month intervals. Photocatalytic ionization was conducted using FreshAir (Vollara, USA). The UV radiation disinfection was conducted using UV flow lamps (Medivent, Poland). Both methods were performed in library and museum in a 24-hour mode. Prior to processes, reference samples of microbiological contamination of the air and surfaces were taken, and subsequently samples were collected after 2, 3, 7 days of continuous purification. The chemical misting disinfection with QACs (the main component - N,N,n,n-didecyl-N,N-dimethylammonium chloride), was conducted using Mist-E TURBO electrical sprayer (Poltech sp. z o.o., Poland) in the library and the Igeba TF 35 thermal sprayer (DEZ DER, Poland) in the museum, composting plant and tannery. The sprayers worked for 20 min. Microbiological samples were collected prior to disinfection and after 1, 3, 5 days.

The reduction of bacterial number in the air ranged from 44 to 78% after chemical misting, 42-87% during photocatalytic ionisation and 79-89% during UV radiation, depending on the analysed workposts. The reduction of the fungal number in the air was at the similar level and equalled to 15-85% after chemical misting, 43-99% during photocatalytic ionisation and 71-93% during UV radiation. The bacterial contamination of the surfaces at tested workposts was reduced by 26-95%, 23-66% and 86-91% for chemical misting, photocatalytic ionisation and UV radiation, respectively. The slightly higher results were obtained during removal of fungal contamination. The reduction ranged from 74 to 83% after chemical disinfection, from 42 to 63% during photocatalytic ionisation and 60-99% during UV radiation.

The chemical disinfection, UV radiation and photocatalytic ionization improved hygienic condition of the air and surfaces, by reducing the number of microorganisms. The UV radiation and chemical misting more effectively reduced microorganisms from the surfaces than from the air. While, the photocatalytic ionization was more efficient in removal of microorganisms from the air than from the surfaces. The durability of chemical disinfection is maintained in the air for 1 day, while on the surfaces for 5. The effectiveness of photocatalytic ionization and UV radiation disinfection increases with their duration. The qualitative analysis revealed that those disinfection methods removed most pathogens.

Keywords: disinfection, workposts, UV radiation, photocatalytic ionisation, chemical misting, microorganisms
Numerical and experimental characterization of dust emission profiles for hand held wood working machines

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There is a clear need of characterizing and evaluating wood dust emission profiles from wood working machines in order to predict potential exposure peaks and to ensure the safety of workers. Indeed, wood dust is classified as a well known carcinogen \cite{1}. Moreover, in the occupational population of the 25 member states of the European Union, around 3.6 million workers were exposed to inhalable wood dust \cite{2}.

In order to limit the exposure of workers to excessive dust, the European directive 98/24/CE has fixed the Occupational Exposure Level (OEL) to 5mg.m\textsuperscript{-3}. This directive has been transcribed into French law in 2003 declaring that the OEL would be lowered down to 1mg.m\textsuperscript{-3}. Among the common wood dust emission sources, the most emissive are by far hand-held electrical wood working tools, such as sanders, routers and circular saw. In the majority of cases, the dust collecting systems are not dimensioned properly; therefore, the wood dust is not well collected \cite{3-4}.

Accordingly, we are currently developing a method that should allow characterizing the emission profiles from wood working machines, so as to classify the machines with respect to their emission potential. The evaluation procedure of wood dust emission is based on the use of a mathematical algorithm called "inversion algorithm" which allows reconstructing the emission rate by means of measurements taken at different working environment points. This procedure includes two distinct steps. The first phase consists in determining the parameters of the inversion model by using a known source of dust and corresponding concentration measurements. In the second phase, the unknown source is reconstructed by inversing the model, with corresponding concentration measurement. After presenting the source-estimation method, this paper discusses two important approaches related to its development. The first one deals with the automatic determination of optimal positions for the sensors, based on the calculation of a term called the "optimization criterion", which allows classifying the sets of 'n' among 'N' sensors (n < N). When the best set of sensor positions is selected, an experimental approach is initiated, aiming at validating the source-estimation method, and its robustness.

\cite{1} Poussières de bois - Prévenir les risques – INRS, ED 974.

\cite{2} Occupational Exposure to Inhalable Wood Dust in the Member States of European Union – Kauppinen et al (2006)

\cite{3} Focus on BIA’s work - N°0047 - Hand-held motor-operated electric woodworking tools 11/2003.

\cite{4} Evaluation des performances de captage de trois types de machines à bois portatives – INRS, ND2321 - 218-10.

Keywords: Dust emission profiles, wood dust, source-estimation method
Evaluation of the antimicrobial activity of nonwovens for respiratory protective equipment

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The microorganisms present in bioaerosols may cause infections, allergies, and other occupational diseases. Especially, the exposure to biological agents affects people working in food production plants; agriculture; healthcare facilities; clinical, veterinary, and diagnostic laboratories; at places, where there is a contact with animals and/or animal products; and in disposal plants and sewage purification installations.

The products, primarily used to ensure respiratory protection against bioaerosols, are air-purifying respirators, which are considered as personal protection equipment. Bioactive air-purifying respirators are expected to have high antimicrobial activity and possess the same properties as traditional filtration equipment.

The objective of the study was to determine the antimicrobial properties of modified PLA-PDAMA nonwovens fabrics with Ag and Cu, both against collection strains and isolates from workplaces, selected by their frequency and potential pathogenicity. Furthermore, we analyzed the flow resistance of the tested materials was analyzed, to verify their usability for the production of bioactive air purifying respirators for the protection of the workers respiratory tracts. The antimicrobial activity of 6 types of PLA nonwoven fabrics with different content of PDAMA, Ag, and Cu were tested with the AATCC 100 method against 11 collection strains and environmental/workplaces isolates. The physical and flow properties of the nonwovens fabrics were determined according to the EN 290731:1999 and EN 143:2004/A1:2007 standards.

It was found, that the higher PDAMA concentrations increased the biological activity of fabrics. The nonwoven with the greatest content of PDAMA (5.1%), demonstrated a strong effect on all bacteria and yeasts, both on ATCC strains and workplaces isolates (reduction R=99.9% at p < 0.05). The activity of 5.1% PLA-PDMA nonwovens against moulds was lower and amounted to 45.0 % to –92.8%, depending on the species.

PLA nonwovens fabrics containing 5.1% PDAMA and 2.7% Ag or 3.8% Cu, exhibited good antimicrobial properties (R>99.9%) and also were characterized by good inspiratory resistance parameters. Environmental strains were characterized by different sensitivity to modified PLA/PDMA nonwovens than ATCC strains. The moulds isolated from workplaces were more resistant than the collection ones, while Gram-positive bacteria showed varied results, depending on the species and used fabric type. It was found, that sensitivity to bioactive nonwovens depended both on the species and on the isolation place.

It was shown for the first time, that PLA-PDMA polymer complexes modified with silver and copper may be used to produce effective bioactive nonwoven fabrics with high antibacterial and antifungal properties.

Keywords: bioaerosol, bioactive half mask respirator, antimicrobial nonwoves, respiratory protective equipment, PLA-PDMA-Ag/Cu
Indoor particles are assumed to induce adverse health effects. People in Western Europe spend up to 95% of their time indoors but little is known about health relevant indoor emissions. In this study, potentially important indoor sources of fine and ultrafine particles were investigated with respect to their emission intensity and their acute health effects. The latter were assessed in a combination of specific toxicological tests and a randomized cross-over sham-controlled exposure study. Here we present the physico-chemical characterisation of particles during the exposure of healthy volunteers at two concentration levels comprising sources such as candle burning, bread toasting or frying sausages. Particle number concentration (PNC), particle size distribution (Ø ~10 – 20,000 nm), lung-deposited (alveolar) surface area concentrations and elemental composition were determined. PM mass was estimated using based on the particle size distribution measurements assuming spherical particles.

The PNC for ultrafine particles was found to be significantly elevated compared to the background during the 2 h exposure for all three scenarios. E.g. for candle burning (level 1 = 20, level 2 = 40 candles) PNC of $2.0 \times 10^6$ #/cm$^3$ (level 1) and $2.8 \times 10^6$ #/cm$^3$ (level 2) were detected for the size range of ~10 – 560 nm. For the surface area 2,261 µm$^2$/cm$^3$ and 3,800 µm$^2$/cm$^3$ were measured, respectively, which is about 50-100 times higher than typical urban air. In contrast, as the size distribution measurements revealed mainly ultrafine particles (< 100 nm) the PM mass was calculated to be 53 µg/m$^3$ and 85 µg/m$^3$, respectively. In conclusion especially fine and ultrafine particles were detected with high number- and lung-deposited surface area concentrations. These exposures might be important regarding short- and long-term health effects.

The determined exposure concentrations will be linked to volunteers short term health effects like changes in lung function and blood pressure as well as to toxicity in cell culture investigations.

**Acknowledgements**

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**Keywords:** indoor exposure, frying, candle burning, toasting, PM exposure characterization
Exposure of office occupants to compounds emitted from potential sources in modern offices can be quite substantial and might significantly affect comfort and human health.

OFFICAIR, a European research project, titled "On the reduction of health effects from combined exposure to indoor air pollutants in modern offices" takes place in eight European countries: Greece, Italy, France, Hungary, Portugal, Netherlands, Spain and Finland. In total, 167 office buildings participated in a questionnaire-survey and 36 of them took part in a detailed air quality survey. One of the objectives of the project, is to investigate and verify causes (mechanisms, events and sources) that have been identified as possible sources of indoor air quality issues in European modern offices, via a field investigation (questionnaires, checklists, air pollutants’ monitoring and ventilation measurements) during two seasons.

This study presents part of the results of the OFFICAIR summer and winter campaign in Greece, which took place in five modern office buildings during July – September 2012 and December 2012-February 2013. Specifically, particulate matter measurements were conducted in five modern office buildings located in urban and suburban areas of Athens. For the purpose of the study, an automatic spectrometer (GRIMM 1.108) was used, measuring particles number concentration in a diameter range between 0.3μm and 20μm, in fourteen size channels with 1-minute time interval. In each building, sampling lasted for five weekdays (Monday to Friday). Indicative results showed that particles with diameter below 1μm ranged in average between 9832 and 1958407 particles/l for the summer period and between 1631 and 241257 particles/l for the winter period. The highest summer concentration for this fraction was observed for building GR05, which is a building located at the center of the city. The corresponding value for winter was observed at building GR04, a building located near a highway junction. Coarser particles (>10μm) maximum concentrations were observed for both summer (167particles/l) and winter (51particles/l) periods at building GR03, which is a modern offices/laboratory building situated in a suburban area and surrounded by pine trees. All buildings were mechanically ventilated. Active air flow measurements were performed in each monitoring room of the investigated buildings using TSI AccuBalance Air Capture Hood flow meter. In building GR22, during summer the measurements ranged between 12 and 35 L/s/person and during winter between 12 and 14 L/s/person. Also PFT technique was used, in GR22 the AER in summer ranged between 0.45-0.8 ach and during winter between 0.35-1.10. The parameters influencing the indoor particle concentration (e.g. printers and photocopy machines presence, intense resuspension, central heating operation etc.) will be
discussed. TSI-model 3007 condensation particle counter (0,01-1μm) was used for monitoring the ultrafine particle fraction. Indicatively, in GR22 during the summer period the concentration was 8164 particles/cm$^3$ (min: 2921-max: 16657, STD: 3629).

Acknowledgement

The OFFICAIR project (On the reduction of health effects from combined exposure to indoor air pollutants in modern offices) is funded by the European Union 7th Framework (Agreement 265267) under the Theme: ENV.2010.1.2.2-1.

Keywords: particulate matter, size distribution, number concentration, modern offices, activities
Measurements of school indoor and outdoor PM1, PM2.5 and PM10 concentrations complemented with single particle analysis

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To what degree indoor particulate matter (PM1, PM2.5, PM10) were affected by outdoor concentrations was investigated in a secondary school, in the centre of Wrocław (ca. 700 000 inhabitants).

The school (ca. 800 pupils at the age of 11-15 years; ca. 30 children per one classroom) is located near busy crossroads. Simultaneous indoor (in the school patio) and outdoor (at the school roof) PM measurements were performed for one week per month from December 2009 to October 2010 with the use of three Harvard cascade impactors per sampling site (MS&m). Single particles were characterized by means of a JEOL 733 electron probe micro-analyzer (EPMA) equipped with a super-atmospheric-thin-window OXFORD energy dispersive X-ray detector. µT Area Samplers, Air Diagnostics and Engineering, Inc., Harrison, ME, USA). Size segregated aerosol samples, from indoor and outdoor air, were collected by Berner-type cascade impactors during teaching hours two times in the winter. The cut-off diameters of 6 stages were: 0.25; 0.5; 1.0; 2.0; 4.0 and 8.0 µm in the summer was generated. It was found that PM1 concentrations inside and outside the school were comparable.

These findings, complemented with single particle analyses revealed that the finest particles, mostly infiltrated from outdoor air, were dominated by organic carbon and sulphates. Soil/fly ash particles in all fractions were often identified together with organic carbon what means a higher health risk than has been expected. As a part of mineral dust calcium carbonate, salt particles and aluminosilicates were identified.

It should be stressed that our data deal with one school building and cannot be representative for other schools, however our findings support the urgent need for further investigations of the PM toxicological characterization in schools and its impact on children’s respiratory system.

Keywords: school, indoor air, outdoor air, particulate matter, single particles analysis
Characterisation of particulate matter in the Barcelona subway system

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Many people living in metropolitan areas worldwide commute using underground subway transportation and spend a considerable amount of time in this indoor environment on a daily basis. The underground subway system is a confined space that promotes the concentration of contaminants either originated outdoors or indoors. Therefore, there has been an increasing concern about the air quality in such environment due to the adverse health effects associated with exposure to high concentrations of airborne particles. An extensive measurement campaign was performed in the Barcelona subway system in order to characterise PM2.5 measuring its concentration and investigating its variability, chemical composition, sources, and attempting to quantify source contributions. Four underground stations with different designs within the Barcelona metro system were selected for air quality measurements from 2nd April to 31st July 2013. Daily measurements were carried out at each station for a month. A high volume sampler (30 m$^3$.h$^{-1}$) and a portable aerosol spectrometer (TSI DustTrak DRX Aerosol Monitor 8533) were placed at the far end of the platform, at the train entry point in each selected station. The high volume sampler was equipped with quartz microfiber filters and programmed to sample PM2.5 from 5 a.m. to midnight (metro working hours), and the DustTrak provided PM2.5 concentrations with a 5-minutes time resolution. Average PM2.5 concentrations between 29 and 72 µg PM2.5.m$^{-3}$ were observed on the platforms during working hours. On weekends the PM levels were 23% lower on average than during weekdays. However, real time measurements revealed drastic peak increments in PM concentration when the metro was not operating, due to maintenance works. The inorganic chemistry of PM2.5 samples was obtained using ICP-MS and ICP-AES, resulting in more than 50 chemical components. The majority of particles in underground PM samples are derived from the interaction between wheels, rails, and brakes, generating airborne particles that consist mainly of Ba, Zn, Mn, Cu, Fe, Sb, Mo, Cr, and Sr, among others.

Keywords: Particulate matter, Subway system, Air quality, Barcelona
Aerosol particles in the indoor environment of different types of archives

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Particulate matter (PM) inside cultural heritage buildings such as museums, libraries and archives possesses different degrees of risk to materials. Particles not only cause soiling but are abrasive, provide sites for surface reactions and have a potential to damage artifacts due to their hygroscopic nature (Hachtfield, 2005).

The study includes indoor/outdoor monitoring of air quality in four archives in the Czech Republic, representing different outdoor environments: Zlatá Koruna (rural), Třeboň (small town), Teplice (industrial area), and Prague (large city with traffic). The archives in Zlatá Koruna, Třeboň and Teplice are only naturally ventilated, while archive in Prague is equipped with ventilation and filtration system. The measurements were performed during 4 intensive campaigns in different seasons of the year at every location and included particle number/mass size distribution and chemical composition. In Prague only indoor measurements were performed, because the archive is absolutely isolated from the outdoor environment.

The aim of this study is to investigate concentrations and sources of PM in the indoor environment of the archives, and to establish the relationship between the indoor and outdoor environment. The results showed that concentrations of fine particles in the indoor environment of the archive in Prague were relatively stable and low (about 10^2 particles/cm^3). The temporal variation of fine particles in the naturally ventilated archives (Zlatá Koruna, Třeboň, Teplice) indicated outdoor air as a main source of particles in the indoor environment. Average values for the indoor/outdoor ratios of the particle number concentration had a maximum between particle diameters of 0.1 – 1 μm, which indicates a maximum penetration factor and low indoor deposition velocity of these particles. The penetration at Třeboň was higher probably due to simple windows with gaps, compared to double glassed windows at Zlatá Koruna and Teplice. The results were confirmed by measurements of the ventilation rate.

Acknowledgements

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Keywords: indoor air quality, number/mass size distribution, penetration, library
Chemistry of PM2.5 in the urban school playgrounds and classrooms

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Children at school during their work and play can respire airborne particles of diverse chemical composition. This diversity depends on such factors as the location of given microenvironments in the city and the day-to-day changes in weather, outdoor air quality, classroom ventilation, and teaching activities. Air quality legislation based solely on PM mass concentrations fails to take into account this chemical complexity and its likely consequent variations in health effects. Here we report on the PM chemistry collected from school playgrounds and classrooms in Barcelona during the ongoing BREATHE project, a database unprecedented in its size and scope. It involves nearly 2900 children and includes 578 analyses of over 50 major and trace elements, organic carbon (OC), elemental carbon (EC), sulphate, nitrate and chloride anions, and ammonium cations in ambient PM₂.₅ collected indoors and outdoors during real-time teaching hours. Average air quality in Barcelona schools is poor (PM₂.₅ = 29 µg m⁻³ in playgrounds and 36 µg m⁻³ in classrooms), although there is great spatial and temporal variation (10-111 µg m⁻³ outdoors, 13-84 µg m⁻³ indoors). The school air is pervasively contaminated by traffic, as recorded by EC concentrations and levels of copper, tin and antimony, with lowest values in suburban green belt locations and highest near busy urban highways (playground EC = 0.2-3.3 µg m⁻³; classroom EC = 0.2 -2.9 µg m⁻³). More traffic pollutants enter the classroom where local road traffic is higher, especially during warmer months when there is more open ventilation, although average indoor/outdoor values are always <1. Inorganic ions, accompanied by metalliferous pollutants, display the typical pattern of higher winter nitrate and higher summer sulphate, with city-wide spikes registered by different schools at the same time. Whereas sulphate particles easily penetrate into the classroom (average SO₄²⁻ I/O = 0.9), given the thermal instability of nitrate ions these are much more common outdoors and in colder weather (average NO₃⁻ I/O = 0.6). Recreational resuspension from gravel playgrounds can raise daytime PM₂.₅ mineral dust levels >50 µg m⁻³, producing enhanced levels of “geological” tracers such as Al, Ti, and Ce. These particles, carried indoors by air currents and the children, can raise daytime PM₂.₅ mineral dust levels in the classroom to over 30 µg m⁻³. Textile (cotton) fibres and blackboard chalk particles make important contributions to ambient classroom PM, especially under conditions of closed ventilation.

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Keywords: School air quality, PM in classroom and playground, Barcelona, BREATHE.
Characterization of multifamily buildings by representative indicators of indoor PM

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Increasing requirements for the building energy efficiency raise new challenges for IAQ management. Building refurbishment process is focused on energy saving and improvement of building systems, but the improvement of occupants’ wellbeing should be an equally important goal. The modification of building systems may have a significant influence on IAQ and subsequently, PM levels.

This study aimed at the characterization of indoor environment of multifamily building as a single unit excluding occupant daily activities and human influence. Ten multifamily buildings (five apartments per building) were included in the measurement campaign during two heating seasons of years 2011 and 2012. PM concentration and size distribution measurements were performed using factory calibrated optical particle counters. Sampling duration in each apartment was at least 24 hours (full day measurement). PM concentration decay rates were determined by exponential regression fitting of the measured PM2.5 concentration decay curves. The selected periods for the determination of the decay had a clear decrease in concentration lasting for a minimum of two hours. In order to identify I/O ratios PM measurements were carried out both inside and outside of the residence (e.g., balcony). Background (nighttime) levels were assessed in order to represent the lowest contribution of indoor sources to indoor PM concentrations; nighttime period of 2–7 am (sometimes 8 am) was generally the period of lowest particle levels in buildings. Particle decay rate, I/O concentrations and nighttime PM levels were considered as most representative indicators. Median indoor PM2.5 concentration decay rate was equal to 0.32 h⁻¹, and varied from 0.14 to 1.93 h⁻¹. The lowest decay rates (<0.2 h⁻¹) were observed in apartments with low temporal variation and absence of high peak concentrations. Hence, the decay was slow, considering minimal air movement in winter at natural ventilation conditions. Highest decay rates were associated with active smoking indoors. Median I/O ratio values for Lithuanian apartments were 0.69 in case of PM1, 0.70 for PM2.5 and 0.98 for PM10. This may indicate stronger presence of fine outdoor particles in Lithuanian apartment buildings due to less airtight building envelopes. In all cases, the selected nighttime intervals were significantly lower (p<0.05) compared to day time concentrations. Median values of background PM2.5 and PM10 were 5.0±2.8 and 6.7±3.5 μg/m³, respectively. Only in 10% of the apartments nighttime PM2.5 exceed 10 μg/m³. Measurements performed during the lowest outdoor temperatures related to the highest nighttime concentrations, due to increased outdoor PM pollution and leaky building structure.

Acknowledgement

This work is being carried out as a part of INSULAtE (Improving energy efficiency of housing stock: impacts on indoor environmental quality and public health in
Europe) project, co-financed by EU Life+ programme.

Keywords: particulate matter, I/O ratio, particle decay rate, night-time concentration, multifamily buildings
Chemical characterization of particulate matter samples collected within and outside of two Schools in Vienna, Austria

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During two sampling campaigns extending over several weeks particulate matter (PM10) was collected within and in front of two schools in Vienna. The vicinity of HBLVA Rosensteingasse (RG) can be characterized as a densely populated residential area with some influence of local traffic.

BG Fichtnergasse (FG), is a residential area with a large number of single family houses and private gardens around. To allow the chemical characterisation of the aerosol sample sampling was performed with a high-volume sampler (Digitel DHA80) using quartz fibre filters and a low-volume sampler (Leckel, SEQ47/50) using cellulose acetate filters. Sampling intervals were 24 hours. Aerosol mass concentrations were determined gravimetrically. Chemical analyses of the filter samples comprised water soluble ions, carbon parameters (total carbon, elemental carbon, organic carbon, carbonates) selected saccharides, cellulose, humic like substances and selected metals. Based on a macro-tracer model chemical concentrations could be related to particulate matter sources. To obtain short time averages of PM10 mass a beta particulate monitor (ESM, Eberline) was installed as well. Average indoor air particulate matter concentrations ranged from 20µg/m³ to 40 µg/m³. Short time averages (30 min) reached much higher up, but filter sampling always included nighttime hours, when no activity was observed within schools and thus concentrations were low. Average concentrations of particulate matter in the ambient ranged from 20 µg/m³ (April) to 81 µg/m³ (November). Chemical analyses accounted for approx. 90 % of aerosol mass. While major inorganic ions (sulphate, nitrate, ammonium) were the largest contributors to aerosol mass in the ambient, this contribution was less pronounced for indoor samples, mostly due to the volatilization of ammonium nitrate at the higher temperatures within the buildings. In the indoor environments the relative contribution of organic material to aerosol mass becomes more important. However, marked differences were observed between the sampling periods and sites. The occurrence of indoor sources for organics is also demonstrated by the saccharide patterns.

The contribution of mineral dust is much more pronounced in FG than in RG. Comparing indoor PM10 concentrations during night time hours and weekends with concentration data from the Vienna ambient air sampling network it could be shown that indoor concentrations are driven by ambient concentrations. When the school is open the situation is different as indoor sources and re-suspension of dust leads to an independent increase of PM10 concentrations. These trends are compared with the changes of the chemical composition of aerosol samples.

This work was supported by the Austrian Federal Ministry for Science and Research, within the Sparkling Science programme (SPA03-33). We thank the Environment Agency Austria and the municipal authority (MA22) for providing part of the sampling equipment.
Keywords: particulate matter, indoor / outdoor ratios, source apportionment, chemical composition, carbonaceous aerosols
Indoor air concentrations of particulate matter in different environments in Vienna, Austria

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To quantify the PM concentrations in environments where the personal exposure is high for young people, several measurements were carried out in the Vienna public transportation, schools and public locations such as restaurants, cafes, etc.

The DustTrak II was used for these measurements. The DustTrak II Aerosol Monitor 8534 is a handheld battery-operated, data-logging, light-scattering laser photometer. It measures aerosol concentrations corresponding to PM1, PM2.5, Respirable, or PM10 size fractions. Initially PM concentrations were measured within a close radius to ambient air monitoring sites in Vienna in order to calibrate the DustTrak II. As a result a calibration factor was obtained which enabled comparability with the data from Vienna ambient air monitoring network and implemented throughout the rest of the campaign. In order to obtain a better perspective on the public transportation, measurements were taken in open and closed subway stations, both in new as well as old trains. A limited number of measurements were taken in trams and buses as well. The school measurements were conducted in two schools in Vienna with slightly different surroundings, an urban and a suburban site. Further measurements were taken in households during different times of the day as well as during different activities.

As expected, measurements at open stations delivered PM concentrations well comparable to data of the Vienna ambient air monitoring network. The measurements in subway stations in the underground have higher deviations and the average concentration is almost twice as much as at the open and semi-open subway stations. Slightly lower concentrations were determined within the trains, with average values being higher in the older trains without air conditioning.

The results of the measurements at the schools were evaluated to capture the significant differences of air quality in dependence of ventilation, motion factor and location of the classrooms. Observations on different types of classrooms were also undertaken (Eg. Gym-Halls, IT-Labs, etc.) PM concentrations on the neighboring streets and local ambient air monitoring site reports were compared with the measured results in the classrooms with open and closed windows as well as in corridors during the breaks and lessons. Average concentrations in corridors and classrooms are up to 40% higher during breaks when pupils are moving around than compared to lessons. Pronounced differences could also be observed when measurements with open and closed windows were compared. It has to be noted that on the days of the measurements, daily PM concentrations in the ambient were below 30µg/m³.

In public locations such as restaurants and cafes, comparison between smoking and non-smoking areas did not only show differences in PM concentrations but also in their size distributions.

Keywords: particulate matter, PM, personal exposure, public transportation, school environment, restaurants, cafes, houses
ORAL SESSION

SESSION III

Aerosols and bioaerosols in occupational and dwellings indoor environment

The genotoxicity of PM10 collected from indoor air in Barcelona schools
To safeguard children’s health it is important to maintain a healthy environment within schools, including good quality indoor air. Children, whose respiratory systems are in a developmental stage, are more vulnerable to the effects of particulate matter (PM10). Furthermore, teachers and the other school staff spend much of their professional life in the same school settings, and therefore are also subjected to long-term exposures to the same indoor air pollution.

Research on air quality in schools is essential to assess exposure levels to harmful particles, which can then be used to devise appropriate remediation and monitoring strategies. PM10 particles were collected during the BREATHE project at twenty schools in Barcelona over two campaigns; summer and winter. The particles’ morphology was investigated using Field Emission Scanning Electron Microscopy (FESEM), and the size distribution of the particles was determined by NanoSight technology. For the toxicology analysis a Plasmid Scission Assay (PSA) was chosen to assess the ability of the collected particles to generate Reactive Oxygen Species (ROS). Ten different concentrations (doses) of PM10 were incubated with plasmid DNA for 6 hours, followed by electrophoresis in agarose gel. This procedure resulted in the separation of three forms of DNA; the undamaged supercoiled DNA, the relaxed form with one strand break (mild damage), and the linear form with breakage of both strands (severe damage). FESEM images revealed a diverse range of morphologies in the PM10. Interestingly, cotton fibers were a very common component of the collected particles. It is assumed that these fibers were sourced from the school uniforms, and it is noted that there is no known respiratory toxicity associated with cotton fibers. In many cases the amount of fibers was so high that their bundles were visible to the naked eye. This abundance of fibers presented technical difficulties in the toxicological analysis of the PM10, due to soot and other natural and anthropogenic particles adhering to the fibers, clumping, and problems determining the weights of non-fibrous PM10. Nanosight analyses showed a varied size distribution from 20 nm to 900 nm. The PSA results confirmed different degrees of DNA damage being exerted by PM10 from different schools. The first observed damage to DNA, which in one school reached 19%, was at a dose of 0.01 µg/ml. The majority of samples showed their first genotoxic effects at a dose of 1 µg/ml. The greatest DNA damage, reaching over 90% at the highest used concentration of 1 mg/ml, was caused by PM10 from 4 of the 20 schools from the summer campaign, and 11 schools from the winter campaign.

Generally, winter PM10 proved to be more genotoxic than summer PM10. Research is now focused on understanding the relationship between the composition and structure of the air pollution particles and their observed genotoxicity.

Keywords: indoor air pollution, PM10, school, genotoxicity
Assessment of bacterial aerosols in waste sorting plant

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The aim of the study was a quantitative and qualitative assessment of bacterial aerosols at workplaces in the waste sorting plant.

The evaluation was conducted at 11 sampling points covering all sorting processes. Air samples were stationary collected in two replicates using a one-stage impactor MAS 100 Eco. One-minute sampling time was used at examined workplaces. Due to collection of microbial aerosol samples there was applied microbiological medium Tryptic Soy Agar with 5% Sheep Blood. All samples were incubated in aerobic conditions according to the scheme: 1 day (37°C) + 3 days (22°C) + 3 days (4°C). This extended incubation of samples for bacterial analysis was applied to allow the growth of slow-growing strains at low temperatures. After incubation, the colonies were counted including the volume of aspirated air. Then the concentrations of micro-organisms were calculated and expressed as colony forming units in cubic meter [CFU/m³]. Microorganisms isolated from air samples were identified to the genus and/or species level based on their morphology, microscopic structure and biochemical reactivity using the following API tests: 20 Staph, 20 Strep, 20 NE, 20 E, 50 CHB/E and Coryne. Average geometric concentration of bacterial aerosol in waste sorting plant counted from all sampling points was 2862 CFU/m³ (geometric standard deviation, GSD=3.29), but in atmospheric air (outdoor background) – 81 CFU/m³ (GSD=1.97), and the difference was significant (p<0.05). The analysis showed the significant difference between particular workplaces (p<0.05). The highest concentration of bacteria – 18253 CFU/m³ (GSD=3.45) was found at the hall of municipal waste importation, and the lowest near the sorting line of paper and foil – 556 CFU/m³ (GSD=1.44). The comparative analysis of samples collected in waste sorting plant and outdoor background showed, that most of the micro-organisms can be associated with municipal waste that are subject to sorting. In air samples there were found Gram-positive cocci of the genera Staphylococcus, Enterococcus, Micrococcus and Streptococcus; bacilli of the genus Bacillus; Gram-positive rods of the genera Microbacterium, Arthrobacter, Rhodococcus and Brevibacterium; mesophilic actinomycetes of the genus Streptomyces; Gram-negative rods of the genera Escherichia, Proteus, Enterobacter, Pantoaea, Pasteurella, Acinetobacter and Pseudomonas. Among all the isolated bacteria nine species belonged to the second risk group according to the Directive 2000/54/EC.

Despite the use of air conditioning in the cabins sorting with high efficiency (approximately 50 air changes per hour) there was occurred in the air a lot of microbial bacteria, which may indicate low efficiency of such a technological solution. There should be consider technological change in the way air exchange at these workplaces in order to protect the health of workers.

Keywords: waste sorting plant, workplaces, bacteria, aerosols, air conditioning
The information concerning particle concentrations in dentist's offices and their harmfulness that has been gathered so far is incomplete. Until now only a few studies have been performed in dentist's offices. Moreover, measurements concerned mainly the risk of an infection of dental workers due to their frequent exposure to microorganisms. No comprehensive studies have been conducted which would take into consideration both the hazard for the dental healthcare workers and for the patients, connected with the exposure to infectious microorganisms and dangerous respirable particles that may additionally contain cancerogenic or toxic trace elements. Aerosol and bioaerosol particles are generated during dental procedures, especially those which are connected with spraying water such as dental drilling, ultrasonic scaling or polishing. Aerosols can contain heavy metals from glass particle or resin-matrix dental composites which are detrimental to health. On the other hand, bioaerosols may contain different types of pathogenic bacteria, viruses and fungi.

The results of the study showed that both the personnel and patients face a high risk of being exposed to aerosol and bioaerosol pollutants during the treatment procedures in a dentist's office. The study demonstrated the significance of a proper ventilation system, effective air cleaners, and personal protection equipment. It also indicated the necessity of implementing safer and more effective medical devices and work practices in order to minimize the exposure to airborne contaminants during dental procedures.

**Keywords:** Aerosol, Bioaerosol, Trace element, Dental office, Dental procedure
Aerosols and bioaerosols in occupational and dwellings indoor environment
Molecular methods for evaluation of microbial diversity of indoor air and historic objects in the museum environments

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Historical objects represent a precious cultural value either for artistic characteristics, or the significant role they play in our history, culture and tradition. However, their properties have constantly been changing due to vital activity of microorganisms. Studies in the field of biodeterioration of cultural assets focused especially on the objects situated outside, such as stone monuments, or historical buildings, as well as, artworks exhibited inside museums, galleries and other indoor environments. Yet, a few investigations have been carried out when it comes to indoor air. Nevertheless, microbial contamination within museums, occurred both in the air and surfaces, should be regarded as a subject for concern. Microbial diversity in museum environments can be revealed by implementation of DNA analysis which offer highly sensitive and rapid detection. Internally transcribed spacer region (ITS) as well as 16S ribosomal RNA fragments are commonly studied in identification of fungi and bacteria, respectively. To determine precisely taxonomic position of microorganisms colonizing artworks different molecular techniques are essential, for instance quantitative PCR for measurement of single species, genetic fingerprinting and separation of PCR fragments using DNA gel electrophoresis (e.g. DGGE, SSCP), ribosomal RNA gene sequencing (e.g. pyrosequencing), bioinformatic tools or metagenomics, which attracts special attention.

In this study, molecular methods were applied to investigate culturable microbial communities present on brick and wooden surfaces exposed in a museum environment. The identification was also extended to analysis of airborne microorganisms. Taxonomic position was examined using molecular methods, based on sequencing of 16S rRNA gene. Obtained nucleotide sequences were compared using BLAST 2.2.27+ with sequences available at National Center of Biotechnology Information.

With respect to the bacterial isolates from indoor air, Gram positive cocci were the most abundant. On the basis of molecular identification, among them Micrococcus sp., Arthrobacter sp. and Staphylococcus sp. were the majority. Above mentioned genera were also detected on historical objects. As compared with the bacteria isolated from the air, high levels of Gram positive bacilli present on the surfaces of brick and wooden museum objects were reported. Within isolated bacteria Bacillus atrophaeus, B. cereus, B. mycoides, B. subtilis, B. gibsonii, B. subtilis, Psychrobacillus psychrodurans, Paenibacillus terrigena were predominant. Above mentioned results were similar to those obtained by Gorbushina et al., 2004; Pangallo et al., 2007; Radaelli et al. 2004.

Molecular methods provide valuable information about presence of different species either in indoor air, or colonizing museum objects. In conclusion, 16S rRNA gene analysis enables fast bacteria identification from indoor air and historical objects.

References:
Generation and transport of bioaerosol exemplified by the waste disposal site in Gdansk Szadolki

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In the period from February until September, 2014, the microbiological assessment of air samples collected at the municipal waste disposal site in Gdansk Szadolki and at sites located in the area of probable exposure to the waste-generated aerosol was conducted. Selected bacteria and molds were identified and enumerated in the collected samples. Based on the number of identified microbes, the range and direction of their spread into the air was estimated; a dependence of the microbial transfer on meteorological conditions, particularly on the wind direction and speed, was evaluated. The risk to human health related to the presence in the area adjacent to the municipal waste disposal site was assessed based on the number of pathogenic and potentially pathogenic microbes present in the collected air samples.

Keywords: bioaerosol, bacteria, municipal waste disposal
The levels of the mold air contamination related to selected home characteristics in urban area.

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Introduction

The aim of the study was to assess the impact of selected home characteristics on the degree of mold indoor air contamination in urban area.

Material and methods

Measurements were carried out in 60 homes selected in a purposeful way from 754 homes under study (interview technique). For the measurement 60 homes were selected from the three groups (20 dwellings from the each):

1. moldy (with visible mold grow on the surface),
2. dampness (with excessive condensation of water vapor on windows but no visible mold growth),
3. with no signs of mold and dampness.

Indoor air samples to the assessment of molds, spores and (1→3)-β-D-glucans levels were collected during the heating season. In homes were measured temperature, relative air humidity, CO₂ and air flow velocity. Samples for mold and (1→3)-β-D-glucans was collected at 1.2 m from the floor by sets of "pump-head with filter" during 24 hours. Samples for spores were collected by the impact method (air sampler Burkard, 10 l/min, 30 minutes), directly on microscope slides coated with glycerin jelly and analyzed microscopically. Mold from the filter after inoculation (10-fold dilution method) on medium plates (MEA with chloramphenicol and streptomycin) were incubated for 5 days at 30 °C. (1→3)-β-D-glucan was analyzed using Glucatell assay in kinetic version. The results of the measurements and questionnaire study were subjected to statistical analysis.

Significant predictors were selected by multivariate analysis (linear regression model with L1 penalty) made automatic selection significant predictors. Concentrations of molds, spores and (1→3)-β-D-glucans were subjected to logarithmic transformation. For the analysis, the R package version 3.0.2 was used.

Results

The multivariate model showed that the main factors significantly increased the concentration of airborne mold are the presence of visible mold grow (especially larger than 1 m²), building material containing wood, no hot water, a musty odor, heating other than central (eg. stoves) and CO₂ concentration. Increased concentration of spores is significantly associated in most of the same characteristics and in addition to: the flooding in the flats in the last year, the number of dwellers and high humidity. The higher concentrations of (1→3)-β-D-glucans are significantly related to wood used in the building construction and the lack of heat registers on radiators.

Conclusion

The indoor air concentration of molds and their derivatives in the homes under study are significantly influenced by a number of...
characteristics associated with the building construction, dwelling characteristics and the way it is use, the visible signs of mold and the occurrence of flooding incidence.

The project was carried out under grant 1754/B/P01/2010/39 and was financed by The National Science Center. Project leader: Prof Irena Szadkowska-Stańczyk

**Keywords:** moldy homes, mold, spores, glucans, fungi, indoor air, air contamination, homes, dwellings, dampness
Assessment of airborne microbial contamination at office workplaces

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In recent years, the growing concern about indoor air quality at the office workplaces has been observed. Special attention is given to the possible health effects associated with exposure to airborne microorganisms and their components (e.g. endotoxins and β-glucans) in the air-conditioned rooms.

The aim of this study was to assess the degree of microbial contamination at office workplaces based on quantitative and qualitative analyses of different bioaerosols of bacterial and fungal origin. The study was carried out at ten sampling points located in an office building equipped with air-conditioning systems in Warsaw, Poland. Sampling of culturable microorganisms was carried out using a six-stage Andersen impactor. All isolated bacterial and fungal colonies were identified to the genus and/or species level. The measurements of PM10 and PM2.5 were performed using Sioutas impactors. CAMNEA method as well as Kinetic-QCL and Glucatell assays were used to quantify total bioaerosol (viable and non-viable microorganisms together) as well as endotoxin and β-glucan concentrations in PM samples, respectively. The concentrations of the culturable bacteria and fungi ranged from 1.1×10² to 9.2×10³ cfu/m³ and from 2.0×10² to 4.8×10² cfu/m³, respectively. The total of 50 bacterial species from 22 genera and 56 fungal species from 24 genera were isolated from the air of office workplaces. >From all detected microorganisms, 8 bacterial (Corynebacterium spp., K. oxytoca, Klebsiella spp., P. aeruginosa, S. aureus, Streptococcus spp., S. albus and Streptomyces spp.) and 1 fungal species (A. fumigatus) were classified to risk group 2 according to the Directive 2000/54/EC and based on that may be responsible for adverse health outcomes in exposed individuals. The mean concentrations of endotoxins, β-glucans as well as total bioaerosol in PM10 fraction at studied rooms were 0.7×10¹ EU/m³, 0.1×10¹ ng/m³ as well as 3.6×10⁴ cells/m³, respectively. The number of culturable microorganisms in studied environment was significantly lower than their total counts, constituting from <0.8% to 5.8% of the total bioaerosol only (p<0.01). The culturable microorganisms were present in the air mainly as single cells/spores (1.1–2.1 µm) or large aggregates (>7 µm), while the main carriers of endotoxins and β-glucans in the air of studied offices were particles with aerodynamic diameters <2.5 µm.

This study indicated that office workers may be exposed to harmful microbiological agents. The analysis of aerosol size distribution revealed that microbial particles may deposit mainly in the lower regions of human respiratory tract and by that be responsible for allergic inflammations. This study showed also that the measurements of total bioaerosol as well as immunologically reactive propagules such as endotoxins and β-glucans should become an immanent part of the hygienic quality control procedures in this type of occupational environment.

Keywords: microbiological contamination, bioaerosol, air-conditioning system, offices
Effects of various factors on the fluorescence properties of fungal spores

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Fungal spores can cause adverse health effects for people and animals both in indoor and outdoor environments. Laser induced fluorescence (LIF) is a modern, widely used technique for real-time bioaerosol detection. In general, only a fraction of fungal spores emit enough fluorescence light to be detected by the instrument. It is known that various factors can affect the fluorescence properties of fungal spores such as heating, UV light exposure and physiological stage of the spores. However, there may be also other factors that can affect the fluorescence properties of fungal spores such as the growth conditions, life cycles, oxidation, humidity and other environmental conditions.

In this study, two LIF based bioaerosol instruments, the BioScout (Environics Oy) and the UVAPS (TSI Inc.), were used to study effects of fungal species, growth substrate, incubation time and air velocity in release process on fluorescence properties of fungal spores. This study provides supporting information for widely used LIF based measurements of fungal spores as well as for behaviour of fungal spores in ambient environment. Three fungal species, Aspergillus versicolor, Cladosporium cladosporioides and Penicillium brevicompactum, were used in the experiment. Fungi were inoculated on two different growth substrates: agar plate and gypsum board. Samples were incubated at room temperature (21 °C) at a relative humidity of 96 % for 1 week, 1 month and 4 months. Fungal spore source strength tester (FSSST) was used to aerosolize fungal particles from growth with three different air velocities (5, 16, 27 m/s). Size and fluorescence properties of spores were measured with the BioScout and the UVAPS. Each sample type was measured three times. Fluorescent particle fraction (FPF) was calculated from the ratio of fluorescent and total particle concentrations in spore size range (1- 5 µm).

The results showed that C. cladosporioides spores had the lowest FPF values compared to A. versicolor and P. brevicompactum spores. The FPF typically decreased with older samples, except for P. brevicompactum samples that showed increasing FPF value with older samples. The FPF of spores was in most cases higher from agar plates compared to gypsum board samples. The FPF increased with increasing air velocity in the FSSST. This indicates that easily released fully-developed spores have more fluorescent compounds compared to forcibly extracted, potentially non-matured, spores.

The current study gives new information about the fluorescence properties of fungal spores in various conditions. The results can be utilized in the real world measurements of fungal spores as well as in instrument calibration and testing in laboratory conditions.

Keywords: fluorescence, fungal spores, real-time, detection
Indoor air quality at the workplaces

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Objectives: The aim of studies was to analyze the degree of microbial contamination and the type of microorganisms in the working environments of archives, libraries, composting plants and tanneries. Health threat was also estimated based on the study of particle size distribution in a selected facilities. Moreover, indicator microorganisms were selected for each tested working environment on the basis of the analysis of their prevalence at workplaces, source of isolation, and health threat determined using literature data, including the classification of the UE Directive 2000/54/EC. Material and method: The studies were conducted in 2 archives, 2 libraries, 4 tanneries and 4 composting plants. The air was sampled with MAS-100 Eco Air Sampler, and microorganisms numbers were determined by culture method. For the analysis of bioaerosols size distribution a six-stage Andersen sampler was used and the microorganisms identification was performed using microscopy and biochemical methods. Indicators strains were identified by 16S RNA and ITS1/2 rDNA analyses for bacterial and fungal species, respectively.

Results: The number of bacteria equaled from $1.1 \times 10^2$ to $4.7 \times 10^3$ cfu/m$^3$ in the air of archives and libraries, whereas the number of moulds ranged from $3.8 \times 10^3$ to $3.4 \times 10^4$ cfu/m$^3$. Moulds were the most often isolated in library and archive premises. The number of microorganisms in composting plants amounted to $6.9 \times 10^2$–$2.5 \times 10^5$ cfu/m$^3$ in the air, the qualitative analysis revealed, that the moulds was the largest group of isolated microorganisms. The microorganisms number in the air of tanneries ranged between $1.2 \times 10^3$ and $3.7 \times 10^4$ cfu/m$^3$, where the bacteria dominated.

Conclusion: 8 indicators of harmful biological agents in archives and libraries: A. alternate, A. versicolor, B. pumilus, C. cladosporioides, P. aurantiogriseum, P. commune, P. crustosum, P. jathinellum, were determined. 10 indicator microbial species: B. pumilus, B. cereus, A. fumigatus, C. cladosporioides, C. herbarum, M. hiemalis, M. fragilis, R. oryzae, P. crustosum, P. simplicissimum were found in composting plants. 11 indicators: B. pumilus, B. subtilis, B. cereus, C. lubricantis, C. cladosporioides, P. commune, P. echinulatum, P. chrysogenum, P. crustosum, C. parapsilosis, C. albicus were determined for tanneries. The bioaerosol particle size distribution determined in the tested production premises indicates the health threats resulting especially from the possibility of inhaling fungal particles of sizes 0.65–1.1 µm and 1.1–2.1 µm, which may adversely affect the respiratory system of workers.

The studies were realized within the project of Polish National Center for Research and Development no. III.B.03.

Keywords: bioaerosol, microorganisms, workplaces, library, archive, tannery, composting plant
Biological contamination of filter mats from ventilation system of airport building

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Airport building is a special place with high intensity of international and intercontinental passenger traffic. Different external and internal sources including travelling people may pollute such indoor environment. Filter mats from ventilation system may be over time contaminated by harmful biological agents. If they will be reemitted into the air may be responsible for numerous adverse health outcomes in exposed individuals.

The aim of the study was to assess the level of microbial contamination of filter mat samples taken from the ventilation system in airport buildings. The study was conducted in spring-summer season (May-September) at one of the airports in Poland. Nine samples of filter mats were collected from the airport building ventilation system by cutting approximately 100 cm² pieces from each tested filters. All these samples were subsequently placed into sterile tubes and after extraction, the quantitative and qualitative analyses of bacteria and fungi were performed. All isolated microbial colonies were identified to the genus and/or species level. The mean concentrations of bacteria and fungi isolated from the filter mat samples were $3.3 \times 10^3$ and $1.4 \times 10^4$ CFU/cm², respectively. Qualitative evaluation of microbial contaminants from the filter mats revealed that the most frequently isolated were filamentous fungi (43%; mainly 12 species belonging to 6 genera: *Aspergillus*, *Penicillium*, *Fusarium*, *Trichoderma*, *Candida*, *Geotrichum*), followed by Gram-positive cocci (26%; mainly *Micrococcus* spp. and *Staphylococcus* spp.), endospore forming Gram-positive rods (18%; mainly species of the genus *Bacillus*) and nonsporing Gram-positive rods (10%; represented by *Corynebacterium* spp. and *Microbacterium* spp.). The least numerous groups of biocontaminants were mesophilic actinobacteria (2.5%; mainly *Nocardia* spp.) and yeasts (0.5%). Identified microorganisms represented mainly saprophytic microflora classified (according to the Directive 2000/54/EC) to risk group 1, i.e. to the agents that are unlikely to cause human diseases; however, two species (*Corynebacterium* spp. and *Aspergillus fumigatus*) belonged to risk group 2, i.e. to the agents that can cause human diseases and may be dangerous to the workers’ health.

This study showed that the filter mats are an important source of microbial air contamination at airport building. Hence, for proper operation of ventilation systems as well as to provide the safe environment for passengers and airport workers, the maintenance practices such as regular inspections, periodic cleaning, replacement of filter mats and verification of air duct cleanliness should be recommended and scrupulously complied.

Keywords: biological agents, filter mats, ventilation system, airport building
Subjective and objective assessment of residential mold contamination

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The aim of this study was to determine the usefulness of the subjective assessment of selected signs of fungal contamination of flats to estimate the actual air contamination with mold and its derivatives.

Materials and methods: Analysis was carried out in 22 Polish flats, where the inhabitants declared during the questionnaire interview the presence of the developed mycelium on solid surfaces. The interview included also questions on, e.g. intensity of the occurrence of other signs of fungal contamination and of various signs of dampness in the premises, as well as the way the flats are used. All flats were located in urban agglomeration.

In flats the air during the heating period was analyzed. Air samples for analyses of culturable molds and (1→3)-β-D-glucans were collected on the glass-fiber filters using the separate aspirators (air flow: 2 l/min; 24h). Air samples for analysis of fungal spores were collected using a Personal Volumetric Air Sampler on glass slides with the optically clear adhesive vaseline (air flow: 10 l/min; 30 minutes).

The quantitative analysis of culturable molds were performed using the standard microbiological procedures. The (1→3)-β-D-glucan concentrations were determined using Glucatell test in kinetic version. The fungal spore levels were assessed microscopically under the 1000x total magnification.

Partial least squares regression (PLS) were used to build predictive model for concentrations of tested biological agents with regard to subjective assess fungal contamination in flat. We used percent of explained variance (%VE) as measure of predictive performance.

Results: Analysis of the questionnaire data indicates that in at least half of tested flats with the observed mycelium growth, the inhabitants declared additionally the presence of some signs of dampness on the walls, perceptible dampness in flat and the precipitated water vapour on windows in the heating period.

The mean geometric concentration of airborne culturable molds, (1→3)-β-D-glucans and fungal spores indoor flats was respectively $2.9 \times 10^2$ cfu/m$^3$, 1.6 ng/m$^3$ and $5.7 \times 10^3$ spore/m$^3$. The concentration of airborne molds in 2% of flats exceed the reference value for the home environment ($5.0 \times 10^3$ cfu/m$^3$, Górny, 2004).

The analysis of predictive model showed a moderate usefulness of the subjective evaluations of inhabitants in evaluation of actual level of airborne (1→3)-β-D-glucans (VE=66.6%) and a lower usefulness in evaluation of actual levels of airborne molds and fungal spores (VE respectively 46.9% and 25.8%).

Conclusions:

- Only in limited number of flats with mold contamination signs concentration of airborne mold exceed the reference value.
- Subjective evaluation of specific signs of fungal contamination of flats is
moderately useful for quantitative evaluation of the actual air contamination with molds and their derivatives.

References:


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Keywords: airborne molds, airborne (1→3)-β-D-glucans, fungal spores, questionnaire survey, dampness, moldiness.
Phthalates in an indoor dust samples: children health risk assessment

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Due to specific characteristics of physio-behavioral development, children might be exposed to a variety of different chemical species. They can be either present in a suspended form or adsorbed form. These volatile and semi-volatile compounds having versatile chemical structure, have therefore varying properties and toxicological profiles. Some of them, like volatile organic compounds (VOCs) are majorly present in gaseous state whereas semi-volatile compounds can be present in both gaseous phase and/or adsorbed on solid phase like phthalates on dust particles. Phthalates are commonly used plasticizers in a variety of synthetic polymers. Since they are not chemically bonded with polymer structure they can easily migrate to any medium they get in touch with. Being esters of phthalic acid, phthalates partially resemble structure of human hormones. Therefore they possess ability to interact with estrogenic/androgenic receptors, thus disabling proper functioning of endocrine system. Exposure to phthalates is particularly dangerous in early stage of physiological development. Epidemiological studies indicate that phthalates are not only responsible for improper development of secondary sex characteristics but also may cause development of child asthma and autoimmune diseases. This paper concentrates on literature study of phthalates concentrations in an indoor air and dust samples and health risk assessment of children from infancy till adolescence. In the last part the results of risk factor will be correlated with case studies concerning certain medical conditions. Moreover, this will prove (in-)validity of risk assessment procedure.

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Keywords: children, dust, phthalates, risk assessment
Harmful actinobacteria in a compost facility bioaerosol

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INTRODUCTION

Actinobacteria are major components of bioaerosols emitted from composting facilities. Airborne spores of Saccharopolyspora, Streptomyces and Thermoactinomyces genera (Firmicutes) are responsible for hypersensitivity pneumonitis and other severe health effects. Spore-forming actinobacteria of the Nocardiopsis genus are opportunistic pathogens and etiologic agent of mycetoma, skin lesions, alveolitis and pulmonary infections. Till now, Nocardiopsis spp. as major indicator microorganism was not reported in compost bioaerosol. Here, we describe an actinobacterial strain isolated from the air of a mushroom compost production facility (MCF) in central Poland. The occupational health service had been informed about a number of respiratory disorders among the workers directly involved in a production, as well as a co-owner of the facility employed in the office. To find a possible microbiological cause of these afflictions, the airborne bacteria were isolated and cultivated.

MATERIAL AND METHODS

The studied locations in the MCF: production and sale halls; laboratory and offices in factory; the factory owners’ house and cars. Outdoor air samples (ca 2 km from the mushroom compost facility), were also collected. Air sampling was done during winter months. In parallel, samples from surfaces (walls and equipment of the production hall) were collected. Comprehensive morphological, chemotaxonomical and phylogenetical characteristics of the most abundant airborne strain was performed.

RESULTS

Airborne bacteria were detected in all study locations; the highest number of actinobacteria was observed in mushroom compost production hall (2.6×10³ cfu/m³); high values were found also in laboratory and office building. The identification results of airborne bacteria in production hall of the MCF, microorganisms present on solid surfaces and in compost revealed one actinobacterial strain (PCM 2702) was found in bioaerosol, in the compost sample and on the solid surfaces; four bacterial species (Bacillus sp., Geobacillus thermoglucosidasius, Methylobacterium mesophilicum, Micrococcus lylae) were present in bioaerosols and in compost. The majority of the strains were isolated from bioaerosol only. On the basis of the results, one actinobacterial strain with aerial mycelium, which was dominating in each location was chosen and subjected to further taxonomic identification. Physiologic properties and chemotaxonomic studies have shown that the airborne isolate had a chemical profile consistent with Nocardiopsis genus, i.e. cell wall chemotype III, the fatty acid profile, the phospholipid type and characteristic glycolipids. 16S rDNA gene sequence analysis revealed that the strain represents Nocardiopsis alba taxon.

CONCLUSIONS

The bioavailability of N. alba in mushroom compost facility creates potential risk for health of workers and the protection
of respiratory tract and/or skin is strongly recommended.

**Keywords:** bioaerosols, exposure assessment, microbiological assessment, actinobacteria, *Nocardiopsis*
POSTER SESSION

SESSION IV

Human immunology and pathology in relations to aerosol exposure
Characterization of Organic & Inorganic species of Delhi Aerosols (Diwali Festival 2013): Possible Health Effects


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Crackers are used to express happiness throughout the world. However, this degrades the air quality for a small time interval and affects the human health. Diwali (Deepavali) known as the festival of lights, is celebrated throughout India every year. In this celebration the cracker bursting is a major activity which gives rise to many toxic organics and inorganics in the atmosphere. To study the particles released during this period, PM$_5$ (Particulate Matter with aerodynamic size ≤ 5 um) particles were collected at National Physical Laboratory (28°38′ 13″ N, 77°10′ 14″ E), New Delhi, India during Diwali festival (3 November; Sampling period from 29/10/2013-22/11/2013) using hand held sampler (APM 801). Particles were collected on PTFE filters and were analyzed for identification of organic functional groups and inorganic species using OP-FTIR (Open Path-Fourier Transform Infrared Spectrometer; Model: IFS 125M) with 4 cm$^{-1}$ resolution and 64 scans. The particles were also collected on the tin substrate for morphological and elemental analysis up to individual particle level using Scanning Electron Microscope with Energy Dispersive X-ray (SEM-EDX) facility at NPL.

The concentration of certain inorganics was found to be enhanced just after Diwali and found diminishing further with time. The partial cloudy conditions till 6 Nov led the pollutants trapped within the lower Atmospheric Boundary Layer (ABL) while the same got diluted due to rise in ABL during sunny days after 6 Nov. Qualitative estimation of various inorganic species and organic functional groups has been carried out based on characteristics wavenumbers of functional groups reported in the particle phase (Polidori et al., 2008). Just after Diwali event (5 Nov.), particles were found to be rich in ammonium ion, sulfate ion, bisulfate ions, aliphatic and aromatic hydro carbons, alcohols, aldehyde, secondary amines, nitriles, carboxilic acid, alkyle halides and ethers. Concentrations of aforesaid species were found to reduce day by day until 21 November when there was an increment of aliphatic and aromatic carbons due to some local source.

As different metals are used in the firecrackers (as coloring agents) to produce glitters and other visual effects, several metal compounds and their oxides, sulphates, phosphates and other byproducts are expected to be ejected in the atmosphere due to their combustion. These products can cause carcinogenic and mutagenic changes to human health. The toxic fall outs caused by firecrackers can cause irritation to skin and dermatitis. Hydrocarbons (aliphatic and aromatic) emitted during the festival can also cause chronic skin irritation, dizziness, headache, nausea as well as vomiting to a person exposed.

Individual particle elemental composition (from SEM-EDX), toxic organics and inorganics (from FTIR) and possible human health effects in tandem with meteorological conditions will be discussed in details during the presentation.
Acknowledgements:

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Keywords: FTIR, health, organic functional group
Aerosol particles during Masses in a church

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Combustion processes are the main source of ultrafine and fine particles. Burning candles and incense during Masses and other religious services in churches is a common practice.

This study presents the changes of the particle mass and number concentrations and the exposure of the churchgoers, the priests and other church workers in a Roman Catholic Church in Poland during a Mass held on a Sunday and during a weekday (Thursday). Candles and the incense were burned at these Masses. The particle mass and number concentrations were simultaneously measured both inside and outside of the church. The particle mass concentrations were determined using the DustTrak DRX model 8533 aerosol monitors. The particle number concentrations were measured by means of P-Trak model 8525 and by OPS 3330 optical spectrometers (TSI Inc., USA). Indoor measurements were conducted using the devices deployed at the side altar. Outdoor measurements were carried out by means of devices installed outside one of the front windows. Approximately 170 people were present during the 60-minute long Sunday Mass and about 100 people attended the Mass held on a weekday. During these Masses three candles were constantly lit at the main altar, while the incense was burned only periodically in the main altar area. The increased concentrations of particles in the church during the Masses were caused mainly by the activity of the churchgoers and the burning processes. Lighting and extinguishing the candles and especially burning the incense contributed to elevating the concentrations of fine and ultrafine particles in the indoor air. The highest indoor to outdoor particle concentration rate values were observed while the incense being burnt. For instance, during the Sunday Mass the maximum PN1, PM2.5 and PM10 concentrations were respectively about 17, 15, and 30 times higher than the levels measured outside of the church. The activity of the churchgoers, such as kneeling, sitting, standing up and moving inside the church contributed to elevating the concentration levels of coarse particles. During the considered Masses the amount of particles inhaled by the churchgoers was considerably higher than the amount inhaled at the same time outside of the church. For instance, during the Sunday Mass the total amount of PN1 and PM2.5 particles inhaled by the churchgoers was respectively about 4.0 and 2.9 times higher than the amount inhaled at the same time outside of the church.

To conclude, the processes of lighting the candles and burning the incense elevated particle concentrations in the church. The exposure of churchgoers, especially the priests and other church workers may, due to their extended stay (for more than one Mass), result in negative health effects.

Keywords: Particle concentration, Particle exposure, Church, Mass
The air quality assessment using tissue cultures

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Previous studies which indicate that effect of airborne pollutants on human health is significant, however it was taken into account only the effects of individual toxic factors. Components of virtually every air breathed by humans include pollution from industry, transport and combustion processes. Unfortunately, little attention is paid to the indoor air pollution. Taking into account the duration of exposure time spent in indoor interior they are also a significant source of toxic substances exposure.

The respiratory system is exposed to contaminants (VOCs) emitted from building and furniture materials which occur in homes, offices, shops, kindergartens, schools, etc. The presence of contaminants that affect human health, including the proper functioning of the respiratory system, causing the need to seek new solutions in the field of toxicity tests. Usually, in order to determine the impact of volatile toxic compounds in the body, the toxicity of metabolites present in the urine, specific proteins in plasma or pulmonary secretions is determined.

A much better and non-invasive solution to evaluate the harmful effects of toxic volatile substances is the use of the cell in vitro models of the lung. In previous studies on the effects of tobacco smoke, exhaust gas, dust or nanoparticles assessment of toxicity usually include observation of morphological changes of cells. Tests are commonly performed staining of cellular structures for determining the overall operation of the agent. Often examined DNA fragmentation and determines the state of the cell (normal, apoptotic, necrotic). Assessment of mitochondrial activity is also subject (XTT colorimetric test), loss of mitochondrial membrane potential, caspase activity, and the presence of other proteins associated with apoptosis. When evaluating the risk of a toxic substance focused primarily on the identification of single factor on the model such as formaldehyde and tobacco smoke. Currently, more often recognizes the need to assess the joint impact of several factors on lung models. This approach allows to determine effects of exposure, which is closer to actual exposure of the lungs to compounds in the air.

The presentation will present advantages and disadvantages of the methods used for assessing air quality with tissue culture using.

Keywords: indoor air, quality, test, tissue culture
Inhaled nanoparticle tracking and oxidative stress biomarkers in apprentice welders

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Inhaled exposure to welding fumes has been associated with adverse cardiovascular and respiratory health effects. Reactive metallic oxide nanoparticles (NPs) present in welding fume may translocate once inhaled and generate a cascade of oxidative stress effects as well as the release of inflammatory mediators to the circulation. Of various welding processes, Tungsten Inert Gas (TIG) welding generates NPs with aerodynamic diameters most relevant for tracheobronchial and alveolar deposition and represents an increasingly popular welding process. However, significant knowledge gaps in the actual deposited dose after inhalation of TIG welding NPs, their fate in the human body and their ability to induce oxidative stress complicate fundamental cause-effect relationships. To address this pertinent research need, we are conducting a human exposure study with healthy, non-smoking apprentice welders. Volunteers generate TIG welding fumes for one hour in a ventilated exposure cabin, and biological liquids (exhaled breath condensate, blood and urine) are collected at several time points before and after exposure. Particle translocation and several markers of oxidative stress are assessed and compared with volunteer control day measurements. A custom designed welding fume characterization mask provides comprehensive physicochemical characterization data on the TIG NPs at the personal breathing zone (PBZ). We completed the pilot phase of this study to assess Standard Operating Procedures and Limits of Detection for analysis methods. Overall, pilot phase findings assert the validity of our study methodology and analysis methods, and further demonstrate that welding fume generation within the cabin mimic workplace concentrations and remain reproducible between volunteers. Characterization results from particle counters at the PBZ demonstrate average particle concentrations of 1.76x10⁶ particles/cm³ with peak concentrations reaching 7x10⁶ particles/cm³ in the time immediately following completion of one welding task. These results further report an average aerodynamic particle diameter of 36 nm ±8nm and TEM micrograph analysis demonstrate chain-like agglomerates of spherical particles. Despite high particle concentrations, gravimetric measurements at the PBZ demonstrate an average mass of 0.33 mg/m³ – well below internationally accepted welding OELs. This finding of high particle concentrations matched with low mass questions the applicability of mass based OELs, particularly for reactive metal oxide NPs. Due to the uncertainty that remains in regards to the kinetics of oxidative stress response of inhaled welding NPs, combined with widespread and increasing occupational exposure to these particles, this study will provide salient safety information for workers worldwide. The developed methodology will further allow for a non-invasive evaluation of the inhaled NPs target dose and will assess the pathways for circulatory translocation of inhaled NPs.

Keywords: Welding; Inhalation; Nanoparticle; Translocation; Oxidative Stress; Characterization
Particulate matter (PM10, PM2.5, PM1) impact assessment on short-term changes in lung function parameters in children

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Particulate matter (PM) is one of the main components of air pollution in urban areas and has a significant impact on the human respiratory system. Studies confirm, that exposure to elevated PM concentrations cause disturbances in the form of airway obstruction, resulting in worse spirometry test results. Most vulnerable to the adverse effects of particulate matter are children, the elderly and people suffering from circulatory and respiratory system diseases.

The aim of our study was to assess the impact of dust particles with different aerodynamic diameters (PM1, PM2.5, PM10), in the air inside and outside the school building, on the degree of airway obstruction, as measured by a series of spirometry tests in schoolchildren. Our study included 180 children aged 13-14 yrs, from a randomly selected middle school in Wrocław, who were being subjected to spirometry tests at the same time of day, each month between 2009 and 2010, with the exception of holidays. Children with pulmonary diseases (e.g. asthma) were excluded from the study. The tests were conducted by two doctors involved in the study and held in accordance with ATS (American Thoracic Society) procedures. Our research focused on short-term PM air pollution impact on spirometric parameters. The impact has been estimated on the basis of relationship between the values of spirometric parameters such as FEV1%, PEF and MEF25% and simultaneously measured PM10, PM2.5 and PM1 concentrations level (8-hour mean), both inside and outside the school building. PM measurements were performed with the use of Harvard Cascade Impactors (MS&T Area Samplers, Air Diagnostics and Engineering, Inc., Harrison, ME, USA).

The results have shown, that only exposure to indoor PM2.5 fine particulate matter was significantly correlated with all considered parameters. Correlation of the lung function parameters with PM1, PM10 concentrations measured indoor and outdoor, were not statistically significant. PM2.5 concentration measured outdoor, was also not significantly correlated with lung function parameters. The most "suitable" model was obtained for FEV1% and PEF parameters; the smallest standard error of estimate for FEV1% and the highest coefficient of determination (R2) for PEF. However, the children did not respond equally to the change of PM2.5 concentration, i.e. with the change of spirometric parameters values. A logistic regression was used to find out what could cause the individual sensitivity. Exposure of children to PM in the studied school is high, especially during the heating season (PM2.5 24-h mean concentration exceeded the WHO Air Quality Guidelines - 25 μg/m³, by 90% of the days when PM measurements were taken).

It is necessary to make an effort to improve understanding of the factors affecting indoor PM concentration levels. Especially there is a need to measure and control PM2.5 fine particulate matter levels, as it poses the biggest threat to children's health.

Keywords: school, indoor air, particulate matter, spirometry tests, schoolchildren, urban environment
Physico-chemical properties and potential health effects of aged brake wear aerosol

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Significant amount of brake wear aerosol can be generated and released to environment due to the increasing number of vehicles. The complex aerosol, although contributes to traffic emission, has not been given much attention. Only a few previous studies analyzed freshly generated brake wear dust and indicated potential hazard health effects. Here, we designed to systematically study aged brake wear aerosol and assess their health effects. We performed transmission electron microscopy (TEM) and scanning electron microscopy (SEM), as well as by energy dispersive X-ray (EDX) to characterize the size distribution and chemical composition of brake wear samples. An important biomarker, generation of reactive oxygen species (ROS), was detected by applying 2’7’-dichlorodihydrofluorescein (DCFH) fluorescent dye in both acellular and cellular assays. Brake wear aerosol was revealed to be heterogeneous particle mixtures, with the majority sizes within the range between PM1 – PM2.5. A total of 17 elements were found from EDX, primarily carbon and metallic iron. High oxygen content indicated the highly oxidized states. ROS generation was observed in the cell-free analysis, while exposed cells were not significantly activated by the same concentrations. Taken together, aged brake wear aerosol can be inhaled, deposit in the respiratory tract and release several metals. It is thus an occupational hazard. However, the potential risk to induce oxidative stress of aged brake wear aerosol was considered moderate for the concentrations tested.

Keywords: Brake wear particles; microscopy; metal; reactive oxygen species (ROS); in vitro; oxidative stress
Microorganisms threatening the people’s health in the work environment and their virulence factors

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The current problem of occupational medicine is the workers exposure to hazardous biological agents (including pathogenic microorganisms, microorganisms components and metabolites) at the workplace. This problem concerns especially diagnostic laboratories, health care, waste management facilities, museums, archives, libraries, composting plants and tanneries.

The aim of study was the assessment of virulence factors of potentially pathogenic microorganisms isolated from workplaces in museums, archives, libraries, composting plants and tanneries.

Microorganisms identification was made based on 16S RNA and ITS1/2 rDNA analysis for bacterial and fungal species, respectively. Microorganisms characterized by high frequency of occurrence and harmfulness to human health belonged to species: B. cereus, B. pumilus, B. subtilis, C. accolens, C. albidos, C. parapsilosis, P. vanouvererensis, S. haemolyticus, A. fumigatus, A. versicolor, P. aurantiogriseum, P. chrysogenum, P. commune, P. crustosum, P. simplissimum were analyzed. Production of polysaccharide capsule was tested with Burri-Gins staining. The presence and type of hemolysis were determined on medium supplemented with 5% defibrinated sheep blood. Toxigenic properties of B. cereus strains were analyzed using the Duopath® Cereus test (Merck).

General cytotoxicity of moulds was determined by MTT test, the profile of mycotoxins produced by moulds was examined with HPLC-MS/MS method. Microorganisms were cultivated on laboratory media and mineral M0 medium with the addition of compounds occurring in the analysed workplaces (cellulose, compost extract, fragments of wet-blue leather shavings). Proteolytic and lipolytic properties of bacteria were determined using TSA with milk and Difco™ Spirit Blue Agar media, respectively. Production of deoxyribonuclease was tested on DNA-se agar.

It has been shown, that all tested bacterial strains had the hemolysis α or β ability; B. subtilis and B. pumilus exhibit protein degradation. Moreover, for C. albidos the production of polysaccharide capsule and the production of deoxyribonuclease, and lipase for S. haemolyticus have been detected. Non-hemolytic enterotoxin (NHE) and hemolysin BL (HBL) were detected for B. cereus.

Among the 9 tested isolates of the genera Aspergillus and Penicillium, 5 of them produced mycotoxins and were cytotoxic to swine kidney cells. The strains of A. fumigatus (concentration in the air in composting plants: 1.0×10^1–1.6×10^2 cfu/m^3) and P. chrysogenum (concentration in the air in tanneries: 2.0×10^1–1.6×10^2 cfu/m^3) produced large quantities of mycotoxins: brevianamid F, fumagillin, fumiquinazoline F, helvolic acid, verruculogen,—meleagrin, secalenic acid D, roquefortine C, emodin and others.
It has been shown that the presence of compost, leather or cellulose in the culture medium, modifies the virulence properties of microorganisms.

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**Keywords:** microorganisms, mycotoxins, harmful biological agents, virulence factors