AIRMON 2011

7th

International Symposium on Modern Principles of Air Monitoring and Biomonitoring

NIVA Course:

Exposure to Unintentionally Formed and Engineered Nanoparticles:
Is there any difference in health effects?

Hotel Alexandra, Loen, Norway
June 19-23, 2011

Programme and Abstracts

Welcome to AIRMON 2011 and the NIVA workshop in Loen!

There is a long established requirement of air monitoring within the preventive framework of identifying and controlling health hazards at the work place and in the environment. For the characterisation of exposure to chemical and biological agents, sensitive, selective and user-friendly methods and relevant sampling strategies are needed. In recent years there have been a variety of new developments and it is essential to promote the knowledge of these newly developed methods and strategies for workplace, indoor and ambient air monitoring. Six previous meetings have been held: at Geilo, Norway in 1993, 1999 and 2008; at Sälen, Sweden in 1996; at Hafjell-Lillehammer, Norway 2002 and at Loen, Norway 2005.

The programme for AIRMON 2011 aims to provide a comprehensive overview of the latest developments in this important field. Therefore some of the world's leading authorities in relevant fields will be present, allowing the symposium to be an excellent forum for the exchange of ideas as well as an opportunity for private informal discussions, for all those who are involved in method development, air sampling, exposure assessment, regulatory issues or other areas related to air monitoring and biological monitoring. This year one day of the conference has been organised in collaboration with Nordic Institute for Advanced Training in Occupational Health (NIVA) and will focus on the emerging issue of understanding potential health effect differences between engineered and incidentally formed nanoparticles.

All contributions (including posters) will be considered for publication in a special issue of Journal of Environmental Monitoring after the symposium.

We know that the natural beauty of the area will captivate you, but we also hope that the conference excursions and outdoor farewell dinner may complement our scientific endeavours. On behalf of the organisers it is our pleasure to invite you to Loen. We promise you an exciting and memorable conference and stay!

For AIRMON 2011:

Yngvar Thomassen,
Dietmar Breuer, Peter Görner, Martin Harper, Alan Howe, Jan Olof Levin,
Olle Nygren, Kai Savolainen

For NIVA:

Mia Latta, Zsuzsanna Renkó-Michelsén

Organisers

AIRMON 2011 is organised by the National Institute of Occupational Health (NIOH), Norway, Umeå University (UmU), Sweden, Health and Safety Laboratory (HSL), UK, the Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA), Germany, and Institut National de Recherche et de Sécurité (INRS), France, Finnish Institute of Occupational Health (FIOH) , National Institute of Occupational Safety and Health (NIOSH), USA and Nordic Institute for Advanced Training in Occupational Health (NIVA).

Organising Committee

Yngvar Thomassen, NIOH, Oslo, Chairman
Jan Olof Levin, Umeå University,
Olle Nygren, Umeå University,
Dietmar Breuer, IFA, Germany
Peter Görner, INRS, France
Alan Howe, HSL, UK
Martin Harper, NIOSH, USA
Kai Savolainen, FIOH, Finland

Conference Secretariat

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Information for Contributors

The official language is English. No simultaneous translation will be provided. Oral presentations will be 20, 30 or 60 minutes, discussion included. Digital projection with PowerPoint software will be available in all lecture rooms. Lecturers are requested to deliver the PowerPoint files to the responsible chairman well before the start of the session. Posters will be displayed from Sunday to Thursday in the Conference Centre. Authors are requested to be at their posters Monday between 20:30 and 21:30. At least one of the authors must be present at the poster during this time.

All contributions will be considered for publication in a special issue of the Royal Society of Chemistry (RSC) journal *Journal of Environmental Monitoring* after the conference, subject to the normal review procedures of the journal. Authors are kindly requested to hand in their manuscripts at the Symposium, the final deadline being 1 August 2011.

General information

Venue

- ***Conference Desk***

The conference desk is situated in the conference foyer of Hotel Alexandra. It will operate as follows:

Saturday	June 18	16:00 - 18:00
Sunday	June 19	08:00 – 09:00
Monday	June 20	08:00 - 09:00
Tuesday	June 21	08:00 - 09:00
Wednesday	June 22	08:00 - 09:00

Participants are requested to register as soon as possible upon arrival to Hotel Alexandra, Loen.

- ***Conference Venue***

All oral and poster sessions will be held in the various auditoriums of Hotel Alexandra.

Tel: +47 57 87 50 00 Fax: +47 57 87 50 51 Email: alex@alexandra.no
Homepage: www.alexandra.no

- ***Meals***

Participants staying at Hotel Alexandra are served breakfast, lunch and dinner (all included in their accommodation package).

Social Programme

Saturday, June 18, 17:00 - 19:00 : Informal Get-together in the Hotel Alexandra Bath & Spa

All delegates and accompanying persons are invited to enjoy the heated outdoor swimming pool and refreshments.
This event is kindly sponsored by *Journal of Environmental Monitoring.*

Sunday, June 19, 14:15: Half-day Excursion to Geiranger

This tour encompasses a mountain plateau above the tree and snow lines, the summit of Dalsnibba (1746 m), and a sail of 25 km along the spectacular Geirangerfjord.
Price per person: NOK 450 (not included in the registration fee, children free).

Sunday, June 19, 14:15: Mountain Hiking for Fit Participants- The Skåla Challenge

Those who want to challenge the Norwegian mountains are offered a guided walk after lunch to the Klaumann Tower at Skåla Mountain. This is the hardest uphills in entire Norway, approx. 1800 m straight up. Presently there may still be much snow above 1000 meters. Hikers are advised to bring appropriate footwear and clothing for this walk. Free of charge, but you will sweat!

Wednesday, June 22, 15:45: Excursion to the Briksdal Glacier with a Conference Outdoor Dinner

You are invited to visit the heart of Norway - an **Unforgettable** trip to the Briksdal Glacier. Participants can enjoy a walk to view the enormous cascade of ice, and afterwards there will be an outdoor barbeque at "Kleivane" (weather permitting - otherwise the grill party will be held at Briksdalen Inn).
The well know Norwegian gourmet chef Frode Aga will be in charge of the preparation to ensure your best outdoor food experience.
Price per person NOK 850 (not included in the registration fee).

Scientific Program

Oral Presentations
Invited plenary lectures and submitted oral contributions will be 60, 30 and 20 minutes in length, respectively (including discussion).
Video projectors will be provided in all lecture rooms.

Posters
The posters should be mounted in the early morning on Sunday June 6, in the poster area located next to the lecture room. Materials for poster mounting are available either from the Conference Desk or in the poster mounting area.

Language

The working language of the conference is English.

Liability

The Organising Committee declines any responsibility whatsoever for injuries or damages to persons or their property during the Conference.

Notices

Messages to the participants, incoming mail, programme changes etc, will be posted on bulletin boards near the lecture rooms. A notice board will also be provided for the use of the participants.

Payment

Unpaid registration will be added to your hotel bill and collected by the hotel upon departure.

Exhibition

The Instrument Exhibition will take place in the Conference Centre. It will be open Monday - Wednesday. The participants are encouraged to visit the exhibition. The following companies have registered for display and demonstration:

Oleico AB
Scantec Miljöinstrument AB
Sigma - Aldrich
SKC Ltd
Teknolab AS

Oral Presentations

Sunday, June 19:

07:30-09:00: **Registration**

09:00-09:30: **Welcome/Opening remarks**

Session I: Environmental and occupational exposure assessment – Strategies and methodologies

Chairman: Jan Olof Levin

09:30-10:30: **Environmental and occupational aerosol exposure assessment: a scientific journey from the past, through the present and into the future**
Jim H. Vincent, Professor Emeritus of Environmental Health Sciences, School of Public, Health University of Michigan, USA

10:30-11:00: **Coffee, exhibition, poster viewing**

11:00-11:30: **Biological monitoring versus air monitoring strategies in assessing environmental-occupational exposure**
Marek Jakubowski, Nofer Institute of Occupational Medicine, Lodz, Poland

11:30-11:50: **Sampling conventions for airborne particles deposited in regions of the human respiratory tract – relevance to inhalation of manufactured nanomaterials**
Göran Lidén[1] and David Bartley[2],[1]Department of Applied
[2]*Annals of Occupational Hygiene*, Cincinnati, USA

11:50-12:10: **Perspectives on sampling and analysis of large particles from the American Industrial Hygiene Conference and Exposition (Portland, Oregon, May 2011)**
Martin Harper [1]and Peter Görner[2], [1] National Institute of Occupational Safety and Health, Morgantown, USA, [2] INRS – Institut National de Recherche et de Sécurité, Vandoeuvre-lès-Nancy, France

12:10-12:40: **Workers exposure to hazardous substances and biological agents in recycling enterprises**
Ralph Hebisch and Gunter Linsel, Federal Institute for Occupational Safety and Health (BAuA), Dortmund, Germany

12:40-13:00: **Influence of a portable air treatment unit on health-related quality indicators of indoor air in a classroom**
Robbert Cremers, Stef PR van Hout, R.B.M. Anzion,
Paul TJ Scheepers, Department of Epidemiology and Biostatistics
Radboud University Nijmegen Medical Centre, Nijmegen,
The Netherlands

13:00-14:10: **Lunch**

14:15: **Excursion to Geiranger, Outdoor activities**

19:00: **Dinner**

Monday, June 19:

Session II: Airmon and NIVA Workshop: Exposure to incidentally formed and engineered nanoparticles: Is there any difference in health effects?

Chairmen: Vidar Skaug and Kai Savolainen

08:30-08:40: **Welcome and opening of the NIVA-workshop**
Zsuzsanna Renkó-Michelsén, NIVA, Finland

08:40-09:30: **Emerging issues on health effects of engineered nanomaterials**
Kai Savolainen, Finnish Institute of Occupational Health, Helsinki, Finland

09:30-10:30: **Characterisation of nanoparticles in ambient and occupational atmospheres by electron microscopy**
Stephan Weinbruch and Martin Ebert, Institute of Applied Geosciences, Technical University Darmstadt, Germany

10:30-11:00: **Coffee, exhibition, poster viewing**

11:00-12:00: **Occupational exposure to ultrafine and nanoaerosols**
Carsten Möhlmann, Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (DGUV), Sankt Augustin, Germany

12:00-13:00: **Which chemical and physical characteristics of nanoparticles are important in the development of adverse health effects?**
Peter Hoet, Catholic University of Leuven, Belgium

13:00-14:00: **Lunch**

14:00-14:30 **Exposure to manufactured nano-objects in research and industry- Results from the European NANOSH project.**
Carsten Möhlmann[1], Johannes Pelzer[1], Markus Berges[1], Delphine Bard[2], David Mark[2], Andrew Thorpe[2], Derrick Wake[2], Elzbieta Jankowska[3], Birgit van Duuren-Stuurman[4], Derk Brouwer[4]
[1] Institut für Arbeitsschutz - IFA, Sankt Augustin, Germany; [2] Health and Safety Laboratory - HSL, Harpur Hill, UK; [3] Central Institute for Labour Protection - National Research Institute – CIOP-PIB, Warsaw, Poland; [4] TNO, AJ Zeist, The Netherlands

14:30-15:30: **Cardiovascular effects of pulmonary exposure to nano or fine particles**
Vincent Castranova, National Institute of Occupational Safety and Health (NIOSH), Morgantown, USA

15:30-16:30: **Is there epidemiologic evidence of increased cardiovascular mortality due to occupational exposure to incidentally formed nanoparticles?**
Helge Kjuus, National Institute of Occupational Health, Oslo, Norway

16:30-17:00: **Coffee, exhibition, poster viewing**

17:00-18:00: **Predictive test systems for nanoparticles**
Maria Dusinska[1,2], Magdolenova Zuzana[1], Fjellsbø Lise[1], Rundén-Pran Elise[1], Martina Drlickova[2], Alena Kazimirova[2], Magdalena Barancokova[2], Katarina Volkovova[2] and the NanoTEST team[3]
[1]Norwegian Institute for Air Research (NILU), Kjeller, Norway
[2]Slovak Medical University, Department of Experimental and Applied Genetics, Bratislava, SK
[3] *www.nanotest-fp7.eu*

18:00–19:00: **Risks from exposures to engineered nanoparticles are not readily derived from those of unintentionally formed (incidental) nanoparticles**
Vidar Skaug, National Institute of Occupational Health, Oslo, Norway

19:00–21:15: **Dinner**

21:15: **Poster discussion with refreshments**

Tuesday, June 21:

Session III: Progress in biomonitoring and characterisation of exposure

Chairman: Martin Harper

08:30-09:00: **Biomonitoring of emerging persistent organic pollutants in environmental and occupational settings**
Georg Becher, Line Småstuen Haug, Cathrine Thomsen,
Department of Analytical Chemistry, Norwegian Institute of Public Health, Oslo, Norway

09:00-09:20: **Exposure assessment by biological monitoring following chemical incidents. A procedure for decision-making**
Paul TJ Scheepers[a], Peter MJ Bos[b], Joke Konings[a], Nicole AH Janssen[b], Linda Grievink[b] ,[a] Department of Epidemiology, Biostatistics and HTA, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands; [b] National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

09:20-09:40: **Simulation of urinary excretion of 1-hydroxypyrene in various scenarios of exposure to polycyclic aromatic hydrocarbons with a generic, cross-chemical predictive PBTK-model**
Frans Jongeneelen[1], Wil ten Berge[2], [1]IndusTox Consult, Nijmegen – NL., [2]Santoxar, Westervoort-NL

09:40-10:00: **Determination of DNA adducts in skin biopsies and 1-hydroxy-pyrene in urine following topical application of coal tar ointment in volunteers and psoriasis patients**
Judith Hendricksen-Roelofzen[1], Pieter van der Valk[1], Roger Godschalk[2], Jeanette van Houtum[1], Laura Golsteijn[1], Cindy Bekker[1] Rob Anzion[1], Katja KH Aben[1], Frederik-Jan van Schooten[2], Lambertus A Kiemeney[1] Paul TJ Scheepers[1], [1]Research Lab Molecular Epidemiology, Department of Epidemiology Biostatistics and HTA, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands
[2] Department of Health Risk Analysis and Toxicology, Maastricht University, Maastricht, The Netherlands

10:00-10:20: **Exhaled breath biomonitoring using cavity ring-down laser spectroscopy**
F. M. Schmidt, M. Metsälä, O. Vaittinen, L. Halonen
Laboratory of Physical Chemistry, University of Helsinki, Finland

10:20-10:50: **Coffee, poster viewing, exhibition**

Session IV: Bioaerosols – sampling and characterisation

Chairman: Alan Howe

10:50-11:20: **State of the art in bioaerosol research – implications for exposure assessment**
Wijnand Eduard, National Institute of Occupational Health, Oslo, Norway

11:20-11:40: **Development of sampling methods for mycotoxins in workplace air**
Danièle Jargot, Sandrine Melin and Odile Moulut, Institut National de Recherche et de Sécurité, Vandoeuvre, France

11:40-12:00: **Documentation of bioaerosol concentrations in indoor composting facilities in France**
Philippe Duquenne, Pascal Poirot, Véronique Koehler, Guylaine Greff and Xavier Simon. INRS - Institut National de Recherche et de Sécurité, Vandoeuvre Cedex, France.

12:00-13:30 **Lunch**

Session V: Progress in sampling, exposure assessment and characterisation of exposure

Chairman: Alan Howe

13:30-14:00: **Estimation of the consumer inhalation risk of waterproofing aerosols**
Wolfgang Koch, Clemens Dasenbrock, Monika Fischer, Fraunhofer Institute of Toxicology and Experimental Medicine, Hannover, Germany

14:00-14:30: **Hot bitumen emission exposure - European data and comparison of different field monitoring methods**
Emmel, C. [1]; Osborn, L.[2], Kriech, T. [2]; Rühl, R. [3]; Musanke, U. [3]; Höber, D. [1]; Breuer, D. [4], [1] BG BAU, Munich, Germany, [2] Heritage Research Group; Indianapolis, USA, [3] BG BAU, Frankfurt/Main, Germany, [4] IFA, Sankt Augustin, Germany

14:30-14:50: **Environmental tobacco smoke at the workplace**
Dietmar Breuer1), Roger Kühn2), Matthias Weigl2), Udo Eickmann3), Tobias Weiß4), Helmut Blome1), Thomas von der Heyden1), Wolfgang Schneider1), 1) Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA), Sankt Augustin, Germany, 2) German Social Accident Insurance Institution for the Foodstuffs Industry and the Catering Trade, Mannheim, 3) German Social Accident Insurance Institution for Health and Social Services, Cologne, 4) The Institute for Prevention and Occupational Medicine of the German Social Accident Insurance (IPA), Bochum,

14:50-15:10: **Screening of deposited airborne emissions, spill and leakage of antibiotics in Swedish Hospitals**
Olle Nygren and Roger Lindahl, Chemical Occupational Hygiene Group, Environmental and Biogeochemistry, Department of Chemistry, Umeå University, Sweden

15:10-15:30: **Particle and nanoparticle exposure during grinding, brazing and welding activities in a mechanical engineering factory**
Ivo Iavicoli, Luca Fontana, Carlo Laurini, Veruscka Leso and Antonio Bergamaschi, Institute of Occupational Medicine, Università Cattolica del Sacro Cuore, Rome, Italy;

15:30-16:00: **Coffee, poster viewing, exhibition**

16:00-18:00: **Short courses:**

1: Working principles of direct reading aerosol monitors
Peter Görner, INRS – Institut National de Recherche et de Sécurité, Vandoeuvre-lès-Nancy, France

2: Size selective aerosol sampling in occupational hygiene
Carsten Möhlmann, Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (DGUV), Sankt Augustin, Germany

3: Bioaerosol assessment – analysis, sampling methods and strategy
Phillippe Duquenne, INRS – Institut National de Recherche et de Sécurité, Vandoeuvre-lès-Nancy, France

19:00: **Dinner**

Wednesday, June 22:

Session VI: Quality assurance and measurement of exposure

Chairman: Dietmar Breuer

08:30-09:00: **Interlaboratory evaluation of inductively coupled-plasma mass spectrometry for the determination of trace elements in workplace air filter samples**
Kevin Ashley[1], Michael J. Brisson[2], Alan M. Howe[3] and Stanley Shulman[1], [1]US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Cincinnati, OH, USA, [2]Savannah River Nuclear Solutions, Aiken, SC, USA, [3]Health and Safety Laboratory, Buxton, Derbyshire, UK

09:00-09:20: **Workplace aerosol mass-concentration measurement using an optical particle counter**
Peter Görner[1], Xavier Simon[1], Denis Bémer[1] and Göran Lidén[2]
[1] INRS – Institut National de Recherche et de Sécurité, Vandoeuvre-lès-Nancy, France, [2] Stockholm University, Department of Environmental Science, Stockholm, Sweden

09:20-09:40: **Multiparametric approach as a tool for the evaluation of nanoparticle emissions from laser printers in the professional exposure assessment**
Paola Castellano[1], Riccardo Ferrante[1], Nunziata L'Episcopo[1], Silvia Canepari[2], Maria Luisa Astolfi[2], Paola Desiderio[3], Emma Incocciati[3]
[1] Italian Workers' Compensation Authority (INAIL), Department of Occupational Hygiene, Chemical Agents Laboratory -Ex National Institute for Occupational Safety and Prevention (Ex ISPESL) - (Rome), Italy, [2] Chemistry Department – University of Rome "Sapienza", Italy
[3] Italian Workers' Compensation Authority (INAIL), Rome, Italy

09:40-10:00: **Performance evaluation of two commercial chemiluminescence NOx analyzers according to Standard EN 14211**
Marta Doval Miñarro[1,2,] and Enrique González Ferradás[1], [1] Chemical Engineering Department, School of Chemistry, University of Murcia, Spain, [2] Instituto Universitario Centro de Estudios Ambientales del Mediterráneo CEAM-UMH, Paterna, Valencia ,Spain

10:00-10:20: **Long-term dust exposure and metal particle characterization in stainless steel melting**
Markku Huvinen[1] , Leo Oksanen[2] , Olli Taikina-aho[3]
[1]Outokumpu Oyj, Espoo, Finland, [2]Outokumpu Stainless Oy, Tornio, Finland, [3]University of Oulu, Center of Microscopy and Nanotechnology, Oulun yliopisto, Finland

10:20-10:50: **Coffee, poster viewing, exhibition**

Session VII: Measurement and characterisation of indoor and ambient air contaminants

Chairman: Yngvar Thomassen

10:50-11:10: **Determination of a large variety of amines in air samples using midget impinger sampling followed by analysis with ion chromatography in tandem with mass spectrometry**
Marie Verriele[1,2,3], Hervé Plaisance[1,2], Virginie Vandenbilcke[3], Nadine Locoge[1,2], and Guillaume Meunier[3] , [1]Université Lille Nord de France Lille, France, [2]Ecole des Mines de Douai, Département Chimie et Environnement, Douai Cedex, France, [3]PSA Peugeot Citroën, Centre Technique de Vélizy, Vélizy Villacoublay Cedex , France

11:10-11:30: **Metal pollution at selected Norwegian industry sites studied by the moss technique: An update**
Eiliv Steinnes, Department of Chemistry, Norwegian University of Science and Technology, Trondheim, Norway

11:30-12:30: **Short course:**

4: Sampling of volatile and semi-volatile organic chemicals
Martin Harper, National Institute of Occupational Safety and Health, Morgantown, USA

12:30-13:30: **Lunch**

13:30-15:30: **Short courses:**

5: The physical behavior of ultrafine particles in the air
Wolfgang Koch, Fraunhofer ITEM, Hannover, Germany

6: Standards setting for inhaled aerosols, from large to nano-sized aerosol fractions
Jim H. Vincent, Professor Emeritus of Environmental Health Sciences, School of Public, Health University of Michigan, USA

7: Biological monitoring – Biomonitoring of exposure
Marek Jakubowski, Nofer Institute of Occupational Medicine, Lodz, Poland

15:45: **Excursion to Briksdal Glacier/Conference Outdoor Dinner**

Thursday, June 23:

Session VIII: Progress in sampling and measurement of occupational exposure

Chairman: Yngvar Thomassen

09:00-09:20: **Sulphuric acid at workplaces – application of the new IOELV for thoracic particles**
Dietmar Breuer, Petra Heckmann, Krista Gusbeth, Carina Engel, Gregoria Schwab and Andreas Moritz, Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA), Alte Heerstraße 111, 53757 Sankt Augustin, Germany

09:20-09:40: **The effect of different types of analgesia equipments on midwives' occupational exposure to nitrous oxide in Finnish maternity hospitals**
Kinnari Henna, Bäck Beatrice, Kekäläinen Pirjo, Kammonen Outi, Salmi Kari, Laaja Timo, Holopainen Rauno and Tuomi Tapani, Finnish Institute of Occupational Health, Helsinki, Finland

09:40-10:00: **Occupational exposure to airborne contaminants during professional ski waxing**
R. Olsen[1], B.I Freberg[1], D.G. Ellingsen[1], P. Molander[1], M. Hersson[1], H.L. Daae[1], S. Thorud[1], L.S. Haug[2], C. Thomsen[2], G. Becher[2]
National Institute of Occupational Health, [2]Norwegian Institute of Public Health, Oslo, Norway

10:00-10:20: **Coffee**

10:20-10:40: **Hydrogen fluoride and aerosol real-time portable spectrometers in combination with PIMEX for visualization of exposure in aluminium smelter potrooms**
Balazs Berlinger, Nils Petter Skaugset and Yngvar Thomassen, National Institute of Occupational Health, Oslo, Norway

10.40-11:00: **Validation of Control Banding – Experience with COSHH Essentials**
Martin Harper and Eun Gyung (Emily) Lee
Exposure Assessment Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, USA

11:00-11:20: **Measurement of trace beryllium in occupational hygiene samples: update of recent research**
Kevin Ashley[1] and Michael J. Brisson[2], [1]Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH 45226, USA, [2]Savannah River Nuclear Solutions, Savannah River Site 707-F, Aiken, SC 29808, USA

11:20-11:40: **Occupational exposure to beryllium in primary aluminium production**
Nils Petter Skaugset[1,2], Dag G. Ellingsen[1], Kari Dahl[1], Ivar Martinsen[3], Lars Jordbekken[1], Per Arne Drabløs[4] and Yngvar Thomassen[1,2],
[1] National Institute of Occupational Health, Oslo, Norway
[2] Department of Plant and Environmental Sciences, Norwegian University of Life Sciencee, Ås, Norway, [3] GE Healthcare, Oslo, Norway, [4] Karmøy Plant - Norsk Hydro, Håvik, Norway

11:40-12:00**:** **Closing remarks**

12:00: **Lunch**

Poster Presentations

Monitoring of Anthropotoxins in Atmosphere of Artificial Objects
Stolyarov S.B., Zamana S.P., Vershinin V.V., Nilipovskiy V.I., Fedorovskiy T.G., Sokolov S.A.,The State University of Land Use Planning, Moscow, Russia, Stolyarov B. S., Korneyeva E.A. Mephi, Moscow, Russia

Exposure to ultrafine particles during welding of PVC membrane and verge building in a subsea road tunnel
Rikke Bramming Jørgensen[1], Solveig Føreland[2,3] and Morten Buhagen[2]
[1] Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Trondheim, Norway,
[2] Department of Occupational Medicine, University Hospital of Trondheim, Norway, [3] Department of Public Health and General Practice, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway

Field comparison of three inhalable aerosol samplers (IOM, PGP-GSP 3.5 and Button) for welding fumes
Agurtzane Zugasti, Natividad Montes and José Mª Rojo, National Institute of Safety and Hygiene at Work, Baracaldo, Spain

Validation and feasibility study of the developed small diffusive samplers for aldehyde and VOC in elementary school children
Atsuko Araki[1,2], Toshio Kawai[3], Tazuru Tsuboi[3], Yu Ait Bamai[2], Tomoya Takeda[2], Eiji Yoshioka[2], Reiko Kishi[1],[1] Hokkaido University Center for Environmental and Health Sciences, Sapporo, [2] Hokkaido University Graduate School of Medicine, Department of Public Health Sciences,[3] Osaka Occupational Health Service Center, Japan Industrial Safety and Health Association, Japan

Real-time measurement of mean particle size and number concentration of nanoaerosols in the range 20-450 nm with the diffusion size classifier
Sébastien Bau[1], Jonathan Jacoby[2], Olivier Witschger[1], [1] Institut National de Recherche et de Sécurité, Laboratoire de Métrologie des AérosolsVandoeuvre Cedex, France, [2] Nancy Université, Laboratoire de Structure et Réactivité de Systèmes Moléculaires Complexes, Vandoeuvre, France

Occupational exposure to lead present in their breathing zone in a ceramic industry
Seyed Jamaleddin Shahtaheri[1], Mahdi Dehghan Nassiri[1], Farideh Golbabaei[1], Abbas Rahimi-Froushani[2], [1] Department of Occupational Health, [2] Department of Epidemiology and Statistics, School of Public Health, Tehran University of Medical Sciences, Iran

Surface monitoring of antineoplastic drugs in Swedish hospitals and hygienic guidance values
Maria Hedmer, Division of Occupational and Environmental Medicine, Department of Laboratory Medicine, Lund University, Sweden

Determination of pesticides in the air of chemical waste site
Pāvels Sudmalis[1,2], Mārīte Ārija Baķe[1], Svetlana Lakiša[1], [1] Riga Stradins University, Institute of Labour Safety and Environment Health, Laboratory of Hygiene and Occupational Diseases, [2] Riga Stradins University, Department of Pharmaceutical Chemistry, Latvia

Sampling conventions for airborne particles deposited in regions of the human respiratory tract – relevance to inhalation of manufactured nanomaterials
Göran Lidén[1] and David Bartley[2], [1]Department of Applied Environmental Science, Stockholm University, Sweden , [2]Assistant editor of *Annals of Occupational Hygiene*, Cincinnati, USA

Characterization of welding fume containing manganese
Göran Lidén[1], Lennart Lundgren[1], Karine Elihn[1], Kjell Jansson[2], Bernt Bergström[3], Göran Säwemark[4] and Michael Blomstrand[5], [1]Department of Applied Environmental Science, Stockholm University, [2]Department of Material and Environmental Science, Stockholm University, [3]Department of Occupational and Environmental Medicine, Örebro University Hospital, [4]ESAB AB, Göteborg, [5]Elga AB, Partille, Sweden

Possible exposure to nanoparticles in power engineering

Leena Korpinen[1], Hiroo Tarao[2], Rauno Pääkkönen[3], Risto Raiko[1], Fabriziomaria Gobba[4], [1]Tampere University of Technology, Dep. of Energy and Process Engineering,Tampere, Finland, [2]Dep. of Electrical and Computer Engineering, Kagawa National College of Technology, Japan, [3]Finnish Institute of Occupational Health, Finland,[4]University of Modena and Reggio Emilia, Dep. of Public Health Sciences, Italy

Relationships between leaf metal accumulation and functional characteristics in *Q. ilex* L.

Giulia Maisto, Lucia Santorufo, Pasquale Alfano, Carmen Arena
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An analytical method coupling ASE, SPME and GC-MS for quantification of non-agricultural pesticides in air samples

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Comparison of total dust versus inhalable personal samplers for the determination of paper dust in a soft paper mill

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A new non-invasive way of sampling potential biomarkers for inflammation in the distal airways

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New development in online air quality monitoring

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Hydrogen sulfide emission rates at several wastewater treatment plants in the Valencian community (Spain)

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Abstracts

Oral presentation

OCCUPATIONAL AND ENVIRONMENTAL AEROSOL EXPOSURE ASSESSMENT: A SCIENTIFIC JOURNEY FORM THE PAST, THROUGH THE PRESENT AND INTO THE FUTURE

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Health risk associated with the inhalation of airborne particulate matter has been recognized for centuries. But near the beginning of the 20th century it started to become the subject of serious scientific enquiry. This presentation begins with an outline of the rationale which links exposure, exposure assessment and standards by which the prevalence of ill-health may be controlled, setting the context for all that follows.

The study of aerosol exposures of industrial workers was driven initially by the prevalence of respiratory ill-health in the mining industries. South Africa led the way, establishing the very first particle size-based criterion for what constitutes a particle potentially contributing to pneumoconiosis, and soon after producing a prototype of a first sampling instrument – the *konimeter* – for counting particles of the most relevant size by optical microscopy after they had been collected onto a glass substrate. In the years that followed, a great deal of exposure data, expressed in terms of particle counts per unit volume of air, was accumulated in South Africa, Canada and Australia using the konimeter and instruments like it. In the 1950s, it became clear not only that particle count was a poor index of aerosol concentration in relation to health but also that the metric of particle size was barely adequate at best. In Britain and elsewhere, a combination of the growth of aerosol science and inhalation research involving human volunteer subjects pointed the way towards a new particle size metric, *particle aerodynamic diameter*. Instruments employing aerodynamic particle size selection soon emerged – elutriators and cyclones, mainly – and these soon found their way into exposure assessments carried out as part of epidemiological studies, again driven by the needs of the mining industries. By the 1970s it was confirmed that aerosol mass concentration was a much more appropriate metric of exposure intensity (than particle count) of the fine *respirable fraction*, that part of inhaled aerosol capable of penetrating down to the alveolar region of the lung. Subsequently a great deal of exposure assessment data was accumulated based on this new rationale which – combined with similarly extensive data on health effects – pointed the way to new control limits. Implementation of these in the mining industries led to enhanced technical dust control measures. A marked decline in the prevalence of health effects soon followed.

In the late 1970s, attention was turned to application of the same rationale to fractions other than respirable which were thought to be associated with other aerosol-related health effects. Wind tunnel studies with mannequins with simulated breathing showed that the particle size-dependent efficiency with which particles entered through the nose and mouth during breathing was very different from true total aerosol, leading to definition of a new coarse fraction, the *inhalable fraction*. Further, based on the (by now) much larger body of information from human inhalation studies, a new fraction was defined, the intermediate *thoracic fraction*, referring to particles capable of penetrating into the lung below the larynx. During the 1980s, standards-setting bodies such as ISO and ACGIH, as well as national regulatory agencies, defined the three aerosol fractions, indicating how they might be applied. Sampling instrumentation for collecting these fractions arrived and began to find application in industrial workplaces, leading to the acquisition of new bodies of exposure data. Much of this involved the determination of mass concentration not only of the overall collected aerosol but also relevant chemical species. In parallel to all this work-related activity, particle size-selective standards – and in turn instruments – for atmospheric aerosols were developed and applied, including for the PM_{10} fraction (very similar to the thoracic

fraction as defined elsewhere) and then, later, a still finer fraction, $PM_{2.5}$ fraction aimed at atmospheric aerosols deriving primarily from combustion sources.

Field studies, both in workplaces and the outdoors environment, produced a great deal of exposure data for these new fractions and information about the relative performances of the myriad sampling devices that were developed to meet the new exposure assessment needs. Some samplers performance better against the new particle size-selective criteria than others, so that professional occupational and environmental hygienists had information on which to base the choice of instrument to carry out each individual exposure assessment. Long-term historical exposure records constitute an important part of epidemiology. For aerosols, however, the shifting sampling criteria, exposure indices, and instrumentation and strategies, have created a very special challenge. The ‘art’ of retrospective exposure assessment has grown as having an important role in rationalizing the historical records and making them useful to epidemiologists.

The work does not stop. Improvement of the criteria and standards for the assessment of aerosol exposures continues. One goal is to make measurements of exposure even more relevant to the *actual* aerosol doses received by exposed people, taking even closer account of the particle size-dependence of particle regional deposition in the human respiratory tract. In addition, new challenges have surfaced. Although aerosols of biological origin have long been known to be associated with a wide range of health effects, efforts over the past 20 years have attempted to unravel the complex issues surrounding the diversity of particle types and their very special sampling and collection requirements. And finally, there is a brand new challenge. The recent rapid growth of nanotechnology has drawn attention to the need to specifically address the matter of nano-aerosols. This is the next big topic.

Oral presentation

BIOLOGICAL MONITORING VERSUS AIR MONITORING STRATEGIES IN ASSESSING ENVIRONMENTAL-OCCUPATIONAL EXPOSURE

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Exposure assessment can be performed with environmental monitoring (EM) and biological monitoring (BM). Environmental toxicologists have worked out procedures for the risk assessment of adverse health effect that were based on the daily intake of a given chemical. The reference values such as reference dose (RfD) or provisionally tolerated weekly intake (PTWI) reflect the level of exposure that should prevent humans from suffering adverse effect of environmental exposure. Industrial toxicologists have developed guidelines for interpreting the concentrations of chemical substances in the air of industrial enterprises. These values have been published either as recommendations or as official lists of admissible concentrations.

The setting of acceptable exposure limits is based on the assumption that there is no appreciable risk at levels below these limits for all or almost all the persons exposed. Although the recommended admissible concentration in environmental media have been commonly used and accepted it has become clear that various factors can affect exposure. These include additional absorption through the skin, differences in individual behavior in the general environment and poor working practice, different uptake at the same air concentration, and the use and effectiveness of personal protection devices. In view of the possible influence of these individual factors, the concept of biological monitoring making possible evaluation of uptake of chemicals was developed. According to the Scientific Committee on Occupational Exposure Limits (SCOEL) the biological monitoring methods that are currently used to assess workplace exposure fall into three main categories: -determination of a substance or its metabolite in a biological medium (biological exposure monitoring)-measurement of reversible, non-adverse biological effects (biological effects monitoring)-mesurement of the amount of substance interacting with a target (biological monitoring of effective dose).

Biological monitoring was for a long time considered as a method complementary to environmental monitoring. At present this attitude is changing and in certain areas biological monitoring is applied as the method of choice for exposure assessment.

*Volatile organic compounds(VOC's):*LEM is commonly used for evaluating occupational exposure to VOC's. Biological monitoring of exposure is based mainly on the determinations of specific metabolites in urine. The method is reliable in the cases involving exposure to a single compound, e.g. styrene, in the production of laminated constructions. Nevertheless, in the occupational settings, VOC's are almost as a rule present in mixtures. Relevant literature reports two methods for simultaneous determination of unchanged compounds in blood and exhaled air. Neither of the methods has gained acceptance. Recently determining unchanged VOC's in urine has been recommended for evaluation of uptake in the case of exposure to mixtures.

*Metals:*Possible application of BM or EM depends on toxicokinetics of particular metal and the kind of effects. For metals being cumulated in the organism with health-based data for interpretation of results (systemic effects) such as cadmium, lead or methylmercury BM is superior to EM. In the other cases, e.g. manganese (high background levels in urine) or arsenic (carcinogenic risk can be calculated only on the basis of concentration in the air), the opposite is true).

*Other:*BM is the method of choice for evaluating environmental exposure to persistent organic pollutants (PCB's, PCDD/PCDF's), pesticides or occupational exposure to cytostatic drugs. On the other hand, although it is possible to evaluate exposure to polycyclic aromatic hydrocarbons by means of BM (determination of metabolites in urine) quantitative evaluation of the cancer risk is possible only on the basis of their concentration in the air.

In summary, today, when the analytical problems have almost ceased due to new laboratory techniques and quality assurance systems, the choice between EM and BM depends mainly on the available methods for interpretation of results.

Oral presentation

SAMPLING CONVENTIONS FOR AIRBORNE PARTICLES DEPOSITED IN REGIONS OF THE HUMAN RESPIRATORY TRACT – RELEVANCE TO INHALATION OF MANUFACTURED NANOMATERIALS

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Manufactured nanoparticles can become airborne in various ways, as individual primary particles, attached to other, already airborne particles or as agglomerates of primary particles. When such particles are inhaled, they might deposit somewhere in the respiratory tract, depending on their airborne size. Depending on the region of deposition, different clearance routes are available, which in turn depends on the size of the deposited nanoparticle. A deposited agglomerate may dissociate or grow in size when it encounters biological fluids containing e.g. phospholipids and proteins or acids. One therefore need to know where airborne nanoparticles may deposit in the respiratory tract.

Based on the ICRP model on the deposition of inhaled particles, ISO has proposed a standard with sampling conventions for the aerosol fractions that deposit by either diffusive or aerodynamic forces in various regions of the respiratory tract. None of these are proposed/ expected to replace existing sampling conventions for the respirable, thoracic and inhalable aerosol fractions. ICRP divides the respiratory tract into five regions – Extra-thoracic 1 and 2 (ET1 & ET2), proximal and distal tracheo-bronchial (BB & bb), and the gas-exchange regions (GE). Some deposition efficiencies are virtually proportional to each other, and for these only one sampling convention is needed. The sampling conventions could either be incorporated into new samplers/measurement monitors for a specific region of the respiratory tract or applied to measured particle size distributions.

ICRP has calculated the deposition efficiencies for the five regions for both separation mechanisms, for four classes of work intensity (lying down, sitting, light work and hard work), for two kind of breathing patterns (normal and mouth breathers) and for both sexes. The curves generally shown (as for example in Hinds – *Aerosol Technology*) is an average for all parameters and only valid for spherical particles with unit density. The differences in deposition efficiencies between the sexes is generally small. The deposition efficiencies for diffusion varies much less with work load and breathing pattern compared to the deposition by aerodynamic forces. Curves will be shown to demonstrate the variability of the deposition in relation to the proposed ISO sampling conventions.

The deposition efficiency is not the same as the amount of material deposited in a region of the respiratory tract. It is this latter quantity that is of interest in epidemiological health effect studies. In order to estimate the amount deposited (especially for aerodynamic deposition), one would need to estimate the breathing pattern (flow rate and whether the worker mainly breaths by the nose), and based upon this calculate the dose. The standard contains a method one based on measuring all the fractions, one can make a less biased estimate of the deposited fraction for a certain work load and breathing pattern, provided these can be estimated.

Oral presentation

PERSPECTIVES ON SAMPLING AND ANALYSIS OF LARGE PARTICLES FROM THE AMERICAN INDUSTRIAL HYGIENE CONFERENCE AND EXPOSITION (PORTLAND, OREGON, MAY 2011)

Martin Harper [1]and Peter Görner[2], [1] National Institute of Occupational Safety and Health, Morgantown, USA, [2] INRS – Institut National de Recherche et de Sécurité, Vandoeuvre-lès-Nancy, France

A Science Symposium, entitled Inhalable Particles: The State of the Science on a Big Particle Problem, was held as a part of the American Industrial Hygiene Conference and Exposition (AIHce) in Portland, Oregon in May. This Symposium is summarized for the benefit of the current audience. It included papers on the science behind inhalable particles and the inhalable convention, development of inhalable exposure limits, how well personal samplers meet the inhalable sampling convention at different wind speeds, whether it is possible to relate historic exposure measurements to inhalable measurements, and practical application of inhalable sampling in real field situations. In addition, the International Symposium WoodDust2011, the third of a series of symposia on wood dust was also held in conjunction with AIHce and featured presentations from the USA, Europe, Canada, and elsewhere on exposures and health effects from exposure to wood dust, mechanisms of disease, development of limit values, procedures for sampling and analysis, and best practices for control. A brief overview of the symposium is also presented with special emphasis on the presentations relating to the sampling and analytical aspects. These two Symposia discussed recommendations for best practice in the measurement of exposures to larger particles. It was noted that samplers varied in their ability to match the inhalable convention, especially at larger particles sizes, whether under calm or moving air conditions. However, it was also noted that the practical effect of this difference is a function of the particle size distribution so that if two samplers have similar collection efficiency for the particles which are actually present in the workplace, they would give similar results. Finally, it was noted that the selection of sampler might also be driven by the desire to collect a larger number of samples, which would be more likely with equipment that was convenient, easy to use and calibrate, and that would not be a burden to the worker. The standard closed-face cassette used in the USA would give results similar to other samplers designed to meet the inhalable convention in situations where particle sizes were small, and results possibly within tolerance for comparison even in situations where there are larger particles, such as wood dust. However, it is necessary to determine the entire aspiration of this sampler for best results, by including wall deposits using an internal capsule or by wiping internal surfaces and adding the wipe sample to the filter catch. Adjusting the orifice to face forwards also assists in matching the inhalable convention more closely.

Oral presentation

WORKERS` EXPOSURE TO HAZARDOUS SUBSTANCES AND BIOLOGICAL AGENTS IN RECYCYLING ENTERPRISES

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In Germany more than 150.000 people are working in recycling enterprises and waste management. During their activities they may be exposed to air-borne hazardous substances and biological agents depending on the branch they are working. Because there are information needs about workers´ exposure BAuA has been performed a comprehensive investigation program during the last decade.

In detail, when recycling the following products workplace measurements were carried out: electronic scrap, used cars, plastics, textiles and paper. In each of these branches at least ten enterprises have been comprised. Generally, the measurements in the enterprises were performed over a working week. As a consequence of the results the investigated branches may be classified into two categories.

During recycling of electronic scrap and used cars workers are exposed to hazardous substances only. When recycling electronic scrap in most cases the OELs for respirable and inhalable particles were adhered to. Damaged electronic equipment causes some problems, e. g. increased cadmium exposure. Car recycling consists of two steps. When draining cars the main source of exposure is gasoline; during dismantling workers are mainly exposed to air-borne particles.

Recycling of plastics, textiles and paper is accompanied by workers exposure to both hazardous substances and biological agents. Beneath respirable and inhalable particles diesel particulate matter may be important if forklifters are used without diesel particulate filters. Normally, other hazardous substances are negligible unless a malfunction occurs. So, hydrogen chloride can be released during recycling of PVC, if the extruder is blocked. The biological agents bacteria, fungi and endotoxins in the inhalable particle fraction were determined. All the workplaces investigated showed an increased concentration of biological agents in relation to the environmental background. High exposures were found e. g. if high contaminated plastic packages with remaining foodstuffs or if uncleaned animal hairs or plant fibres as additives for production of non-woven from textile fibres were handled. High biological burden occurred as well at sorting belts in inadequately ventilated booths.

The results of the investigation have been used for establishing recommendations for practice. If the enterprises are working according to these standardised working procedures they can perform risk assessments for activities involving hazardous substances without performing workplace measurements.

Oral presentation

INFLUENCE OF A PORTABLE AIR TREATMENT UNIT ON HEALTH-RELATED QUALITY INDICATORS OF INDOOR AIR IN A CLASSROOM

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Indoor air quality in schools may affect the health of children. Therefore, the performance of a portable air treatment unit (PATU) was evaluated in a primary school. Indoor air quality was characterized during periods of two weeks in a primary school classroom in February and June, 2010. Four PATUs were placed in one class room. In the first week the PATUs were turned off and in the second week they were turned on again.

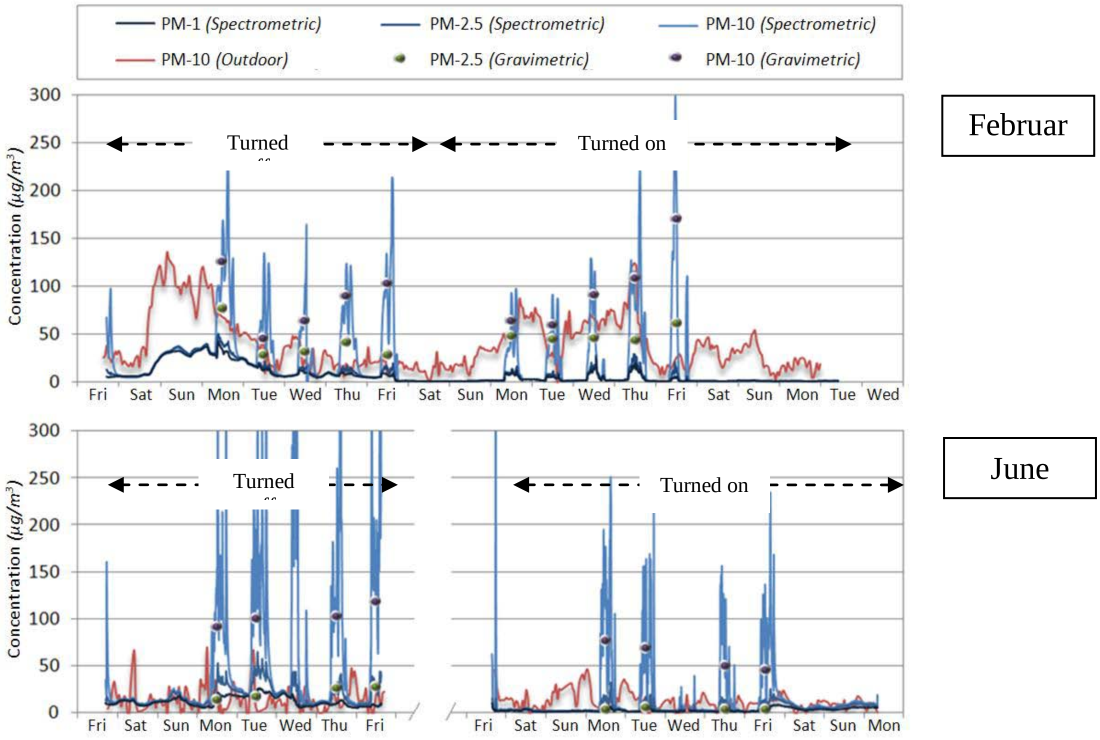

Figure 1: Time resolved registration of indoor particle concentrations.

On weekend days, PM-10 was reduced by 87% and 70% in February and June, respectively. After correction for outdoor concentrations, these reductions were 66% and 39%. On schooldays, PM-10 was increased by 6% in February and reduced by 43% in June. Reductions of 41% and 7.5% were observed after correction for outdoor PM-10. For PM-2.5 the (uncorrected) reductions were 89% and 80% on weekend days in February and June, respectively. In February for PM-2.5 an uncorrected increase of 15% was observed, whereas in June PM-2.5 was reduced by 83% (uncorrected). In February (but not in June) total volatile organic compounds (corrected for outdoor values) were reduced by 82% on weekend days and 57% on schooldays. No significant influence of the PATUs on the air concentrations of formaldehyde, NO_2, O_3 and molds was observed. During teaching hours on schooldays the PATUs appeared to perform worse than on undisturbed weekend days.

Our study suggests that air treatment devices should be tested in real-life settings to evaluate their influence on health-related indicators of indoor air quality.

EMERGING ISSUES ON HEALTH EFFECTS OF ENGINEERED NANOMATERIALS

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The significance of engineered nanomaterials (ENM) and nanotechnologies grows rapidly. In the near future, nanotechnology-based applications will have a marked impact on human every-day life. However, very little is known of the possible risks of ENM to occupational safety and health (OSH). The exposure of workers, consumers and susceptible groups has to be though considered. However, knowledge of the exposure to, or effects of, ENM on human health and safety is limited and does not allow reliable risk assessment of ENM. Several issues related to ENM require marked attention. The most topical issues include: 1) improved understanding of ENM metrics that determine their toxicity; 2) development of monitoring devices for ENM exposure assessment; 3) understanding the changes of ENM structure and state of agglomeration at different concentrations in aerosols; 4) understanding biological effects of ENM in the human body; 5) the development of tiered approaches for testing of safety of ENM; and 6) utilizing these data for health risk assessment. Available data on several ENM - ability to enter the body and reach almost any organ, to cause pulmonary inflammation and fibrosis, and to cause increased risk of mesotheliomas in animal models, call for immediate action to identify those ENM that may cause OSH risks from those that are innocent. Thus, there is an urgent need for information that allows categorization and classification of ENM based on their biological properties. Supported by the European Union 7th Framework Program Grant CP-IP-211464-2 (NANODEVICE Project).

CHARACTERIZATION OF NANOPARTICLES IN AMBIENT AND CCUPATIONAL ATMOSPHERES BY ELECTRON MICROSCOPY

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Fine and ultrafine aerosol particles show a consistent and strong association with adverse health effects, both in ambient as well as occupational atmospheres. The combination of scanning and transmission electron microscopy (including X-ray microanalysis and electron energy loss spectroscopy) offers unique possibilities for characterization of individual particles in the nanometer size range and is indispensable for exposure characterization.

Properties of nanometer-sized particles that can be obtained from electron microscopy include size, shape, morphology, fractal properties, nanostructure, elemental and phase composition, mixing state, and oxidation state (of selected elements). In addition, the hygroscopic behaviour of individual nanoparticles in a wide temperature and humidity range can be studied in situ.

In the present contribution, we want to give an overview from own work on the composition of the fine and ultrafine particle fraction in ambient air. Examples include the urban background aerosol, traffic hotspots, industrial hotspots (open pit mining and metallurgy), biomass burning as well as long-range transported desert dust. In all these examples, the dominance of soot – externally and internally mixed – among the insoluble aerosol fraction will be demonstrated. In addition to soot, complex secondary aerosol particles (mixtures of sulfates, nitrates and organic material) are an important component of the fine and ultrafine size fraction of ambient aerosols.

At workplaces, the particle composition is highly variable depending on the exact work environment under consideration. Thus, it is not attempted to give an overview of occupational nanoparticle exposure. Instead, three different topics will be addressed in detail: (a) mixing state, (b) fractal properties, and (c) hygroscopic behaviour with examples from welding as well as from Ni and Al production. In all cases investigated, workplace aerosols consist predominantly of internally mixed particles, pure phases are rarely observed. Particles originating from high temperature processes are often agglomerates that show a fractal-like geometry. Determination of the fractal properties of these agglomerates is important as they strongly influence the dynamic behaviour as well as reaction kinetics. The in situ investigation of particles at high relative humidity by ESEM/ETEM allows to study processes that take place after particles have entered the respiratory tract. In the case of aluminium smelters it is shown that a considerable fraction of highly water-soluble gases (HF and SO_2) will be transformed to the aerosol phase and carried to the lower respiratory tract.

OCCUPATIONAL EXPOSURE TO ULTRAFINE AND NANOAEROSOLS

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For measurements of ultrafine particles, a common definition for the size of ultrafine particles was released by some European research institutes for occupational health [1]. It says that the mobility equivalent diameter of ultrafine particles is regarded to be smaller than 100 nm. Nevertheless larger particles of a few hundred nm diameter shall be detected, because they can consist of agglomerated primary particles. Ultrafine aerosol particles are for the most part the product of condensation in thermal and chemical reactions.

The definition for nano-objects is given in ISO/TS 27687 [2] and includes the size between approximately 1 and 100 nm. Depending, on the number of dimensions for which the size of the nano-objects is smaller than 100 nm, the objects are called nanoplate, nanofibre or nanoparticle.

Since 1998 approximately 50 different industries had been examined for ultrafine particles in workplace air and data on about 170 different workplaces had been gathered. Number concentrations range from about 10 000 particles per cm^3 in non-polluted areas and offices up to a few ten million particles per cm^3 in welding plumes. The size distribution varies considerably with maxima from around 10 nm (airport field) to 600 nm (certain welding processes).

The occurrence of nano-objects in workplace air was investigated at different industries like TiO2 and ZnO production, mixing of nanomaterials into paints, carbon nanotube production and handling and application, use of nano-sprays. Single nanoparticles are rarely found. In most cases agglomerates were found when using nanosized powder materials. The measurement strategy needs to address the influence of background aerosols. Additionally samples of aerosols are needed to identify engineered nanoparticles in air. Common European activities (e.g. NANOSAFE, NANOSH) had been performed to determine workplace exposure. The development of new monitors for nanoaerosols is on the way (NANODEVICE).

[1] Möhlmann, C.: Ultrafeine (Aerosol)-Teilchen und deren Agglomerate und Aggregate. Kennzahl 0412/5. 38. Lfg. IV/2007. In: Messung von Gefahrstoffen - BGIA-Arbeitsmappe. Ed..: Berufsgenossenschaftliches Institut für Arbeitsschutz - BGIA. Erich Schmidt Verlag, Bielefeld 1989 – loose leaf collection (only in German)

[2] ISO/TC 27687: Nanotechnologies — Terminology and definitions for nano-objects — Nanoparticle, nanofibre and nanoplate, ISO 2008

[3] Möhlmann, C.: Ultrafeine Aerosole am Arbeitsplatz. Sicherheitstechnisches Informations- und Arbeitsblatt, Kennzahl 120130, BGIA-Handbuch, Lfg.2 - IX/2007, Erich Schmidt Verlag, Bielefeld

AIRMON and NIVA Workshop

WHICH CHEMICAL AND PHYSICAL CHARACTERISTICS OF NANOPARTICLES ARE IMPORTANT IN THE DEVELOPMENT OF ADVERSE HEALTH EFFECTS?

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The toxicity/health effects of (engineered) nanomaterials is, at the moment, of great interest. One of the central questions is whether nanoparticles have properties affecting either exposure or hazard that are fundamentally different from those shown by larger particles of identical composition. Due to already existing evidence we can conclude that, indeed, size does matter.

The uncertainty on the correct dose metric for nanoparticles illustrates the importance of a better insight of the leading physico-chemical determinants. It seems that dose for nanoparticles is more complicated, and less comparable across particle types than it is for soluble chemicals. Currently three metrics are frequently used: mass (‘traditional’ approach); surface area (SA) or particle number (both metrics specific for particles). So far, surface area has been pointed out as the most relevant. On the other hand, the universal correlation between SA and nanoparticles effects has been questioned especially in considering the state of dispersion of nanoparticles. Some (most) engineered nanomaterials tend to aggregate and/or agglomerate rapidly to form larger particles, with dimensions often exceeding the nanometric range, introduces an additional level of complexity to characterize nanoparticle behavior/toxicity. Nevertheless, a careful consideration of the dose is needed in both experiments and in regulation.

Another issue which has recently gained more attention and is a subject of ongoing debate is the binding of biological/organic molecules (proteins, surfactant, endotoxin…) present in suspension, forming a (protein) corona around the nanoparticle. Significant different protein adsorption profiles were found for different nanomaterials. The composition of the adsorbed layer depends on the affinity of the different proteins for a given surface which, ultimately, is related to the physico-chemical properties of proteins and the surface itself.

Unfortunately, the existing data on the physico-chemical determinants of toxicity of nanomaterials are fragmentary and often confusing due to apparent discrepancies among published studies and the lack of physical and chemical characterization of nanomaterials within experimental systems.

EXPOSURE TO MANUFACTURED NANO-OBJECTS IN RESEARCH AND INDUSTRY – RESULTS FROM THE EUROPEAN NANOSH PROJECT

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The NANOSH project focused on occupational exposure to nanoparticles and their health effects. Reliable and simple methods and strategies were to be developed for discriminating between manufactured nanoparticles and non-intentionally produced nano-sized particles present in the ambient atmosphere.

During the NANOSH project 4 partners performed measurements at workplaces in nanotechnology in 19 companies resulting in 150 single measurement sets/workplaces. Workplaces varied from research settings, nanomaterial production sites and downstream use. In the field of production 48 sets were achieved, in downstream use 102, both including mainly research activities.

A measurement strategy was applied to distinguish between non-engineered and engineered nanoparticles (Brouwer 2009). Two approaches had been used: sequential measurement periods of similar length for nano-activities and non nano-activities or the use of a closed cabin to avoid influence of external sources. Several direct-reading instruments were used to determine the number concentrations, particle size distributions, surface area concentrations and additional mass concentrations.

The results were collected in a database and the differences between nano-activity and non nano-activity periods assessed to derive a significant change in concentration. Additional aerosol sampling using TEM grids was performed to get an additional assessment criterion for the occurrence of nanoparticles.

The following groups of nanomaterials had been investigated: high aspect nano-objects (CNT, fibres), metal oxides (Zn, Ti), plates and miscellaneous nanomaterials.

In general, the increase of particle number or surface area concentrations during an activity related to a manufactured Nanomaterial was limited and most TEM grid analyses showed large agglomerates. However, according to the proposed decision logic, approximately 30 % of the exposure situations were evaluated as likely to have potential for exposure. Currently the NANOSH dataset is analysed in more detail and is intended to be fed into a larger database on a European level.

Brouwer D, van Duuren-Stuurman B, Berges M, Jankowska E, Bard D and Mark D (2009) *From workplace air measurement results toward estimates of exposure? Development of a strategy to assess exposure to manufactured nano-objects*. J Nanopart. Res., 11, 1867-1881

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CARDIOVASCULAR EFFECTS OF PULMONARY EXPOSURE TO NANO OR FINE PARTICLES

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Epidemiology studies have linked ambient particulate matter exposure with an elevation of cardiovascular morbidity and mortality. However, the mechanisms by which pulmonary exposure to particles induces cardiovascular dysfunction are unclear. The objectives of research in our laboratory have been to: 1) determine if pulmonary exposure to particles alters the responsiveness of systemic microvessels to vasodilators, 2) determine the dose dependence of this response, 3) determine the relative potency of fine vs. ultrafine particles, and 4) elucidate mechanisms involved in this microvascular dysfunction. In this study, rats were exposed by inhalation to various doses of fine (CMAD = 710 nm) or nano (CMAD = 123 nm) titanium dioxide for 6 hours. At 24 hours post-exposure, pulmonary inflammation and damage were determined by monitoring neutrophil counts, LDH, or albumin in bronchoalveolar lavage (BAL) fluid and by histological evaluation. Systemic microvascular function was determined by monitoring the responsiveness of arterioles in the shoulder muscle to dilators using intravital microscopy or the dilatory responsiveness of excised coronary arterioles. At lung burdens of titanium dioxide below 90 ug/lung, no changes in BAL markers of pulmonary inflammation or damage were noted. However, significant impairment of systemic or cardiac microvascular responsiveness to dilators was noted. On an equal mass lung burden basis, nano titanium dioxide was 7 fold more potent than fine titanium dioxide in causing cardiovascular dysfunction. This potency difference was eliminated when dose was normalized to equivalent particle surface area deposited in the lung. Under the conditions of this experience, titanium dioxide was below the level of detection in the systemic or coronary arterioles. However, pulmonary exposure to particles potentiated the release of reactive oxygen species (ROS) from blood polymorphonuclear leukocytes (PMN), induced adherence of PMN to microvascular walls, induced ROS production at the microvascular wall, and decreased the production of nitric oxide by endothelial cells in response to dilators. Addition of antioxidants restored normal nitric oxide production and dilation. Systemic depletion of PMN and blockade of nervous input to arterioles restored normal dilation. Therefore, it appears that systemic microvascular dysfunction after pulmonary exposure to particles involves both inflammatory and neurogenic pathways.

IS THERE EPIDEMIOLOGIC EVIDENCE OF INCREASED CARDIOVASCULAR MORTALITY DUE TO OCCUPATIONAL EXPOSURE TO INCIDENTALLY FORMED NANO-PARTICLES?

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There is currently a high focus on potential health risks from engineered nano-particles. In spite of a rapid increase in toxicological studies addressing this problem, there is still a lack of epidemiological studies in this field.Still, humans have for centuries been exposed to nano-particles, or ultrafine particles (UFP), as incidental products of processes such as combustion and welding. Thus, experiences from epidemiological studies among occupationally exposed groups, such as welders and foundry workers may contribute to the discussion of potential health risks from engineered nano-particles. Numerous studies have also implicated air pollution, and in particular exposure to small sized particles, e.g. $PM_{2.5}$, as an important contributor to morbidity and mortality from cardiovascular causes in the general population. Diseases of the cardiovascular system seem therefore to be the outcomes of particular interest in this connection. This presentation reviews epidemiological studies on cardiovascular diseases (CVD) among selected occupational groups exposed to UFP, primarily furnace workers and welders. Although the majority of the studies are hampered by crude outcome measures (mortality), comparability problems such as the “healthy worker effect” and uncontrolled confounding, there is some evidence for an increased risk of CVD related to occupational exposure to fine particles and/or combustion products. To which degree this risk is related to exposure to ultrafine particles per se, or other components, however, has still to be clarified. With regard to possible exposure-response relationships, there is a remarkable discrepancy between results from epidemiologic studies in the external and occupational environment. Further incidence-based prospective studies of cardiovascular diseases among populations occupationally exposed to UFP is urgently needed, together with studies of intermediate endpoints, such as heart rate variability and biomarkers of systemic inflammation.

PREDICTIVE TEST SYSTEMS FOR NANOPARTICLES

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Engineered nanoparticles (NPs) with their unique beneficial properties also cause the safety concern as their possible impact on human health is not known. A better understanding of how properties of NPs define their interactions with cells in exposed humans is a considerable scientific challenge. We evaluate possible toxic effects and interactions of NPs with biological systems by studying the uptake and transport of NPs through biological barriers, and by addressing key endpoints of cytotoxicity, oxidative stress, inflammation, immunotoxicity and genotoxicity. There are a number of characteristics, which may influence transport and toxicity of NPs including size, surface area, coating and charge. We investigate how these characteristics relate to possible adverse health effects. We study the effects of NPs in several target systems derived from different biological systems: blood, vascular system, liver, kidney, lung, placenta, digestive, and central nervous systems by evaluating existing and developing new *in vitro* assays. Final goal is to develop alternative testing strategies essential for detailed risk assessment, applying high-throughput *in vitro* methods. The most advanced and standardised techniques are being adapted for high-throughput system and automation.

So far, the reference NPs, the PLGA-PEO polymeric NPs (140 nm, provided by P10 ADVANCELL), uncoated iron oxide NPs (Fe_3O_4 , 8+3 nm core) and oleic iron oxide NPs (both provided by PlasmaChem), titanium dioxide (TiO_2) NPs (provided by JRC, manufactured by Evonik), fluorescent (Rhodamine) silica NPs (size 25 nm and 50 nm) both provided by Microspheres-nanospheres were fully characterized. In addition to basic primary characterization, advanced primary characterization for some specific NPs (such as photocatalicity and magnetic properties) has been performed. Moreover, a detailed investigation of behavior (agglomeration, stability, precipitation) of selected NPs in all tested biological media has been carried out.

Several methods have been employed for genotoxicity testing. The alkaline comet assay (for detection of strand breaks and alkalilabile sites), modified version of the comet assay with lesion specific enzyme formamidopyrimidine glycosylase (FPG -for detection of oxidised purines), as well as micronucleus assay. As there was an interference of NPs with cytochalasin B (inhibitor of actin and also endocytosis) the condition for micronucleus assay used for testing NPs had been modified. All reference NPs had been tested for the comet assay and micronuclei in human blood lymphocytes as well as in lymphoblastoid TK6 cells. Additionally, the comet assay was performed in cells from all cell organs and tissues apart the gastrointestinal system. We found that the response to NPs depends on size, coating, concentration, time of exposure and cell type. The oleic acid coated iron oxide appeared to be most cytotoxic as well as genotoxic, even in non-cytotoxic concentrations, in all cell types. Results are being validated in an experimental ethically approved *in vivo* model.

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RISKS FROM EXPOSURES TO ENGINEERED NANOPARTICLES ARE NOT READILY DERIVED FROM THOSE OF UNINTENTIONALLY FORMED (INCIDENTAL) NANOPARTICLES.

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Humans have been exposed from ancient times to incidentally formed nanoscaled particles < 100 nanometers from natural causes such as fires or volcanoes. Also incidental nanoscaled particles (INPs) (ultrafines) of anthropogenic origin have been located in the general (urban) environment due to traffic and heating and in the occupational environment mainly due to exhaust from vehicles, hot metal work and other industrial processes. Epidemiological studies indicate an increased risk for diseases from some of these exposures, i.e. lung diseases, immunological effects, cardiovascular effects and possibly cancer. No such data exists for engineered nanoparticles (ENPs). However, since involuntary generated particles to some extent share the same nanoscaled dimensions with ENPs, efforts have been made to evaluate ENPs for similar effects in vivo and in vitro.

In terms of number concentration of NPs, exposures to welding fumes (which is expressed in mass/mg) and diesel exhaust particles examined in human studies, outnumber by far those of low soluble low toxic NPs which causes significant biological reactions in experimental animals. Main differences relates not only to size, but also to surface reactivity, solubility, shape, crystalline structures, coatings and surface functionalization and the degree of agglomeration /aggregation. Here we discuss the literature data on similarities and dissimilarities between INP and ENPs with respect to particle characterization, doses and experimental biological effects in various organs, of importance for risk assessment in workers exposed to ENPs.

Oral presentation

BIOMONITORING OF EMERGING PERSISTENT ORGANIC POLLUTANTS IN ENVIRONMENTAL AND OCCUPATIONAL SETTINGS

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Human Biological Monitoring (HBM) has long been used in occupational health as part of a preventive strategy in the medical surveillance of workers. HBM is the measurement of chemicals or their reaction products in human specimens, such as blood, breast milk or urine. Currently, HBM is also increasingly used as a tool in environmental health policy. More than the classical environmental measurements, it makes pollution personal by providing information on individual exposures.

HBM not only provides valuable information on exposure and thereof possible effects on health, but has also a great impact on raising awareness for possibilities of prevention, and serves as a basis for establishing and evaluating policy measures. In particular HBM has potential uses for

- measurement of internal doses
- determination of spatial and temporal trends
- identification of sources and pathways of exposure
- early warning signals about exposure to emerging pollutants
- development of reference values
- identification of populations at risk of elevated exposure

Among the organic environmental toxicants the first class of compounds to which HBM was applied, are the persistent organic pollutants (POPs). Due to their low metabolisation rate and high lipophilicity, they accumulate in adipose tissue and have been detected in breast milk and blood from populations world wide. The Norwegian Institute of Public Health has been involved in HBM of POPs in the Norwegian population for over 20 years. Recent studies have focused on emerging environmental pollutants such as brominated flame retardants (BFRs) and perfluorinated alkyl compounds (PFCs) which are widely used in consumer products. Our investigations have revealed both occupational exposure during handling of products containing these compound classes, as well as a widespread exposure of the general population. Temporal trend studies show that a ban or restriction of chemicals of high concern leads to an instantaneous decrease in human body burdens. Dietary intake, especially of seafood, is regarded as the dominating exposure route for POPs. However, we have recently demonstrated that besides food, indoor environments play a significant role in the exposure to BFRs and PFCs. Body burdens of POPs in Norwegian adults are often lower than in more densely populated industrialised countries. However, there are public health concerns about potential effects following pre- and postnatal exposure to POPs, because of possible toxic impacts during a sensitive period in the development of the organism.

Oral presentation

EXPOSURE ASSESSMENT BY BIOLOGICAL MONITORING FOLLOWING CHEMICAL INCIDENTS. A PROCEDURE FOR DECISION-MAKING

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Determination of the level of exposure during and after a chemical incident is crucial for the assessment of public health risks and for appropriate medical treatment, as well as for subsequent health studies that may be part of disaster management. The aim of this study was to prepare a stepwise procedure for decision making on the use of biological monitoring after chemical incidents.

Input parameters for a stepwise procedure for decision making were identified. Information on parameters relevant for decision making on biomonitoring of fifteen priority substances was retrieved from literature sources.

The persistence of a biomarker in biological tissues, the mechanism of toxicity and the sensitivity of the analysis of a biomarker were identified as the key parameters to support a decision on the feasibility and usefulness of biological monitoring to be applied after an incident involving the release of hazardous chemicals. Methods for rapid decision-making on the usefulness and feasibility of employing biological monitoring are needed. In this contribution, a stepwise procedure for taking such a decision is proposed.

As part of this procedure a simple algorithm is proposed for calculation of the time available for collecting biological materials. When the biomarker follows first order kinetics, the biomarker concentration (C_t) at any time-point after cessation of the exposure (t) can be calculated as $Ct = \frac{Ce}{2^{(ts/t½)}}$ (1), in whichC_e is the concentration of the biomarker at the end of the exposure (estimated by e.g. dispersion modeling),$t½$ is the half-life of this parameter in hours and$t_s$is the time (in hours) lapsed between the end of the exposure at the chemical incident location and the time when the biomarker level is expected to reach C_t. For $C_t \sim LOQ$, equation 1 can be rewritten to $ts \leq t½ \cdot 2\log\left(\frac{Ce}{LOQ}\right)$ (2).

Equation 2 shows that reducing the LOQ for the analysis of the biomarker will increase the time available to set up a biomonitoring campaign and collect the biological materials. For biomarkers that follow zero order elimination (such as hemoglobin adducts) this equation can be simplified to $ts \cong 2 \cdot t½$, if $LOQ << C_e$(see Scheepers et al., 2011).

The use of the proposed procedure will be demonstrated for two case studies based on documented chemical incidents in The Netherlands. A stepwise procedure for decision-making can help to implement a biological monitoring campaign quickly after an incident, especially when key information is collected in advance.

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Scheepers PTJ, Bos PMJ, KoningsJ, Janssen NAH, Grievink L (2011) Application of biological monitoring for exposure assessment following chemical incidents. A procedure for decision-making. J Expo Sci Environ Epidemiol.21(3):247-261.

Oral presentation

SIMULATION OF URINARY EXCRETION OF 1-HYDROXYPYRENE IN VARIOUS SCENARIOS OF EXPOSURE TO POLYCYCLIC AROMATIC HYDROCARBONS WITH A GENERIC, CROSS-CHEMICAL PREDICTIVE PBTK-MODEL

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INTRODUCTION - A Physiologically Based ToxicoKinetic model (PBTK) model can predict blood and urine concentrations, given a certain exposure scenario of inhalation, dermal and/or oral exposure. The recently developed PBTK-model IndusChemFate is a unified model that mimics the uptake, distribution, metabolism and elimination of a chemical in a reference human of 70 kilograms. Prediction of the uptake by inhalation is governed by pulmonary exchange to blood. Oral uptake is simulated as a bolus dose that is taken up at a first order rate. Dermal uptake is estimated by the use of a novel dermal physiologically based module that considers dermal deposition rate and duration of deposition. Moreover, evaporation during skin contact is fully accounted for and related to the volatility of the substance. Partitioning of the chemical and metabolite(s) over blood and tissues is estimated by a Quatitative Structure-Property Relationship (QSPR) algorithm.

EXPERIMENTAL– In the last three decades numerous biomonitoring studies of PAH-exposed humans were published that used the bioindicator 1-hydroxypyrene (1-OH-pyrene) in urine. Longitudinal studies with repeated sampling in time were selected to test the accuracy of the PBTK-model IndusChemFate by comparing the reported concentrations of 1-OHP in urine with the model-predicted values. Two controlled human volunteers studies and three field studies of workers exposed to Polycyclic Aromatic Hydrocarbons (PAH) were included.

RESULTS –The urinary pyrene-metabolite levels of a controlled human inhalation study, a transdermal uptake study of bitumen fume, efficacy of respirator use in electrode paste workers, cokery workers in shale oil industry and a longitudinal study of five coke liquefaction workers were compared to the PBTK-predicted values. The simulations showed that the model-predicted concentrations of urinary pyrene and metabolites over time, as well as peak-concentrations and total excreted amount in different exposure scenarios of inhalation and transdermal exposure were in all comparisons within an order of magnitude. The model predicts that only a very small fraction is excreted in urine as parent pyrene and as free 1-OH-pyrene. The pre-dominant urinary metabolite is 1-OH-pyrene-glucuronide. Enterohepatic circulation of 1-OH-pyrene-glucuronide seems the reason of the delayed release from the body.

CONCLUSIONS – It appeared that urinary excretion of pyrene and pyrene-metabolites in humans is well predictable with the PBTK-model. The model outcomes have a satisfying accuracy for early testing, in so-called *1st tier* simulations and in range finding. This newly developed generic PBTK-model IndusChemFate is a tool that can be used to do early explorations of the significance of uptake of pyrene in the human body following industrial or environmental exposure scenarios. And it can be used to optimize the sampling time and urine sampling frequency of a biomonitoring program.

Oral presentation

DETERMINATION OF DNA ADDUCTS IN SKIN BIOPSIES AND 1-HYDROXYPYRENE IN URINE FOLLOWING TOPICAL APPLICATION OF COAL TAR OINTMENT IN VOLUNTEERS AND PSORIASIS PATIENTS

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Coal tar ointments (CTO) are used for the treatment of psoriasis. CTO contains polycyclic aromatic hydrocarbons (PAH), which are known for their carcinogenic potency and are skin absorbed. The aim of this study is to compare uptake, bioavailability and bio-activation of topically applied PAH in dermatologic ointment in patients and healthy volunteers.
Ten healthy subjects and ten patients with chronic plaque psoriasis received an application of 0.28 g/cm^2 of CTO (14 mg/cm^2 PAH). Biopsies were taken just before and 96 h after treatment. DNA was isolated from skin biopsies and analyzed for PAH-DNA adducts using ^{32}P-postlabelling. 1-Hydroxypyrene was analyzed in urine by HPLC-Fluorescence.

Table 1. Median levels of the sum of PAH-DNA and BPDE-like DNA adducts in volunteers and patients before and after CTO application (in adducts per 10^8 nucleotides).

	Before CTO application (t = 0 h)		After CTO application (t = 96 h)	
	BPDE-DNA adducts	Sum of PAH-DNA adducts	BPDE-DNA adducts	Sum of PAH-DNA adducts
Volunteers	< 0.1	3.5 (1.0-5.2)	8.2 (3.9-13.3)*	21.1 (12.9-29.2)*
Patients	< 0.1	1.0 (0.6-2.9)	1.1 (0.5-6.7)	3.6 (2.1-18.9)

*p < 0.05

Benzo[a]pyrene-diolepoxide (BPDE) like adducts (expressed as medians and ranges in adducts/10^8 nucleotides) increased from non-detectable before application to 8.2 (3.9-13.3) at 96 h in volunteers but only to 1.1 (0.5-6.7) in patients (Table 1). The sum of PAH-DNA adducts increased six fold in healthy volunteers but only four fold in patients. At 96 h BPDE and PAH-DNA levels were higher in healthy volunteers than in patients ($p < 0.05$). After 48 h a twofold higher 1-hydroxypyrene excretion in volunteers, compared with patients, reached statistical significance ($p < 0.05$).
We suppose that the uptake of PAH in psoriatic skin might be slower. Also increased cellular proliferation and DNA-repair activity in the patient's skin may explain the differences in DNA-adduct levels.

Oral presentation

EXHALED BREATH BIOMONITORING USING CAVITY RING-DOWN LASER SPECTROSCOPY

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Due to its non-invasive nature and fast response time, the analysis of exhaled human breath is a promising alternative to urine or blood analysis in biological monitoring. However, for breath analysis to become a routinely used tool for (occupational) health assessment, standardization of sampling techniques and further knowledge on background levels and sources of biomarkers in breath under normal environmental conditions are needed.

Cavity ring-down spectroscopy (CRDS) is an established, highly sensitive and selective laser-based absorption technique. We use a home-built CRDS instrument based on a near-infrared diode laser that enables direct, fast and accurate quantitative detection of biomarkers such as hydrogen cyanide (HCN), acetylene (C_2H_2) and ammonia (NH_3) in air and exhaled breath with detection limits in the sub-parts per billion by volume range. Sample pre-concentration and frequent calibration procedures are not required [1].

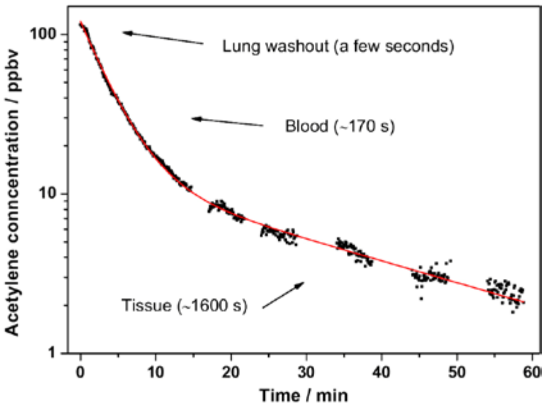

Fig. 1. Decay of breath C_2H_2 after smoking, and residence times in different body compartments.

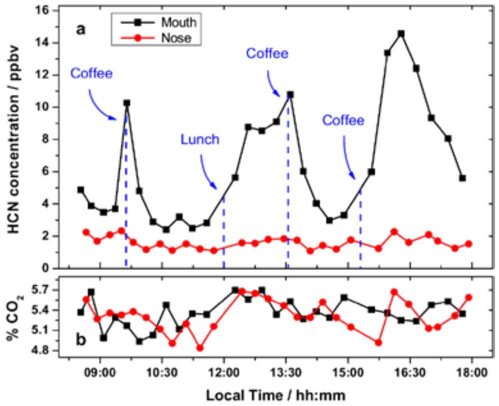

Fig. 2. Typical diurnal variations of HCN (a) and CO_2 (b) in alveolar mouth and nose breath.

The CRDS spectrometer was recently used to monitor C_2H_2 in Helsinki indoor and outdoor air [1], to establish the background levels of C_2H_2 in the exhaled breath of the healthy population [2], and for real-time elimination kinetics measurements of breath C_2H_2 after smoking [2]. In the latest measurement campaign, the background levels and diurnal variations of HCN in breath and skin gas were investigated using different sampling techniques. Furthermore, the decay of HCN in the breath of volunteers who had been exposed to 10 $\mu g/m^3$ of HCN in air for one minute was studied in real-time. The decay data can be interpreted with a pharmacokinetic model relating time constants (residence times) to different compartments (such as blood and tissues) of the body.

1. F. M. Schmidt *et al.*, Appl. Phys. B, **101**, 671–682 (2010).
2. M. Metsälä *et al.*, J. Breath Res. **4**, 046003 (2010).

Oral presentation

STATE OF THE ART IN BIOAEROSOL RESEARCH – IMPLICATIONS FOR EXPOSURE ASSESSMENT

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Background: The first measurements of airborne microorganisms were published by Louis Pasteur in 1861 using both microscopic and cultivation methods. A century later human challenge studies showed that inhalation of spores from thermophilic actinomycetes and fungi could induce attacks of farmers lung in patients, and in the 1970-80ties exposure to Gram-negative bacteria and their endotoxins were identified as the most likely causal agents for byssinosis in cotton workers. Since then, epidemiological and toxicological studies have demonstrated the role of many different agents in inflammatory respiratory diseases and effects, including house dust mites, pollen, enzymes, and allergens originating from insects, mites, micro-organisms, animals and plants.
Measurements methods: Airborne fungi and bacteria can be quantified by cultivation and non-culture based methods. However, the focus on culture techniques diminished with the understanding that dead micro-organisms could induce responses similar to the viable organisms. The quantification of bioaerosol agents is complicated by the diversity of these agents. Microorganisms represent a highly diverse group and different species may not be expected to have the same toxicity. But even the chemical structure of endotoxins, toxic molecules that are located in the outer cell wall of Gram-negative bacteria, differ between species. Endotoxins are therefore assessed by an assay that compares the endotoxin activity to a reference endotoxin from *E. coli* using the *Limulus* amebocyte lysate (LAL) assay. Allergens are typically characterized by immune-chemical methods such as enzyme-linked immune-sorbent assays (ELISA).
Risk assessment and exposure limits. The risk assessment of bioaerosol exposed workers is limited by the lack of exposure limits. For endotoxins an occupational exposure limit of 90 endotoxin units/m^3 has been proposed in the Netherlands. For fungal spores from non-pathogenic and not mycotoxin producing species, a lower observed effect level of 100,000 spores/m^3 has been proposed in an extensive review of the litterature. For other agents risk assessments can only be based on information from relevant epidemiological studies.
Future developments: Recently the Organic Dust Tromsø Symposium was organized in Norway, where the state of the art was presented by prominent scientists in this field. Several new developments were presented. Multiple resistant *Staphylococcus aureus* strains were measured by molecular biological methods and were shown to be transmitted from swine to humans in several studies as well as their presence in outdoor air. Fragments smaller than spores have been shown to be released from fungal colonies, which has initiated studies into their occurrence and health effects as well as of larger hyphal fragments, which mainly have been neglected. Recent studies using molecular biological methods have shown the presence of previous unnoticed micro-organisms such as the Archaebacteria in high concentrations in animal houses. Biodiversity of microorganisms assessed in genomic studies have shown promising results in asthma research. New/improved methods for quantification of fungal antigens, proteases, other enzymes and allergens were also presented. These new developments will improve the toolbox available for exposure assessment in future studies.
Conclusions: The exposure assessment of bioaerosol exposed populations is still in a developmental stage. Only for endotoxins and fungal spores have exposure criteria been proposed. The complex composition of bioaerosols represent a major challenge for future risk assessments. However, the field is rapidly progressing.

Oral presentation

DEVELOPMENT OF SAMPLING METHODS FOR MYCOTOXINS IN WORKPLACE AIR

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Mycotoxins have received increasing interest for food safety, as they are not only toxic for liver and kidney, but also suspected or confirmed carcinogens. In poor hygienic or environmental conditions prior to harvest or during storage, some types of fungi can grow on cereals, coffee beans and nuts and contaminate them with a metabolite they produce : ochratoxin A, fumonisine or aflatoxin (among the most known species). To protect humans and animals, the European Union enacted maximum allowable limits for levels in food. But mycotoxins can be probably inhaled through airborne particulates of contaminated materials and workers could be exposed whenever they store, load, handle or mill contaminated materials. Yet, until a few years ago, only scarce studies were related to the impact of mycotoxins in workplace air, with so heterogeneous results that it is still impossible to conclude about their significance in workers diseases.

Our aim is to use our knowledge in the field of aerosol sampling and the improvements in sample purification to develop and validate user-friendly and sensitive monitoring methods for the most frequently occurring mycotoxins. We make these methods available to laboratories which carry out field measurements. Their data will be later used by the scientific community to evaluate the risk of mycotoxins inhalation and the need to study their mechanism of action by this route.

One of the strong points of our study was to perform the sampling task in an artificial dusty atmosphere, generated from naturally contaminated material. The particle size distribution was determined in raw material and airborne dust. The samples were collected on a polyurethan foam inside the rotating cup of the Individual Sensor for Dust (CIP10), validated for the inhalable health-related aerosol fraction sampling with a flow rate of 10 L min^{-1}. With this important flow rate, the accumulation of dust is more important and is well fitted with a low mycotoxin concentration. The substances were recovered from the sampling media and the inside part of the cup in a solvent mixture. The extracted solutions were then purified and concentrated through a solid-phase extraction (SPE) cartridge, like an immunoaffinity column (IAC) or a molecularly imprinted polymer (MIP). Conventional SPE protocols have been adapted with respect to the sample weight (as low as 30 pg) as this critical step strongly affects the recovery yield. Until now, our methods are based on the use of liquid chromatography and fluorescence detection with a native fluorescence for some mycotoxins or pre- or post-column derivation for others. The results indicate a satisfactory collection efficiency and a good analytical recovery. We observed that contamination of airborne flour dust is much higher than contamination of raw flour, and thus the risk of exposure also. We explained it with the airborne particulates coming mainly from grain shell, the most contaminated part of the grain. The methods are reproducible and reliable enough to be adopted by occupational “routine” laboratories. Field measurements of ochratoxin A and fumonisins B1 and B2 were performed in a commercial sea-port. Even if it is always difficult to identify *a priori* the presence of this type of contaminants in grains or other raw materials, the results demonstrated that the CIP-10 personal sampler was very suitable for measuring the exposure of workers to mycotoxins.

Oral presentation

DOCUMENTATION OF BIOAEROSOL CONCENTRATIONS IN INDOOR COMPOSTING FACILITIES IN FRANCE

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Concentrations of airborne cultivable microorganisms and endotoxins were investigated in 10 indoor composting facilities differing by the organic matters being processed (household wastes, industrial and sewage sludges and residential organic wastes, green waste), the process used (aeration, type of mechanical) and the level of confinement. Stationary bioaerosol samples were collected by filtration for the analysis of mesophilic bacteria (25°C, TSA+actidione), thermophilic bacteria (56°C, TSA), mesophilic fungi (25°C, MEA), thermophilic fungi (47°C, MEA) and endotoxins (LAL). A wide range of bioaerosol concentrations was measured during the survey, from below the detection limit to 10^8 CFU/m^3 for cultivable microorganisms and to 27 500 EU/m^3 for endotoxins. Indeed, the concentrations were highly variable due to a number of influencing factors such as composting site, type of waste, working tasks, stage of composting and meteorological conditions. The coefficient of variation calculated individually for each sampling point varies from 1 to 1000 %, from one day to another and over a whole working day (successive 30 minutes samples). The agitation of compost during the process (shredding, turning, screening…) clearly appears to be one of the most important source producing bioaerosols. This is illustrated with data from one compositing site where the concentrations of thermophilic microorganisms during turning of a compost pile were significantly higher than those measured before pile turning (figure 1). The overall correlation coefficient (when considering all the data collected on the 10 composting facilities) was high between mesophilic and thermophilic bacteria (r^2 = 0,57; n = 179), as indicated in figure 2. It was moderate between mesophilic and thermophilic fungi (r^2 = 0,28 ; n = 179) and between endotoxins and mesophilic bacteria (r^2 = 0,37 ; n = 166). Correlations between the different microbial parameters differed considerably from a composting facility to another, ranging from no correlation to very strong correlation. These results constitute new data that will be helpful for the setting of a sampling strategy for bioaerosol exposure measurement in composting facilities. They also seat the filtration sampling method as a useful tool for studying bioaerosols in that occupational environment.

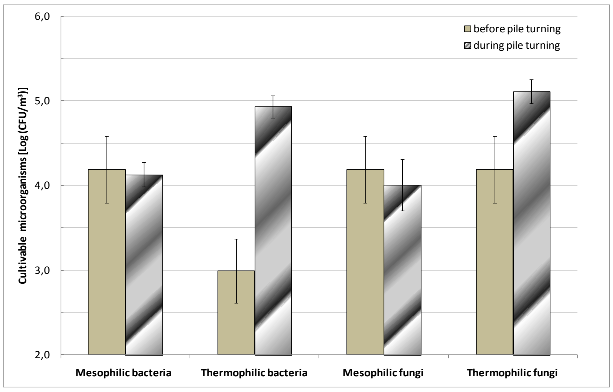

Fig 1

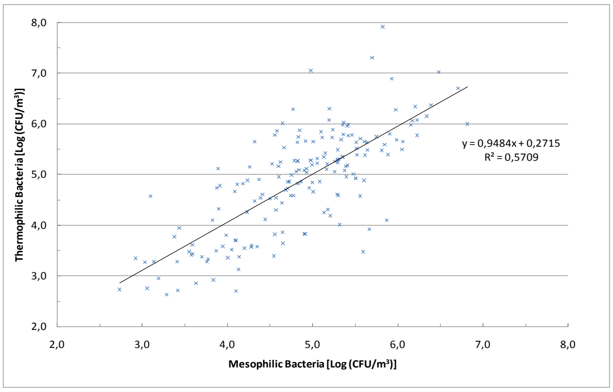

Fig 2

Oral presentation

ESTIMATION OF THE CONSUMER INHALATION RISK OF WATERPROOFING AEROSOLS

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Waterproofing sprays are widely used consumer products for the treatment of leather, textiles or indoor surfaces such as tiles and glass. The surface active substances are for example fluorinated polymers or silicon based compounds dissolved in alcohols or volatile petroleum distillates. The formulation is released either by a pump spray technique or using propellants such as propane or butane. There have been repeated reports on cases of severe acute respiratory disorders especially when using products that newly entered the market. These new products were often slightly modified versions of previously safe sprays. It is hypothesized that impairment of the pulmonary surfactant by deposition of inhaled respirable particles of the active compound is one of the main causes of the acute lung injury. Since the inhalation toxicity cannot be predicted a priori based on the physical chemical properties of the formulation, proper test strategies are required to ensure consumer safety.

In this presentation we propose a screening test addressing both, exposure and acute lung toxicity. The exposure potential of the spray product is characterized by determining the release fraction of the active compound in the respirable particle size range under conditions relevant for the product application. This is carried out by spraying defined quantities of the product into a control volume and measuring the concentration of health related size fractions of the aged aerosol. This is different from measurement of the droplet spectrum of the spray since it takes into account size reduction of the droplets due to solvent evaporation.

The isolated perfused lung is used as a model for testing acute toxicity. In this test ventilated rat lungs are exposed to aged aerosols generated from the liquid spray formulation. Respiratory parameters such as lung compliance and lung resistance are continuously monitored during exposure. Dose dependent deviations of the read-out parameters from the normal values (without exposure) caused for example by impairment of the surfactant layer are used for assessment of the acute lung toxicity. At the end a histological assessment of the lung is carried out.

Using the combined procedure, different sprays could be ranked according to their realistic exposure risk and, most importantly, sprays with known lung toxicity could be uniquely distinguished from those that have been shown to be safe. In its current stage of development the simple test method is recommended for screening of substances only.

Oral presentation

HOT BITUMEN EMISSION EXPOSURE - EUROPEAN DATA AND COMPARISON OF DIFFERENT FIELD MONITORING METHODS

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Approximately 85% of all bitumen production is used for paving and about 10% for roofing. The remaining 5% includes various bitumen products such as cutbacks, emulsified bitumen, paints and mastic asphalt (of particular importance in German-speaking countries). During most of these applications, bitumen and its products are heated to temperatures above 100°C. Since workers are potentially exposed to aerosol and vapour emissions from bitumen, many exposure monitoring studies have been conducted. Bitumen emissions consists of numerous compounds which can vary in composition depending on the source of the crude oil and the manufacturing conditions of the bitumen itself and its products. Elucidation of all the compounds present is not a practical goal for exposure monitoring. Therefore, various summation measures have been developed to estimate the exposure and hence in several countries there exist different threshold limit values.

In view of the variety of the international approaches for measuring the emissions from hot bitumen (i.e., differences in collection, analysis, measuring strategy, manufacturing processes and threshold limit values which are related to different fractions) there exists uncertainty as to the comparability of air-monitoring values reported in the literature. This is a question of substantial importance when comparing or pooling data from different scientific studies. Therefore, in addition to an inter-laboratory study [1], parallel measurements in the field with common measuring systems were performed at multiple bitumen-related workplaces (paving of rolled asphalt, mastic asphalt, manufacture and application of bitumen membranes) on construction-sites in several countries [2]. This study confirms a relationship in principle between the measuring techniques used.

The possibilities and limitations of an exposure assessment based on different measuring methods for bitumen emissions are discussed using examples of selected European data. Special attention is devoted to the influence of sampling techniques (effect of the sampling device, flow rate); analytical processes including solvents, calibration standards, confounding substances; measurement strategy (task-relation vs. shift relation); and benchmarking of exposure levels with different threshold limit values.

[1] Ekström, L. G.; Kriech, A.; Bowen, C.; Johnson, S.; Breuer, D.; J Environ Monit. 3 (2001), 439-45
[2] Kriech, A. J.; Emmel, C.; Osborn, L. V.; Breuer, D.; Redman, A. P.; Höber, D.; Bochmann, F.; Rühl, R.: J Occup Environ Hyg. 7 (2010), 712–725

Oral presentation

ENVIRONMENTAL TOBACCO SMOKE AT THE WORKPLACE

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The smoking of cigarettes, cigars, cigarillos or pipes produces a highly complex mixture of over 4,000 compounds which has been shown to present a hazard even to non-smokers. Owing to their large number, it is impossible for all of these compounds to be studied. Nicotine has proved to be a suitable indicator substance for tobacco smoke. Past studies were primarily conducted in the catering sector, and in isolated cases in offices. DGUV and the German Social Accident Insurance Institutions now considers all working areas, particularly those in which continual exposure to tobacco smoke or very high exposure peaks of short duration may be assumed. The data used for calculation were compiled with reference to the microcensus statistics on the smoking habits of the German population published by the German Federal Office of Statistics. A light smoker smokes up to five cigarettes a day, a normal smoker up to 20 and a heavy smoker approximately 35, half of which are smoked at the workplace. The calculations for the catering sector are based upon experience gained by the German Social Accident Insurance Institution for the foodstuffs industry and the catering trade.

The tobacco smoke exposure is estimated for several exemplary cases. Very high levels of exposure to tobacco smoke were observed in the catering sector at unfavourable ratios of the number of guests to the size of the room, as is for example the case in discotheques or small pubs. In the restaurant sector, lower exposure levels were observed owing to the more favourable ratio of the number of customers to the size of the rooms; in offices without ventilation equipment, concentrations were observed in the winter with the doors and windows closed that were the same as in the parts of the catering sector exhibiting higher exposure. In special areas, such as control rooms, foremen's offices, break rooms and drivers' cabs in the commercial transport sector, considerable exposure levels were observed briefly or even over entire shifts; corresponding levels doubtless also occurred in the smoking compartments on trains or in the smoking sections of airliners. The exposure to tobacco smoke in outdoor areas such as the open-air catering sector or in larger production shops is largely negligible.

Oral presentation

SCREENING OF DEPOSITED AIRBORNE EMISSIONS, SPILL AND LEAKAGE OF ANTIBIOTICS IN SWEDISH HOSPITALS

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This presentation summarizes a two-phase study of the occurrence of deposited airborne emission, spill and leakage of twelve substances present as active components in frequently used antibiotics has been carried out.[1] The first phase was a screening of the antibiotic substances at 21 hospital wards in 16 hospitals. Phase two was an extended investigation where different measures to reduce airborne emissions, spill and leakage were implemented and a follow-up screening was made to evaluate the effect of the measures. The efficiency of the general cleaning procedures was also investigated.

At the basic screening, 206 wipe samples were collected from various surfaces using a validated wipe sampling procedure. The samples were analyzed using high performance liquid chromatography tandem mass spectrometry (HPLC-MS/MS).[2] The result was used to classify the wards into four classes: *Low*, *Mean*, *High* and *Very high* contamination level. Spatial distribution patterns and the effect of compounding systems were also investigated. The screening showed that spill and leakage occur at all wards. Eleven of the 21 wards showed a *High* or *Very high* contamination level. This result also showed that the substances were distributed according to three possible patterns. Moreover, the compounding system used was found to have an impact on the spill and leakage. All four wards that used a closed compounding system were found among the six wards with the lowest contamination level, while all three wards that used open venting systems for compounding were found among the six wards with the highest contamination level. Another finding from the result was that it is possible to handle antibiotics with only insignificant airborne emissions, spill and leakage, i.e., by using a closed compounding system.

Three wards, classified as having *Very high* contamination level, were included in the second phase. Measures to decrease airborne emission, spill and leakage and to reduce the distribution of the substances were implemented. After two month, a follow-up screening was carried out. The result showed lower contamination levels at all three wards and the implemented measures had some effect. The cleaning procedure, however, did not show to be efficient in removing these substances from contaminated surfaces.

Simple and easy-to-do measures can contribute to reduce the occurrence of airborne emission, spill and leakage. There is still, however, a need to discuss how to handle antibiotics in a safe way to reduce possible airborne emission, spill and leakage and to prevent the spatial distribution of this contamination to secondary surfaces.

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[1] Nygren O, Lindahl R. Screening of spill and leakage of antibiotics in hospital wards. *J ASTM International*, accepted 2011.

[2] Nygren O, Lindahl R. Development of a method for screening spill and leakage of antibiotics on surfaces based on wipe sampling and HPLC-MS/MS analysis. *J ASTM International* accepted 2011

Oral presentation

PARTICLE AND NANOPARTICLE EXPOSURE DURING GRINDING, BRAZING AND WELDING ACTIVITIES IN A MECHANICAL ENGINEERING FACTORY

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Welding is a major industrial process used for joining metals, brazing is a versatile thermal joining process in which a molten brazing filler metal is drawn into a capillary gap between the metals being joined and grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material. Although these activities are essential in several industrial sectors, they determine the formation of different types of airborne particulate matter to which workers are exposed. In fact, in literature there are a number of studies that assessed this kind of exposure and investigated its potential adverse health effects. However, in recent years concern has arisen regarding the potential exposure of workers to nanoparticles (NPs) during welding, brazing and grinding activities. In fact, as a result of their small size (according to ISO/TS 27687 a NP is a nano-object with all three external dimensions in a size ranging from approximately 1–100 nm) and unique physicochemical properties, the toxicological profiles of NPs may differ considerably from those of larger particles composed of the same materials. For this reason, in this study we have performed, in different departments of a mechanical engineering factory, an occupational health monitoring, according to EN 481, of inhalable, thoracic, and alveolic mass fractions and of NPs with aerodynamic diameter greater than 25 nm. We used the NanoCheck^{TM} 1.320 (Grimm Aerosol Technik, Ainring, Germany) in combination with a Grimm Aerosol Spectrometer 1.109, to monitor the full aerosol size range from a few nanometers (25 nm) up to 30 μm in different size channels. The samplings, each lasting approximately 1 hour, were carried out in different departments of the factory to assess the exposure to airborne particulate matter at different workstations. In particular, measurements were performed in the departments where welding, brazing and grinding activities were performed. All the investigated workstations were equipped with ventilation ducts located at the top of the workbench. In order to achieve true breathing zone samplings, the instrument sampling head was located very close to the worker's breathing zone. During grinding activities, the mean levels of inhalable, thoracic, and alveolic mass fractions were 75.6, 45.4 and 25.4 $\mu g/m^3$, respectively and the NP number concentration was in the range of 1.79×10^7 particles/l with a geometric mean size of 60.4 nm and geometric standard deviation of 13.7. The levels of inhalable, thoracic, and alveolic mass fractions were similar during welding activities with mean values of 63.8, 46.4 and 26.9 $\mu g/m^3$, respectively, but the NP number concentration was significantly lower, in the range of 5.9×10^6 particles/l with a geometric mean size of 80.6 nm and geometric standard deviation of 7.8. However, the lowest levels of inhalable, thoracic, and alveolic mass fractions (55.5, 35.8 and 20.6 $\mu g/m^3$) but the highest NP number concentration (1.06×10^7 particles/l with a geometric mean size of 63.4 nm and geometric standard deviation of 5.3) were found during brazing activities. These results showed that during welding, brazing and grinding activities there is an occupational exposure to NPs with an aerodynamic diameter in the range of 60 – 80 nm. Modification of the existing ventilation methods or the adoption of additional ventilation systems, such as ventilation ducts located below the work bench, could significantly limit the exposure of workers to inhalable, thoracic, and alveolic mass fractions of particulate matter and to NPs.

Short course

WORKING PRINCIPLES OF DIRECT READING AEROSOL MONITORS

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Many kinds of direct reading methods are used for real time aerosol monitoring. They are based on different principles. First series of instruments uses classical sampling combined with automatic weighing of filter. The automatic weighing is based either on β ray attenuation or on the effect of piezoelectricity. Triboelectricity is also used, but for higher concentrations, essentially in aspiration exhausts. The most numerous methods for airborne particle detection and measurement are optical methods. They use optical properties of airborne particles to detect them and to measure their size and concentration. They are based on the principle of light attenuation or they take advantage of light beam- particle interaction (light scattering). Most of current light scattering devices are photometers and optical particle counters. Condensation particle counters take also place among scattering devices but before optical detection, particles are artificially grown by vapour condensation.

Size resolved methods used for the assessment of submicron particles can be based on low pressure impaction, diffusion mechanism or electrical mobility analysis. Global concentration measurement of these particles is mostly based on electrical methods (diffusion charges), allowing assessing particle surface-area.

Short course

SIZE SELECTIVE AEROSOL SAMPLING IN OCCUPATIONAL HYGIENE

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Aerosols of different size penetrate to different regions in the respiratory tract. Certain diseases are located to these sub-regions, e.g. silicosis to the alveolar region. This leads directly to the concept of size-selective sampling and assessment of exposure. Subsequently, occupational exposure limits are oriented against these size fractions. International standards like ISO 7708 and EN 481 describe these fractions in dependence of the aerodynamic diameter. They include the inhalable, thoracic and respirable dust fraction. Limit values exist for inhalable and respirable dust, if not otherwise toxic, in a lot of countries. Sampling methods are described in national manuals like the NIOSH methods 0600 for respirable dust and 0500 for total dust, the MDHS 14/3 in UK, the German IFA-Folder (IFA-Arbeitsmappe) or even in a CEN document TR 15230. Personal sampling is to be preferred instead of stationary sampling in order to effectively assess the personal exposure in comparison with limit values. A sampling time of several hours up to a whole shift is performed to get enough dust mass on the filter for subsequent analysis. At least a gravimetric analysis is to be carried out, but also elemental chemical analysis can be performed for proof of toxic elements. A sampler for the inhalable dust fraction shall be able to collect particles up to 100 µm. An evaluation of different personal samplers can be found in [Kenny1997]. For the selection of fractions comprising smaller particles (thoracic, respirable) can be achieved in applying different aerodynamic principles like centrifugal forces in cyclones, impaction on plates, elutriation or sedimentation in vertical or horizontal direction or retention in foams. Apart from these sampling methods, direct reading monitors can be applied to measure dust fractions. Optical methods like light scattering are widely applied but are limited in assessing a mass of aerosols. An instrument using an oscillating microbalance is better suited for determinng the mass directly. Particles in the sub-micrometer range will be assessed differently, because the surface area and the number concentration play a more important role for their health impact. This requires separate measurement methods (see ISO/TR 27628).

ISO 7708:1995: Air quality - Particle size fraction definitions for health-related sampling
EN 481:1993: Workplace atmospheres; size fraction definitions for measurement of airborne particles
CEN/TR 15230:2005: Workplace atmospheres - Guidance for sampling of inhalable, thoracic and respirable aerosol fractions
Kenny 1997: L.C. Kenny et al.: A collaborative European study of personal inhalable aerosol sampler performance, Ann. occup. Hyg., Vol 41, No 2, pp 135-153, 1997
ISO/TR 27628:2007: Workplace atmospheres -- Ultrafine, nanoparticle and nano-structured aerosols -- Inhalation exposure characterization and assessment

Short course

BIOAEROSOL ASSESSMENT – ANALYSIS, SAMPLING METHODS AND STRATEGY

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Bioaerosol sampling and analysis is an important step for the evaluation of occupational exposure to bioaerosols. Ideally, the measurement method should allow a quantitative (quantification of relevant microbial groups) and qualitative (identification of bacteria and fungi to genus and species) evaluation of the risk. Indeed, bioaerosol assessment requires adequate sampling and analytical methods. The presentation browses the principal methods that can be used for sampling bacterial and fungal bioaerosols and for their subsequent analysis. Several sampling methods can be used to monitor microorganisms in the air. Bioaerosols are generally sampled by aspiration of the air and by separation of the particles from the air stream. The most common methods are based on air filtration, particle impaction and sampling into a liquid media. The choice of sampling method (single stage impactors, cascade agar impactors, centrifugal agar sampler, liquid Impingers, CIP 10-M centrifugal liquid sampler and membrane filter cassette sampler) depends on the expected biological agents, the supposed aerosol concentration, and the analytical method to be used. The performance of sampling methods should be taken into account. The physical and biological efficiency are the most important parameters of sampler performance. The limits of detection and saturation should be also known. The flow rate of the sampler should be correctly measured and calibrated. The bacterial and fungal abundance in air samples can be analysed by counting microbial cells or by analysing the microbial components, metabolites and by-products. Despite its limits, culture is the most commonly used method for counting viable and cultivable microorganisms as Colony Forming Units (CFU). The identification of individual colonies can be performed according to morphological, biochemical or molecular criteria. Methods for counting dead and viable microbial cells, including “Epifluorescent Microscopy”, “Electronic Microscopy” and “Flow Cytometry” provide additional information. Microbial components can be analysed using bioassays, like immuno-assays for allergens and the Limulus Amoebocyte Lisate (LAL) test for the endotoxins and the glucans. High Performance Liquid Chromatoraphy (HPLC), Gaz Chromatograpy (GC) and Mass Spectroscopy (MS) are used singly or in combination to quantify and identify “chemical markers” (ergosterol) and toxins (mycotoxins). A growing interest is expected in the next years for molecular techniques, such as Polymerase Chain Reaction (PCR). Thus, numerous methods are available for the measurement of microbial aerosols but they are not equally characterised and standardised. After a brief description of these methods, the presentation discuses their degree of standardisation, development and the information they provide. We focus on concrete examples to illustrate the utility of the main available methods and discuss handling and preservation of samples. The practical approach is amended with recent progress on the development of rapid, sensitive and specific methods (PCR, combined methods) for the measurement of exposure to bioaerosols at workplace.

Oral presentation

INTERLABORATORY EVALUATION OF INDUCTIVELY COUPLED-PLASMA MASS SPECTROMETRY FOR THE DETERMINATION OF TRACE ELEMENTS IN WORKPLACE AIR FILTER SAMPLES

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Inductively coupled plasma – mass spectrometry (ICP-MS) is becoming more widely used for trace elemental analysis in the occupational hygiene field, and consequently new ICP-MS international standard procedures have been promulgated by ASTM International and ISO. However, there is a dearth of interlaboratory performance data for this analytical methodology. In an effort to fill this data void, an interlaboratory evaluation of ICP-MS for determining trace elements in workplace air samples was conducted, towards fulfillment of method validation requirements for international voluntary consensus standard test methods. The interlaboratory study (ILS) was performed in accordance with an applicable ASTM International standard practice, ASTM E691, which describes statistical procedures for investigating interlaboratory precision. The evaluation was carried out using certified 37-mm diameter mixed-cellulose ester (MCE) filters that were fortified with 21 elements of concern in occupational hygiene. Elements were spiked at levels ranging from 0.025 to10 µg/filter, with three different filter loadings denoted "low", "medium" and "high". Participating laboratories were recruited from a pool of over fifty invitees; ultimately twenty laboratories from Europe, North America and Asia submitted ILS results. Triplicates of each certified filter with elemental contents at three different levels, plus media blanks spiked with reagent, were conveyed to each volunteer laboratory, along with a copy of the test method which each participant was asked to follow; spiking levels were unknown to the participants. The laboratories were requested to prepare the filters by one of three sample preparation procedures, i.e., hotplate digestion, microwave digestion or hot block extraction, which were described in the test method. Participants were then asked to analyze aliquots of the prepared samples by ICP-MS, and to report their data in units of µg/filter sample. Most interlaboratory precision estimates were acceptable for medium-level spikes (RSD <20%) but generally yielded greater uncertainties than were anticipated at the outset of the study.

Oral presentation

WORKPLACE AEROSOL MASS-CONCENTRATION MEASUREMENT USING AN OPTICAL PARTICLE COUNTER

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Direct-reading aerosol measurement usually uses the optical properties of airborne particles to detect and measure the particle concentration. In the case of occupational hygiene, measurement of mass concentration is often required. Two aerosol monitoring methods are based on the light scattering principle: Optical particle counter (COP) and photometer. The first analyses the light scattered by a single particle, the second that by a cloud of particles. Both methods need calibration to transform the quantity of scattered light detected into particle concentration. Photometers are simpler to use and can be directly calibrated to measure mass concentration. However, their response varies not only with aerosol concentration but also with particle size-distribution, which frequently contributes to biased measurement.

Optical particle counters directly measure a number particle concentration and particle size allowing assessment of the particle mass, provided the particles are spherical and of known density. An integrating algorithm is used to calculate mass concentration of any conventional health-related aerosol fraction. The concentrations calculated in this manner have been compared with simultaneous measurements by conventional gravimetric sampling.

Aerosol concentrations were measured in the food industry by the OPC GRIMM 1.108 and by the CIP 10 “Inhalable” and CIP 10 “Respirable” (ARELCO®) aerosol samplers while meat sausages were being brushed and coated by calcium carbonate. Previously, the original OPC inlet had been adapted to sample inhalable aerosol. A mixed aerosol of calcium carbonate and fungi spores was present in the workplace. The OPC particle-size distribution and an estimated average particle density of both aerosol components were used to calculate the mass concentration. The results are presented as follows:

Mass concentration	OPC calculated (mg.m^{-3})	CIP 10 sampled (mg.m^{-3})	OPC sampled* (mg.m^{-3})
Inhalable fraction	10.0	10.1	11.2
Respirable fraction	2.4	2.04	
Thoracic fraction	6.8		

*The OPC outlet filter was used to weight the OPC sampled particles.

The concentrations reported are time-weighted average concentrations from two days of measurement. The inhalable and respirable aerosol fractions calculated from the OPC data are closely correlated with the results of particle size-selective sampling by CIP10. Furthermore, the OPC data allow calculation of the thoracic fraction of workplace aerosol (not measured by sampling), which is interesting in the presence of allergenic particles like fungi spores. The results also show that the inhalable aerosol sampling efficiency of the OPC (modified inlet) is quite high. This study served as a pre-normative scientific background for the CEN (Comité Européenne de Normalisation) standardisation process preparing a guide for the use of direct reading instruments for aerosol monitoring.

Oral presentation

MULTIPARAMETRIC APPROACH AS A TOOL FOR THE EVALUATION OF NANOPARTICLE EMISSIONS FROM LASER PRINTERS IN THE PROFESSIONAL EXPOSURE ASSESSMENT

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Recently published studies focused on potential sources of indoor unintentionally formed nanoparticles (NPs), e.g. from combustion processes, have evidenced that laser printers and photocopiers release, during the heating in printing processes, substances that represent a human health hazard. Generally, the evaluation of occupational exposure to NPs in workplaces needs dimensional and chemical characterization. However, the main problem is linked to the choice of the appropriate sampling and dimensional separation techniques. Therefore, a convenient multiparametric approach to improve the knowledge on NPs exposure from laser printers is characterized by the contemporary use of different sampling, measuring and chemical analysis instrumentations. In the present work, as the study performed on a single predominant source allows to overcome the problems connected with the simultaneous contributions of different and time dependent sources, for the evaluation of professional exposure to NP preliminary results of emissions from isolated laser printers (different in brands and in toner's age), obtained by measures performed in an experimental box-chamber, are reported and discussed. In particular, in order to combine chemical and dimensional results, the experimental design has included: size-resolved characterization measurements (by a Fast Mobility Particle Sizer -FMPS) and the chemical characterization, obtained on size-segregated particles collected by multistage cascade impactor (NanoMoudi 122R), was performed by an Inductively Plasma Mass Spectrometer (ICP-MS) and a Gas-Chromatography Mass (GC-MS) respectively for the detection of metal ions (by which toners are charged) and Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs). Size segregated samples were also analysed by Scanning Electron Microscope (SEM) in order to correlate the obtained chemical results with morphological information (e.g. relating the formation of aggregates and/or agglomerates of NPs). Furthermore, fluctuations of ozone and VOCs concentrations inside the experimental box during the printing process, were detected by a photometric gas analyzer (Thermo Environmental Instrument 49C Ozone Analyzer) and a photoionization detector (PID) (MultiRae IR-Multi-GAS MONITOR PGM-54) respectively, whilst changes in temperature and humidity were checked by a microclimatic control instrumentation (BABUC). The standardisation of the multiparametric approach proposed can represent a valid support for the overall characterization of particles emitted from specific sources (such as laser printers) and for the arrangement of appropriate prevention and protection interventions which fulfill high standards of occupational health and safety of workers. Furthermore, the results obtained by the application of this approach can be considered a useful tool for the definition of Occupational Exposure Limit Values for NPs and, for this purpose, future efforts should be directed to study the complementary of different kinds of measurements.

Oral presentation

PERFORMANCE EVALUATION OF TWO COMMERCIAL CHEMILUMINESCENCE NO_X ANALYZERS ACCORDING TO STANDARD EN 14211

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Air pollution data quality improvement and assurance are issues of major concern in the European Union (EU). Directive 2008/50/EC establishes new standards for the reference methods for measuring NO_x, NO_2, SO_2, O_3, CO and benzene in air, which include a broad section about type-approval. Thus, all the automatic analyzers of these gases commercialized in the EU for air monitoring purposes according to the above-mentioned Directive must be approved type.

To assess the performance of current NO_x analyzers with respect to the Standard EN 14211:2005 (*Ambient air quality- Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen oxides by chemiluminescence*), two NO_x analyzers (Thermo Scientific 42i and SIR S5012, models widely used in air quality networks in Spain) have been subjected to the type-approval test. This test consists of performing laboratory and field tests and calculating the expanded uncertainty of measurements in the NO_2 hourly limit value.

Neither of the tested analyzers passed the type-approval test satisfactorily. The performance criteria not met by each of the analyzers are shown in Table 1.

Table 1.- Criteria not met by each of the tested analyzers.

Thermo Scientific 42i (TS)	**SIR S5012 (SIR)**
Water vapour interference	Difference in response times
Ozone interference	Water vapour interference
Long term drift	Ozone interference
	Long term drift

With respect to the uncertainty calculation, we obtained expanded uncertainties of 54.4% for TS and 60.8% for SIR; these values are 3 to 4 times higher than the maximum uncertainty permitted by the legislation (15%).

Although both analyzers failed to meet some of the requirements, the test and calculation procedures of the Standard were found to be questionable in some cases. Discussion of these aspects is also carried out and a new uncertainty calculation is given.

Oral presentation

LONG-TERM DUST EXPOSURE AND METAL PARTICLE CHARACTERIZATION IN STAINLESS STEEL MELTING

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The production volumes of stainless steel are growing steadily. Most of the new production units are built in Asia. The growth of capacity means that the number of exposed workers is increasing all over the world. All stainless steels contain iron and chromium. Austenitic stainless steels contain also nickel, and acid resistant steels molybdenum in addition.

Outokumpu Group started to produce stainless steel in 1976. Today Outokumpu's Tornio Works is the most integrated stainless steel production site and among the four largest ones in the world. Occupational exposure data has been collected ever since the beginning. The data include exposure to total dust, contents of various metal compounds in the dust, particle size distribution and electron microscopic examinations.

The stainless steel plant has an in-house occupational health unit, which has monitored continuously health of the workers including biological monitoring.

The presentation will first review detailed exposure data from 1976 to 2010 with special reference to the effect of technical process improvements on the decrease of exposure levels. These workplace air measurement results will be linked with data on biological monitoring and clinical examinations of the workers.

In co-operation with the Center of Microscopy and Nanotechnology of the University of Oulu a study on metal particles smaller than 10 µm was carried out in 2011. The aim of the study was to obtain new information on the chemical composition of the metal particles. The samples for SEM-EDS study were prepared from mixture of dust and epoxy which was polished in order to be able to study also the core of 0,5-10 µm diameter particles. The results indicate that the metal particles in the ambient air in the stainless steel melting shop consist mainly of stainless steel either austenitic steel or ferrite steel following the melting process. Particles were mostly more or less spherical, chemically homogeneous and slightly cracked.

Oral presentation

DETERMINATION OF A LARGE VARIETY OF AMINES IN AIR SAMPLES USING MIDGET IMPINGERS SAMPLING FOLLOWED BY ANALYSIS WITH ION CHROMATOGRAPHY IN TANDEM WITH MASS SPECTROMETRY

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A method has been developed for the determination of a large variety of amines in air samples. Amines can be found in various environments from synthetic raw building products, indoor equipment, industrial or livestock areas to wastes. Because of their fishy-like odor activity, there is an interest to determine low concentration levels of amines looking for the air quality improvement. A major indoor source of amines is the polyurethane foam, because of the amines application as foaming catalysts [1,2,3].

Several analytical methods have already been described in literature: gas chromatography (GC) [1], ion chromatography (IC) [2] or high performance liquid chromatography (HPLC) [3]. A time consuming derivatization step is often required for GC and HPLC analysis of amines. The tertiary amines do not react with the derivatization agents, involving the subsequent unsuitability of these derivatization techniques for their determination. Moreover a specific method is consequently needed because of the complexity of the indoor air matrix since usually the amines are not the major compounds, but coexist with a broad variety of volatile organic compounds. Otherwise, IC requires only the collection by bubbling the air through aqueous solution. The separation and detection limit, especially for low molecular weight aliphatic amines are insufficient with conductimetric detection.

This study targets the development of an IC-MS (Ion chromatography in tandem with mass spectroscopy) method, suitable for the simultaneous determination of 18 amines in spite of the presence of ammonia: low weight aliphatic amines (methylamine, ethylamine, diethylamine …), amino-alcohols (dimethylaminoethanol …), cyclic amines (cyclohexylamine, triethylenediamine, caprolactame) and bis(2-dimethylaminoethyl)ether. The gaseous analytes are collected quantitatively at a flow rate of 200-500 ml min^{-1} in high-purity deionised-water using two 15 mL-impingers mounted in series. Amines are identified and quantified by IC in tandem with a quadripole mass spectrometer equipped with an electro spray ionization source. The linearity interval for amines is in the range 0.5 – 100 µg m^{-3} , the detection limits is around 0.5 µg m^{-3} and RSD determined for 50 µg m^{-3} is less than 8% for a 1-hour sampling at a flow rate of 500 ml min^{-1}. Sampling time can be suitable from various durations depending onto the concentration levels of the air. This method was successfully applied to foams for which, ethylamine, bis(2-dimethylaminoethyl)ether, triethylenediamine and caprolactame were quantified.

[1] Namiesnik J., *et al.*, 2003, *J. Chromatogr. A*, 1013, 1-9
[2] Chang I.H., *et al*., 2003, *Anal. Chem.*, 75, 6141-6146
[3] Rampfl M, *et al*., 2008, *Environ. Sci. Technol.*, 42, 5217-5222

Oral presentation

METAL POLLUTION AT SELECTED NORWEGIAN INDUSTRY SITES STUDIED BY THE MOSS TECHNIQUE: AN UPDATE

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At the 2008 AIRMON meeting a detailed account on atmospheric deposition of metals around 15 industrial plants based on the moss biomonitoring technique was presented. The results were based on multi-element analysis by sector-field ICP-MS, and data for 12 selected elements were discussed, based on surveys in 2000 and 2005. In the present paper an update is given based on corresponding data from a moss survey carried out at the same sites in 2010.

The excessive deposition levels observed around some metallurgical industries in the previous surveys are partly confirmed in the 2010 survey. Whereas the conditions around most aluminium smelters are generally satisfactory and improving over time, improvements around some other metal smelters over the last 10 years have been only minor and much work appears to be necessary before satisfactory conditions are reached. The situation in Odda/Tyssedal (Zn-smelter, titanium industry) and Mo i Rana (ferroalloy production/ scrap metal smelter) will be illustrated in particular.

Short course

SAMPLING VOLATILE AND SEMI-VOLATILE ORGANIC CHEMICALS

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Inhalation is the main route of exposure for many organic chemicals in the workplace, causing narcosis and irritation, but also longer-term problems including disorders of internal organs, such as the liver, kidney, heart and brain, and the central nervous system. Health-based limit values are designed for worker protection. Sampling and analytical methods have been developed to assess exposures. This course presents aspects of sampling strategy, sampler design and evaluation and aspects of laboratory operation particular to assessing inhalation exposures to both volatile and semi-volatile organic chemicals. At the close of the course students will

1) understand the different philosophies behind real-time and time-weighted average measurements,
2) understand how sampling and analytical methods are validated and the limitations of sorbent sampling,
3) appreciate the advantages and disadvantages of active and passive sampling and solvent and thermal desorption techniques,
4) be aware of new developments in semi-volatile sampling,
5) appreciate critically important criteria for selecting an analytical laboratory.

Short course

THE PYHSICAL BEHAVIOR OF NANOPARTICLES IN THE AIR

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This tutorial is intended to highlight some issues related to airborne nanoparticles in context with human exposure in the workplace environment. Physical parameters characterizing the nanoparticles and mechanism controlling the dynamic behaviour of particle populations are presented.

At the beginning definitions and some useful aspects of single particle characterization are addressed. Next we present formation and growth processes of nanoparticles such as nucleation, coagulation and condensational growth. Special emphasis is directed to agglomeration of nanoparticles as the agglomerated structure is the predominant morphology of solid NPs at workplaces.

We also look at removal processes eventually limiting the residence time of nanoparticles in the work environment. Here we cover primarily diffusion processes, thermophoretic particle migration and scavenging of naoparticles by dust particles that are concurrently present in the workplace environment.

Short course

STANDARDS SETTING FOR INHALED AEROSOLS, FROM LARGE TO NANO-SCALE FRACTIONS

James H. Vincent, University of Michigan, Department of Environmental Health Sciences, School of Public Health, Ann Arbor, MI 48104

Material for this tutorial is drawn from Chapters 10 and 11 of the presenter's 2007 book "*Aerosol Sampling: Science, Standards, Instrumentation and Applications*" (Wiley & Sons, Chichester, England, UK, 616 pages). Copies of these chapters are provided, courtesy of kind permission from the publisher.

In the first part, the tutorial addresses the development of criteria for the coarse fraction, the *inhalable* fraction that enters the body during breathing, aimed at replacing the previous – and poorly defined – concept of '*total*' aerosol. In the second part, the tutorial moves on to talk about the development of finer fractions defined in terms of *penetration* of inhaled particles (a) into the lung below the larynx (the *thoracic* fraction); and (b) deeper still into the alveolar region (the *respirable* fraction). These fractions form the basis of aerosol standards today, both for workplaces and – in part, at least – for the ambient atmospheric environment.

We then move on to speculate about possibilities for defining fractions more relevant to actual dose – that is lung *deposition* as opposed to simply *penetration*. Further, the current great interest in *ultrafine* – or *nano-scale* – particles is stimulating the search for criteria for defining these. The large body of cumulative research data which is now available for deposition of large, intermediate, fine and very fine particles in humans provides a good basis for thinking about such criteria in future standards-setting forums.

Short course

BIOLOGICAL MONITORING - BIOMONITORING OF EXPOSURE

Marek Jakubowski

1. Toxicokinetics
1.1 Absorption of organic compounds (lungs, skin, alimentary tract)
1.2.Absorption of aerosols (particle size, solubility)
1.3.Distribution
1.4.Biotransformation
1.5.Excretion
1.6.Kinetics of elimination

2. Biomarkers of exposure
2.1.Definitions
2.1.Why biomonitoring
2.2.Choice of biological material
2.3.Sampling strategy
2.4.Interpretation of results
2.4.1. Biological exposure indices set as equivalents to Occupational Exposure Limits
2.4.2 Health-based recommendations
2.4.Recommendations- occupational settings
2.4.Reference values-general environment
2.5.Evaluation of trends of exposure

3.Examples
3.1.Volatile organic compounds
3.2.Metals
3.3.Environmental tobacco smoke (ETS)
3.4.PCDD/PCDF’s, PCB’s
3.5.Cytostatic drugs

Oral presentation

SULPHURIC ACID AT WORKPLACES – APPLICATION OF THE NEW IOELV FOR THORACIC PARTICLES

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At the end of 2009, the EU published the third supplement to the list of Indicative Occupational Exposure Limit Values (IOELV)[3]. One of the new limit values concerns the most important industrially used acid, sulphuric acid. Particularly striking at first sight is the low numeric value of 0.05 mg/m³. What is new is that the thoracic particle fraction is now named as the relevant particle fraction for sulphuric acid. Although the thoracic particle fraction was for a long time known and defined in the field of occupational safety & health, no limit values have so far been established for this particle fraction in Germany and in Europe. In Germany the MAK Commission proposed the air limit value of 0.1 mg/m³ for the inhalable particle fraction[4].

For the sampling of thoracic particulates suitable sampling systems are therefore rare and experience with them is limited. Furthermore sulphuric acid attacks numerous materials, so the range of possible materials is very limited. A sulphuric acid resistant steel cyclone (V4A steel, type 1.4404) identical in construction to IFA's so called 10-l cyclone for the sampling of respirable dusts is suitable for the thoracic particle fraction at a flow rate of 5.3 l/min. With this cyclone it was possible to compare measurement for the inhalable and thoracic fractions. In the recent month IFA has carried out numerous measurements comprehensively in all branches of industry where sulphuric acid is used e.g. production and use of lead acid batteries, anodising of aluminium, copper refining and galvanising processes.

The results are very reasonable, at concentration below 0.02 mg/m³ only very low differences arise between thoracic and inhalable sulphuric acid mists. At higher concentrations the fraction of the thoracic mist decreases. For concentrations above 0.1 mg/m³ for the inhalable fraction only about 40 % was found as thoracic mist. If one now compares the proposed limit values of the EU and the MAK Commission, it can be concluded that these two limit values represent an absolutely comparable level of protection.

1. COMMISSION DIRECTIVE 2009/161/EU of 17 December 2009 establishing a third list of indicative occupational exposure limit values in implementation of Council Directive 98/24/EC and amending Commission Directive 2000/39/EC
2. List of MAK and BAT Values 2010: Maximum Concentrations and Biological Tolerance Values at the Workplace, Deutsche Forschungsgemeinschaft (DFG) (Editor), Wiley 2010

Oral presentation

THE EFFECT OF DIFFERENT TYPES OF ANALGESIA EQUIPMENTS ON MIDWIVES' OCCUPATIONAL EXPOSURE TO NITROUS OXIDE IN FINNISH MATERNITY HOSPITALS

Kinnari Henna, Bäck Beatrice, Kekäläinen Pirjo, Kammonen Outi, Salmi Kari, Laaja Timo, Holopainen Rauno, Tuomi Tapani
Finnish Institute of Occupational Health (FIOH)

Introduction and objectives

In Finland during 2000 - 2005 nitrous oxide (N_2O) was used in 54 % of deliveries. Finnish 8h Occupational Exposure Limit value (OEL) is 100 ppm. Exposure to nitrous oxide during pregnancy should not exceed 10 % of the OEL. Based on the occupational hygienic surveys performed by FIOH (1996 - 2008) 40 % of the measurements in delivery rooms exceeded the OEL_{8h} and 84 % the OEL for pregnant workers. This survey is a part of the ongoing project "Safe Use of Nitrous Oxide in Delivery Suites" funded by The Finnish Work Environment Fund. Using questionnaires and occupational measurements one of the aims was to find out current technical possibilities to enable safer working conditions for pregnant workers.

Material and methods

Two different questionnaires about the methods of using nitrous oxide and the quality of technical apparatus and ventilation were sent to head nurses and technical personnel in Finnish maternity hospitals (n=34). Based on the response, hospitals using different types of analgesia equipments were selected for detailed measurements. Time-weighted 8h worker exposure evaluation (n=70) as well as stationary sampling in suites (n=72) were assessed.

Results and discussion

Hospitals (n=26) responded to questionnaires (response rate 57 %). In these nitrous oxide was used for analgesia in 48 % of deliveries. Two types of dosing apparatus were in common use: an older model with no ejector for excess gas (45 % of respondents' apparatus) and a newer one equipped with an ejector (55 % of respondents' apparatus). Double masks connected to local exhaust ventilation was used in one hospital. Midwives´ N_2O exposure exceeded the OEL_{8h} in 3 % of the measurements and 49 % exceeded the OEL for pregnant workers. The concentrations of N_2O in suites exceeded the OEL_{8h} in 39 % and the OEL for pregnant workers in 89 % of the measurements. The average concentration in delivery rooms equipped with old dosing apparatus (no ejector) was 635 ppm (n=19) and in suites with ejector model the average concentration was 198 ppm (n=16). In tests with ejector apparatus connected to double mask with local exhaust ventilation average concentration of N_2O was reduced to 37 ppm (n= 28). Based on our results, occupational exposure to N_2O gas is regularly too high for pregnant midwives. A combination of dosing apparatus with ejector and double mask connected to local exhaust ventilation was the most effective blending/evacuating system. To day none of the maternity hospitals in Finland has this equipment.

Oral presentation

OCCUPATIONAL EXPOSURE TO AIRBORNE CONTAMINANTS DURING PROFESSIONAL SKI WAXING

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3) The Norwegian Biathlon Union, Oslo, Norway

N-alkanes, semifluoro- and perfluoro-n-alkanes are used in high performance gliders which are applied to skis to reduce friction between skis and snow and improve water repellency. The glide waxes are available as solid blocks or powders that are melted or sprinkled on the ski sole and heated at 120-180°C for the preparation of a smooth surface. During heating and the following mechanical brushing, fluorinated compounds are released into the work atmosphere as vapors or aerosols. The persistence and bioaccumulative and toxicological properties of PFCs has raised concern about possible health risks connected with human exposure. The aim of our study was to assess the blood levels of PFCs in professional ski waxers and investigate a possible link to workplace air samples as well as ski wax products.

Thirteen male professional ski waxers were recruited from two Norwegian national winter sports teams participating in World Cup competitions. Blood was collected at the end of the season (March) in 2008 and 2009 and beginning of the season (October) in 2008. Airborne particulates were collected in six different waxing cabins during the 2007/08 seasons using a multistage virtual impactor defining inhalable, thoracic and respirable aerosol fractions. Furthermore, 11 solid waxes and 11 powders from six different manufacturers were assessed for contents of PFCs.

Perfluorinated carboxylic acids (PFCAs) from C_4 to C_{14} were detected at elevated concentrations in the serum samples with PFOA as the most abundant PFCA. The median PFOA concentration in the ski waxers was about 25 times higher than that found in the general population. Several PFCA serum levels were significantly associated with the number of years working as a ski waxer.

In workplace particulate matter collected during preparation of skis, the same PFCAs were identified with C_{12} and C_{14} at highest concentrations. Levels of the different PFCAs were similar in all the three aerosol fractions.

Finally, C_4 to C_{14} PFCAs were detected in all the 22 glider wax blocks or powders at the ng/g to μg/g level with higher concentrations in the powders. The highest median concentrations were measured for PFOA in the solid blocks whereas PFTeDA was found at the highest level in the powders.

This study demonstrates links between the occurrence of PFCAs in ski wax products, work room aerosols and ski waxers’ blood. Not only professional ski waxers but also the significant larger group of amateur skiers and waxers are potentially exposed to these compounds. Because of the bioaccumulative properties of several of the PFCAs in humans and insufficient human toxicological data, these findings underscore the importance to reduce exposure to PFCs during preparation of skis.

Oral presentation

APPLICATION OF HYDROGEN FLUORIDE AND AEROSOL REAL-TIME PORTABLE SPECTROMETERS IN COMBINATION WITH PIMEX FOR VISUALISATION OF PEAK EXPOSURE EVENTS IN ALUMINIUM SMELTER POTROOMS

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In a recent study it was concluded that a significant fraction of gaseous hydrogen fluoride (HF) present in aluminium smelter pot rooms might be transported into the lung by the aerosol phase due to the hygroscopisity of co-inhaled particles[1]. Thus, it is an urgent need in this industry to identify and manage peak exposure events where water soluble thoracic particles could be present simultaneously with HF.

A novel portable tuneable diode laser absorption spectrometer has recently been developed (NEO Ltd, Oslo, Norway) for real-time measurements of HF in occupational atmospheres. This instrument and a thoracic aerosol real-time portable spectrometer in combination with a PIMEX 2008 system has been applied for the visualisation of peak exposure events in aluminium smelter pot rooms using Søderberg or prebake anode technologies. The HF and the thoracic fraction particulate matter air concentrations were measured during different working operations in both technologies. The main sources of exposures were identified and described. The major sources of HF present in the workroom atmosphere were replaced anodes and hot bath residues.

[1] S. Weinbruch, N. Benker,W. Koch, M. Ebert, P. A. Drabløs, N. P. Skaugset, D. G. Ellingsen and Y. Thomassen, Hygroscopic properties of the workroom aerosol in aluminium smelter
potrooms: a case for transport of HF and SO2 into the lower airways
J. Environ. Monit., 2010, 12, 448–454

Oral presentation

VALIDATION OF CONTROL BANDING – EXPERIENCE WITH COSHH ESSENTIALS

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Application of Control Banding can potentially lead to one of two adverse outcomes – underprotection or overprotection. Underprotection is obviously undesirable, since it leads to potential harm to workers, but, less obviously, overprotection is also undesirable. Overprotection is an unwelcome expense, possibly diverting resources away from other safety and hygiene issues and, ultimately, resulting in a loss of confidence in the system that generated the unnecessary burden. Thus, it is very important that Control Banding systems be shown to give appropriate recommendations in as many different situations as possible. However, validation of Control Banding advice is neither simple nor easy. The gold standard is the advice that would be given by an experienced professional hygienist with access to comprehensive exposure data. COSHH Essentials was applied to two different industrial situations, one small printing shop and one medium-large automotive coatings producer, and the predicted exposure range was compared with representative sampling results. In addition, the COSHH Essentials output was compared to expert advice based on these comprehensive exposure measurements. The criticality of the assumptions in the model will be highlighted. A very important outcome is how this kind of experience can be used to further refine Control Banding systems.

Oral presentation

MEASUREMENT OF TRACE BERYLLIUM IN OCCUPATIONAL HYGIENE SAMPLES: UPDATE OF RECENT RESEARCH

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ABSTRACT: Beryllium is widely used in industry and commercial products for its unique properties; however, occupational exposure to beryllium particles can cause dermal sensitization and a potentially fatal lung ailment, Chronic Beryllium Disease (CBD). Consequently, exposure limits for beryllium particles in air and action levels on surfaces have been established in the USA in efforts to minimize exposure risks for workers. In recent research, methods for the determination of trace beryllium in workplace samples, i.e., air filters and dust wipes, have been evaluated and validated through intra- and inter-laboratory testing. For air filter samples, an interlaboratory evaluation of acid dissolution and ICP-MS measurement was conducted. Overall, laboratory performance was generally acceptable, although accurate ICP-MS analysis results for low-level Be samples were reported by less than half of the participants. Related studies evaluated various acid mixtures for their efficacy in dissolving high-fired beryllium oxide (BeO), and this allowed for recommendations on effective dissolution media for refractory Be materials. In other studies, a technique that entails extraction of sampled Be in dilute aqueous ammonium bifluoride, followed by fluorescence measurement using a high quantum-yield fluorophore, has been evaluated and validated. The method is effective for the dissolution and quantitative determination of beryllium extracted from refractory BeO particles and silicate media such as soils. In related work, procedures for surface sampling have been standardized and evaluations of Be surface sampling materials have been carried out. ASTM International voluntary consensus standards and US National Institute for Occupational Safety and Health (NIOSH) methods based on the methodologies have been promulgated.

Oral presentation

OCCUPATIONAL EXPOSURE TO BERYLLIUM IN PRIMARY ALUMINIUM PRODUCTION

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Occupational exposure to Be may cause injury to lung and skin through both direct chemical toxic effects and to induce Be antigen-specific sensitisation and granulomatous lung disease.
New epidemiological and toxicological data have raised considerable concern that the current occupational exposure limits (OELs) provides insufficient protection for Be exposed workers. Although the exposures to the major pot room contaminants in the primary production of aluminium (Al) metal have partly been characterised, little information is available regarding the occupational exposure to Be. It is a large range of reported natural abundances of Be in bauxite; from 0.13-0.60 ppm (mg/kg) to as high as 180 ppm in bauxite from Jamaica.

The purpose of this study was to assess aluminium smelter pot room workers' potential exposures to Be in association with other major volatile pot room contaminants such as Al, sodium (Na) and fluoride (F^-) by analysis of the water-soluble and water-insoluble sub-fractions of the inhalable, thoracic and respirable aerosol fractions by personal workroom air sampling.
Several workroom air sampling campaigns for Be were conducted during the period 2003 - 2006 in conjunction with a larger occupational exposure assessment study of pot room workers in seven Norwegian primary aluminium smelters with Søderberg and/or pre-bake technology. The Be concentrations in air vary somewhat between the different smelters, but also between the Søderberg and pre-bake pot rooms within a smelter. The far highest inhalable full shift air GM concentration of Be among the different smelters was measured in the pre-bake pot room of a smelter with predominantly use of Jamaican alumina (112 ng/m^3) where, also the highest individual air concentration was identified (270 ng/m^3).

Be is likely to be present as traces in the airborne particulate matter by replacing Al atoms in the condensed fluorides and/or as a major element in a nano particle sized fluoride. Nevertheless, the major amount of Be present in the work room atmosphere of Al smelter pot rooms to which workers are exposed, will always be present in combination with substantial amounts of water soluble Al, F^- and Na. This could explain the reduced rate of Be sensitization among pot room workers compared with other Be exposed populations.

Poster presentation

MONITORING OF ANTHROPOTOXINS IN ATMOSPHERE OF ARTIFICIAL OBJECTS

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Presence of a human in Artificial Atmospheres of Hermetically Sealed Chambers (AAHSC) pollutes the atmosphere among other agents with endotoxins, therefore one of the key points in optimization AAHSC is sanitation and contamination estimate of the proportion of the agents in AAHSC. This estimate should be aimed at specification of safe concentration of harmful agents. AAHSC is polluted with human metabolites: carbon monoxide, phenols, ammonia, acetone, dimethylamine and methane.

Resulting from experimental works for the Maximum Allowable Concentrations have been developed in mg/m^3 as follows: ammonia – 5, aliphatic hydrocarbons – 300, amino compounds-1, acetone - 50, CO – 15, phenols - 0,3. In 6 days residence time the exhaled air in AAHSC contains 4 times higher level of acetone, 1,4 times – of carbon monoxide (CO). Excretion of hexane and ethanol after initial fall-off almost doubles in 10 day's time. However, by the 15th day hexane concentration recovers its original value, while ethanol keeps increased value. Acetaldehyde concentration of 0,1 mg/m^3 in the exhaled air increases to 0,15 mg/m^3 not until the 5th day. From toxicological point of vier, such metabolites as CO and CO_2 are of the greatest importance. Estimation of the combined effect of both has shown that given low concentration one can observe separate effects, given high - strengthening of toxic effect.

One of the waste products, forming AAHSC, is methane. Literary data on the quantity of methane emitted by a human differ. The researchers examined 300 men of about 20 years old before putting the examinees into exactly the same extreme conditions and after. This experiments showed that methane level in exhaled air of different people varied from 0,1 to 30 mg/m^3. Average value equals to 2,8±0,7 mg/m^3. However extensive population variability of methane levels in the exhaled air was, a gas chromatograph proved able to respond to inter-temporal changes of methane concentration of each individual. Therefore, these changes altogether with supplementary data may describe individual peculiarities of human metabolic processes.

Multidirected change of enzymic strength of neutrophils and feeling unwell arises from exposure to CO, oxides of nitrogen, and hydrocarbons levelled 5-110, 0,1-15, 60-130 mg/m^3 respectively. The received data, having shown that toxic pollutants cause distinct changes of cytochemical indices, can become informative criterion to estimate effects produced by anthropotoxins.

The data given proves that the level of metabolites in exhaled air indicates fitness of a person fairly just, because it reflects complex alterations of metabolic processes in extreme conditions. The connections that have been found allow us to take the part of exhaled air in forming AAHSC with much consideration. Dynamics of cumulation of anthropotoxins makes it impossible for a man to stay in AAHSC long without their being disposed of.

Poster presentation

EXPOSURE TO ULTRAFINE PARTICLES DURING WELDING OF PVC MEMBRANE AND VERGE BUILDING IN A SUBSEA ROAD TUNNEL

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Introduction:

A 5,1 km long subsea road tunnel on the west coast of Norway has been rehabilitated due to leakage of sea water into the tunnel. The work was performed at night time while traffic passed in convoys. The rehabilitation included mounting and welding of a waterproofing tunnelsealing membrane made of PVC and building concrete verges using a slipforming machine. The measurements of ultrafine particles are part of a larger study on exposure to dust and exhaust related agents.

Materials and methods:

A TSI 3091 Fast Mobility Particle Sizer (FMPS) with a flow rate of 10 l/min, a resolution of one second and a diluter with dilution rate 100:1 were used to measured the total number concentration and particle number distribution of particles in the size range 5.6-560 nm. The measurements were performed in the operators breathing zone by the use of a 9.51 m long flexible conductive silicone tubing. Measurements were performed on three different job-groups in addition to measurements of background levels: the driver of the slipforming machine, operators finishing the surface of the verge and operators welding the PVC membrane.

Results:

	Aritmetic mean (#/cm^3)	Max (#/cm^3)	Min (#/cm^3)	Standard deviation	Number of samples
Driver slipforming machine	1 022 614	1 300 075	856 480	82 538	191
Finishing the verge	866 911	1 126 561	663 822	91 461	135
PVC welding	1 663 966	8 137 426	16 606	1 694 789	1458
- Horizontally	626 957	8 137 426	16 606	1 008 056	900
- Vertically	3 336 561	6 408 931	250 965	1 154 586	558
Background	312 526	565 061	20 197	136 184	2234
- Low range (break)	40 028	62 340	20 665	8 176	115

The results are given as number concentration (#/cm^3) of particle in diameter range 5.6 nm-100 nm. The two operators finishing the verge had similar exposure to ultrafine particles.

Discussion:

The measurements performed on operators were all higher than background levels. This suggests that the work performed and/or machines used are important sources of ultrafine particles. The higher exposure of the driver of the slipforming machine compared to the finishing operators might be due to the position of diesel exhaust pipe close to the drivers head combined with the lack of closed cabin. The difference seen between the horizontally and vertically PVC welding is probably due to different techniques used. The vertically welding was more or less continuous while during horizontally welding, tasks like gluing and moving rack was performed as part of the welding process.

Poster presentation

FIELD COMPARISON OF THREE INHALABLE AEROSOL SAMPLERS (IOM, PGP-GSP 3.5 AND BUTTON) FOR WELDING FUMES

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Inhalable sampler performance depends on the particle size of the aerosol to be sampled. In order to carry out a comparative study on their behaviour in the actual conditions, field sampling at selected workplaces were planned. The results for the IOM, Button and PGP-GSP 3.5 inhalable samplers for welding fumes are presented. Sampling was carried out in a welding training centre that allowed to assure very repetitive welding work. Manual Metal Arc Welding (MMA) and Metal Active Gas Welding (MAG) processes were used. Samples were taken for five months throughout 2009 and 2010.

A sampling assembly was designed to place 12 samplers at the same time. The designed device comprised two bars spaced at 15 cm and positioned at 150 and 165 cm above the floor. Samplers were placed 15 cm from one to another allowing six sampling positions at each bar. This assembly allowed to compare two types of samplers at the same time (Button/IOM, Button/PGP-GSP 3.5 and PGP-GSP 3.5/IOM). For each sampling run, six sampling units of each of the two sampler's type were used. The location of the samplers was selected at random for each sampling run. In addition, particle size distributions of the welding aerosols were determined by an eight-stage Marple cascade impactor, situated at the same sampling assembly.

Glass fibre filters were used as collection substrates. Per type of sampler, three field blanks per day were included. After sampling, the filters were conditioned during 48 h and weighed on an analytical balance with a resolution of 1 µg. After rejecting some data due to pump failure and mishandling samples, 232 pairs of valid results were considered.

A preliminary study showed that welding fumes in the sampling area were homogeneous as to allow comparison of samplers. For each type of sampler, the pooled coefficient of variation of all the replicated samples resulted to be less than 3%, confirming the preliminary data.

Welding fumes particles with aerodynamic diameters between 1.55 µm and 0.52 µm were mainly collected by the Marple cascade impactor.

The ratio of concentrations was the chosen parameter to compare the behaviour of samplers. The mean ratios for Button/IOM, Button/PGP-GSP 3.5 and PGP-GSP 3.5/IOM were 0.90, 1.00 and 0.92 respectively.

For MMA and MAG processes and a particle size distribution of the welding fumes mainly in the range of 1.55 µm to 0.52 µm, the IOM sampler collects significantly more amount of the aerosol ($P < 0.001$) than the Button and the PGP-GSP 3.5 samplers, which have a similar performance ($P = 0.598$).

Poster presentation

VALIDATION AND FEASIBILITY STUDY OF THE DEVELOPED SMALL DIFFUSIVE SAMPLERS FOR ALDEHYDE AND VOC IN ELEMENTARY SCHOOL CHILDREN

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Aim Exposure to various chemicals is known to cause adverse effects on health, such as asthma and allergies especially in children. Indoor chemical levels in schools and dwellings have been measured in many studies, however, data on personal exposure levels in children are scarce. The aim of this study is to develop and validate small diffusive samplers for school children and to measure personal daily chemical exposure levels.

Methods Developed diffusive samplers were 20 mm in length, 11 mm in diameters, and 1.67 g in weight. They were cylindrical shaped with polytetrafluoroethylene membrane filters placed at both ends. To measure aldehydes and acetone, 30 mg 2,4-dinitrophenylhydrazine was inserted as an absorbent, and to measure VOC, a carbon molecular sieve was used. The sampling rate for each chemical was determined by parallel sampling with active samplers in a chamber as described in Araki et al. (2009). To examine the application of the samplers in a field study, 65 elementary school children carried them for 24 hours.

Results The determined sampling rates for formaldehyde, acetaldehyde and acetone were 20.9, 22.9, and 19.7 mL/min, respectively and the limits of quantification (LOQ) for 24-hour sampling by HPLC/UV analysis were 7, 13, and 14 µg/m^3, respectively. Sampling rates for 11 VOC were determined and ranged from 3.3 mL/min for stylene and 2-ethyl-1-hexanol to 11.7 mL/min for benzene, and LOQ for 24-hour sampling by GC/MS analysis ranged from 10.4 µg/m^{3}for limonene to 138.9 µg/m^3 for methylethylketone. Storage stability for 5 days at 4 ℃ were 94.8-118.2%. Formaldehyde, acetone, benzene, and toluene were detected above LOQ more than 90% children, and median concentrations were 21.7, 20.9, 10.1, and 21.5 µg/m^3, respectively.

Conclusion This study shows that developed small diffusive samplers were acceptable for children to carry and valid to measure children's daily chemical exposure.

Araki A., et al. Indoor Air **19**(5):421-432 (2009)

Poster presentation

REAL-TIME MEASUREMENT OF MEAN PARTICLE SIZE AND NUMBER CONCENTRATION OF NANOAEROSOLS IN THE RANGE 20-450 NM WITH THE DIFFUSION SIZE CLASSIFIER

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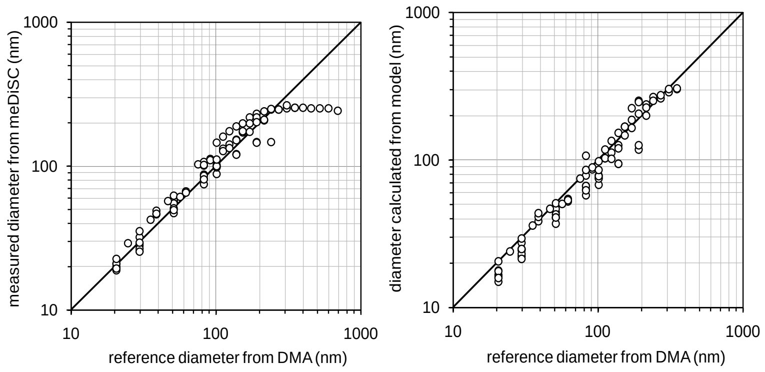
Regarding exposure to workplaces or environmental aerosols of nanoparticles, referred to as nanoaerosols, our knowledge remains scant. One reason of this is the lack of measurement instruments with known performances. In this context, the objective of this experimental and theoretical study is to investigate in the sub-450 nm range the performances of a recent commercially available instrument for the real-time measurement of two key aerosol parameters (size and number concentration): the Diffusion Size Classifier (meDiSC, Matter Engineering, Switzerland).

Within the meDiSC, particles are first positively charged by means of a diffusion charger; they are then collected either on diffusion grids or on the terminal filter according to their diffusion equivalent diameter. Three consecutive current measurements allow the real-time determination of particle mean size (20-200 nm) and number concentration (10^3-10^6 #/cm^3).

Test nanoaerosols composed of different materials (C, Ag, CuO, Al_2O_3, NaCl, $CaCl_2$, Cu/Ni mixture) were produced by means of the CAIMAN facility, and selected through a DMA (Differential Mobility Analyser, Grimm ‘Vienna Type’) in a range from 20 to 700 nm in terms of equivalent mobility diameter. Number concentrations measured by the meDiSC were compared to data from a CNC (Condensation Nucleus Counter, TSI model 3786); in parallel mean sizes from meDiSC were compared to DMA-selected sizes. Relative biases were found up to 50% in the size range from 20 to 200 nm, and up to 200% beyond this range (fig. 1a). No significant effect of particle composition or morphology can be noted. From experimental data, a diffusion model was optimised, allowing the calculation of particle size from the measured currents up to 450 nm (fig. 1b). Finally, investigations regarding polydisperse nanoaerosols (count median diameters from 25 to 70 nm, geometric standard deviations from 1.8 to 2.5) were performed and compared to SMPS number size distributions.



a) b)

Fig.1: Evolution of the measured (a) and calculated (b) diameter with the reference diameter

Poster presentation

OCCUPATIONAL EXPOSURE TO LEAD PRESENT IN THEIR BREATHING ZONE IN A CERAMIC INDUSTRY

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Lead is one of the most important toxic metal used in different industries, therefore, environmental and occupational exposures are commonly taken place. Because of highly potential toxicity of lead, serious damages are routinely happen. The aim of this study was to evaluate the exposure to lead in ceramic industry, in which, considered as a domestic industry in Iran. To do this study, 55 glaze workers (39 tillers and 16 potters) were selected as the case samples. A questionnaire was used to collect individual characteristics of the workers as well as their positions at work. The mean value of the lead concentration was correlated to the variables including work shift, work type, ventilation system, and the extra work hours over the shift. A sampling pump (SKC Co.) and ester cellulose filter of 0.8 µm in pore size and 37 mm in diameter were used for sampling process. The flow-rate was adjusted at 2 l/min based on the NIOSH 7300 method. After sampling, each filter was taken to the laboratory and digested to the nitric and perchloric solutions (4:1). Then, the prepared samples were analyzed by Induce Coupled Plasma Atomic Emission Spectrometry (ICP-AES). Also, spirometric tests were performed for both the case and control groups. The results obtained from this study showed that, the lead concentrations were more than the TLV (0.17 mg/m). Independent t-test showed that, there is a significant relation between the lead concentration present in the breathing zone air and the variables of shifts work (morning and afternoon) as well as the ventilation system in tillers. Also, the one-way ANOVA showed that, there is a significant relation between the lead concentration present in the breathing zone and the extra hour work over the shift. The lead concentration in the breathing zone of the workers was more than the TLV. Because of hazardous adversity of exposure to lead, an extensive personal protective programme is needed to be organized. Moreover, clinical monitoring including periodic visit, spirometric tests are also strongly advised when the workers are engaged for any job at risk of exposure to lead in order to guarantee their occupational health.

Poster presentation

SURFACE MONITORING OF ANTINEOPLASTIC DRUGS IN SWEDISH HOSPITALS AND HYGIENIC GUIDANCE VALUES

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Aims: Antineoplastic drugs are frequently used in anticancer therapy. Health care workers can be occupationally exposed to antineoplastic drugs classified as carcinogenic, mutagenic or teratogenic to humans. Monitoring of surface contamination is a common way to assess occupational exposure to antineoplastic drugs. Two frequently used antineoplastic drugs, cyclophosphamide (CP) and ifosfamide (IF), were used as markers for surface contamination of antineoplastic drugs. CP is classified as carcinogenic to humans by IARC and IF as probably carcinogenic to humans. Since no occupational limits for antineoplastic drugs in work environments exist guidance values (GV) might be used instead. GVs are practicable, achievable levels and not health based, and set at the 90th percentile of available monitoring results collected from representative workplaces with good occupational hygiene practice [1]. The aim was to propose hygienic GVs for surface monitoring of CP and IF in Swedish hospitals. **Methods**: In total, 14 wards specialized in oncology, surgery and hematology located at 5 hospitals in Sweden were surveyed by wipe sampling. Nine of the workplaces were outpatient wards. Wipe samples were collected with wetted wipe tissues (0.03 M NaOH) [2]. Surface areas of 400 cm^2, defined by a plastic frame, were sampled on floor and work areas. Handles had well-defined areas. Analysis was performed by liquid chromatography combined with tandem mass spectrometry [2]. From workplaces with good hygienic conditions (N=11) 90th percentile values were calculated for the following locations: floor, work area and handle. **Results:** Contamination of CP was found on 59% of the sampled surfaces. The corresponding value for IF was 36%. The surface loads of CP and IF ranged between <0.05-10800 pg/cm^2 and <0.13-2300 pg/cm^2, respectively. The highest contaminations for both CP and IF were detected on floors in patient lavatories. Hygienic GVs are presented in Table 1. **Conclusions:** The GVs can be applicable to hospital workplaces where patients are treating with CP and IF. The GVs for surface monitoring of antineoplastic drugs can help to control and reduce occupational exposure to antineoplastic drugs in hospitals.

Table 1. Number of wipe samples and GVs for different types of surfaces in hospitals

Location	N	% wipe samples > LOD[a]		GV	
		CP	IF	CP (pg/cm^2)	IF (pg/cm^2)
Floor	66	88	70	260	59
Work area	23	9	17	<0.05	1.0
Handle[b]	39	38	18	11	0.2

[a]Limit of detection (LOD) for CP: 0.02 ng/wipe sample (0.05 pg/cm for 400 cm^2 area); LOD for IF: 0.05 ng/wipe sample (0.13 pg/cm for 400 cm^2 area)
[b]Unit: ng/sample

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2. Hedmer M, Georgiadi A, Rämme E, Eksborg S, Jönsson BAG, Ehrsson H. Surface contamination of cyclophosphamide packaging and surface contamination with antineoplastic drugs in a hospital pharmacy in Sweden. Ann Occup Hyg 2005;49:629.

Poster presentation

CHARACTERIZATION OF WELDING FUME CONTAINING MANGANESE

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Eight welding methods generating manganese-containing fumes were investigated; different combinations of Manual Metal Arc Welding, MIG welding, MAG welding, Metal Cored AW and Flux Cored AW and three types of steel (unalloyed steel, stainless steel and Mn-rich steel). The welding was carried out by professional welders at the laboratories of the two welding equipment manufacturers. The tests were carried out in test boxes designed for standard classification of welding fume generation rate and chemical content. Each weld run took approx. 1 min, and several were collected for each welding method.

For each welding method, samples were collected from the pillar of fume approx. 1 m above the weld joint. Welding fume samples were collected on 240 mm filters for bulk analysis, and on 37 mm PC filters with a TEM grid mounted at the centre for EM studies. For the bulk analysis, the collected fume was retrieved from the filters and kept in closed jars. The total particle number concentration and the particle number and mass size distributions were measured with a pTrak, an SMPS and a MOUDI. The bulk samples were analysed with x-ray fluorescence (XRF) to determine the chemical composition of the fumes, and with sequential leaching in four steps using ICP-MS. Morphological analyses were carried out on the PC filter samples in a SEM and on the TEM grids in a TEM. Elemental analysis was carried out on the respective samples in both the SEM and TEM. The MOUDI samples were analysed for elemental composition with ICP-MS.

The XRF analyses showed that the fraction of Mn in the fume ranged 5–20% and the ratio of Fe to Mn ranged 1–12. The morphological studies showed that except for three welding methods, the generated fume particles had the expected shape – small particles attached to each other as beads on a string. Apart from these particles, supermicron individual spherical particles were also detected. The unexpected particle shape consisted of compact agglomerates of primary particles. The SEM and TEM analyses of the welding aerosol particles showed that the elemental composition varied strongly both within and between particles, and additionally, that particles with a size of a few hundred nanometre consists of many subparts, some of which may be crystal and other amorphous. The leaching analysis showed a large variation between methods, but for all but three methods, steps 2+3 contained most Mn. The cascade impactor data showed that the size distribution generally was unimodal. The dominant aerodynamic peak for all methods was close to approx. 400 nm. For half of the methods, a second mode with a peak at approx. 2 or 8 µm occurred. The SMPS data showed that for each new weld run, the size distribution was slightly changed. This could be caused by the welding fume generation rate not being constant between weld runs, but depended on the welding process. For all welding methods, the size distribution was unimodal, and could be divided into three groups. For six methods the peak occurred for electrical mobility diameters in the range 160–220 nm, whereas for the remaining two the peak occurred at 110 and 275 nm, respectively.

Poster presentation

POSSIBLE EXPOSURE TO NANOPARTICLES IN POWER ENGINEERING

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The introduction of nanotechnology is revolutionizing several sectors such as research and manufacturing. During the past few years its use has increased exponentially. Employees involved in the development, production, distribution, and use of these nanoparticles are potentially exposed to materials of uncertain toxicity. However, the general population can be also exposed. An area potentially involving exposure to nanomaterials is power engineering. The aim of this paper is to present examples of exposure to nanoparticles in power engineering, and to look into how we can study exposure in the future.

Polymer nanocomposites are possible applications of nanotechnology in the power sector: these nanoparticles can be applied as dielectrics and in electrical insulation, e.g., in the switchgears, dc power cables, enameled wires, rotating machines, and power electronics [1]. Furthermore, nanotechnology can be applied to improve power engineering areas, e.g., in batteries, for refining hydrocarbons, and transformers [2].

In the combustion processes for energy production, fine particles and nanoparticles can be released into the atmosphere. Another possibility is the relation to the possible content of nanomaterials (e.g. nano paper) in waste; during the burning of waste nanomaterials can drift into the atmosphere. Other uses of nanotechnologies potentially inducing exposure, are the use of different nanoparticles to refine oil and natural gas (hydrogen production), and in fuel cells and hydrogen storage. It is also possible that nanomaterials may to be vital for improving the efficiency of solar energy systems.

Exposure to nanoparticles is possible in both workers and the general population. Some examples of occupational exposures are e.g. during maintenance or while working near an electrical device, and a breakdown (short-circuit) occurs. In the general public, exposure is possible for those who live near power plants which burn waste including nanomaterials.

The possible health risks related to nanotechnology must be urgently evaluated in power engineering. Adequate methods for environmental monitoring, possibly including dermal exposure assessment, and medical surveillance, are still in progress, and shared guidelines are currently lacking. Therefore, new experimental and qualitative data is needed. At the same time data on health effects, symptoms, and adverse phenomena should be collected

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Poster presentation

RELATIONSHIPS BETWEEN LEAF METAL ACCUMULATION AND FUNCTIONAL CHARACTERISTICS IN *Q. ILEX* L.

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In urban environment, metals are among the most abundant air pollutants. Plants are continuously exposed to air pollution, and then accumulate, particularly in the leaves, contaminants. Heavy metal accumulation in the leaves may cause alteration in leaf morphology and physiology. In the Mediterranean basin, *Quercus ilex* L. is one of the most representative evergreen species, widespread in woodlands as well as in urban areas. *Q. ilex* leaves, accumulating metals and polycyclic aromatic hydrocarbons, are properly used as biomonitors of air quality.
This study aimed to evaluate the relationships between metal accumulation and functional traits both in *Q. ilex* leaves and leaf litter. For this purpose, mature leaves of *Q. ilex* were collected at five sites (ACT, MIA, MAD, IOL, CAP) in downtown of Naples (Southern Italy). At the bases of the same specimens, *Q. ilex* leaf litter and surface soils (0-10 cm) were also collected. Leaf physiological performance was assessed by measures of leaf functional traits, photochemistry and photosynthetic pigment content. On the sampled litters, leaf functional traits were determined, too. The soil samples were characterized for pH, water and organic matter content. In addition, soil Cu and Pb concentrations were measured. The analyses of leaf functional traits and photochemistry, as well as the concentrations of metal Cu, Cr, Cd, Ni, Pb and V in the soil, leaf and litter samples are in progress. However, the first results showed that in the soil the highest Cu and Pb concentrations were detected at IOL (Fig. 1).

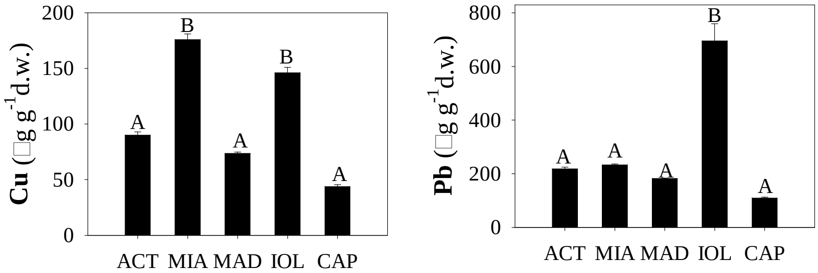

Fig. 1. Mean values (± s.d.) of Cu and Pb in soils.

The lowest values of Specific Leaf Area (SLA) and Relative Water Content (RWC) and the highest value of Actual Water Content (AWC) were detected in the leaf litter of ACT (Table 1). No differences in Leaf Dry Matter Content were detected among the sites (Table 1).

Tab. 1. Mean values (± s.e.) of leaf traits in litters.

Sites	**SLA**	**LDMC**	**AWC**	**RWC**
ACT	76,97 ± 5,29	0,42 ± 0,007	20,66 ± 1,93	80,78 ± 2,23
MIA	96,25 ± 4,20	0,38 ± 0,008	13,51 ± 0,54	90,45 ± 0,48
MAD	87,32 ± 4,99	0,41 ± 0,007	10,66 ± 0,21	91,68 ± 0,32
IOL	86,65 ± 4,82	0,42 ± 0,016	14,82 ± 0,40	86,89 ± 1,08
CAP	91,76 ± 6,79	0,42 ± 0,015	13,22 ± 1,13	88,69 ± 1,45

Poster presentation

PESTICIDES IN AIR AND DUST OF 5 HOUSES IN FRANCE AND LUXEMBOURG

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Indoor concentrations of pesticides are of increasing interest in Europe and particularly in France. Sensitive, simple and discrete sampling methods are needed for intensive investigations of these contaminants in indoor environments together with accurate analytical methods. The consecutive analysis of air and dust permits the identification of the main source of exposure for these contaminants in particular since many of them are of low volatility.

Analysis of pesticides in indoor air and dust from 5 houses (4 in east of France and 1 in Luxembourg) were performed by using passive sampling in Tenax® tubes and glass fiber filters for air and passively deposited dust respectively. Passive samplers were exposed for 15 days while dust sampler were exposed for one month in order to get enough materials for analysis. For air sampling, two passive samplers were installed one outdoor, near the house, and one indoor in order to tentatively evaluate pesticides transfer from outdoor.

A representative list of 31 pesticides currently used in agriculture (i.e. metazachlor), in non agricultural application (i.e. oxadiazon) and indoor for insects or wood treatments (i.e. permethrin) together with forbidden but eminent compounds (i.e. lindane, pentachlorophenol) was established and monitored.

Passive and dust samples were respectively analysed by two original methods: thermal-desorption GC/MS and ASE extraction followed by SPME-GC/MS. These two methods include a derivatisation step before injection with M*t*BSTFA since some pesticides cannot be analysed directly by GC. The simultaneous analysis of all of the pesticides (direct and derivatised) in one GC run was found to be possible and efficient.

Some pesticides were detected in passive samplers and dust samples coming not only from agricultural use but also from domestic use (i.e. trifluralin, 2,4-D, MCPA). It was not surprising to detect lindane, a wood preservative, in all the samples as it was always observed in the previous French studies. It was also the pesticide with the highest amount on the PAS (22 to 142 $\text{ng}\cdot\text{PAS}^{-1}$). The presence of pentachlorophenol and lindane show evidence that is it still possible to detect banned pesticides having a high level of persistence. However, pentachlorophenol was detected only on older houses and this is in relation with its banned used for wood treatment.

Poster presentation

COMPARISON OF TOTAL DUST VERSUS INHALABLE PERSONAL SAMPLERS FOR THE DETERMINATION OF PAPER DUST IN A SOFT PAPER MILL

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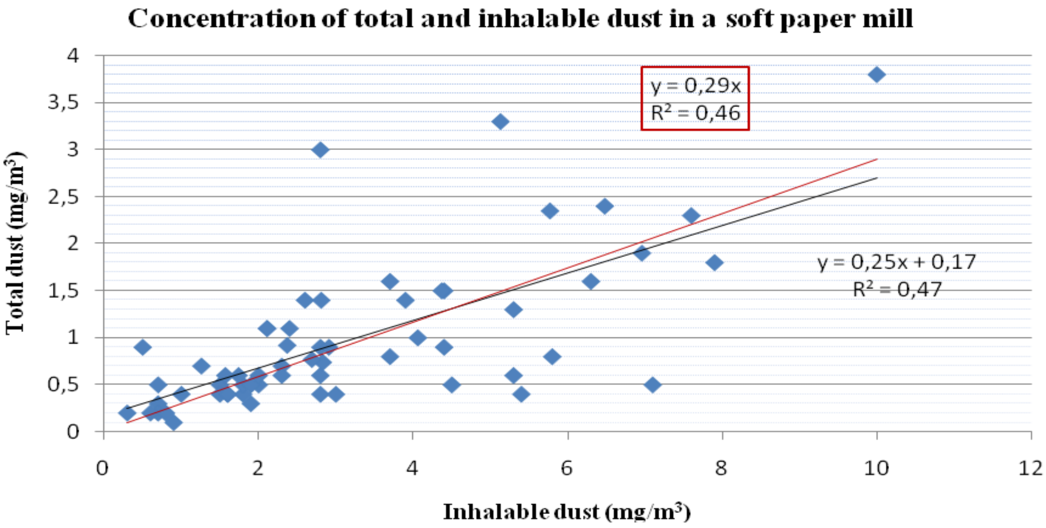
The Swedish Work Environment Authority have converted several threshold limit values (TLV) concerning dust from *total* dust to *inhalable* and *respirable* dust. At present, paper dust has a Swedish threshold limit value of 2 mg/m^3 valid for total dust. The total dust sampler does not sample all airborne particles and there is no physiologic motive for the term *total dust*. In the European standard SS-EN48, different size fractions for airborne particles are defined, i.e. inhalable, thoracic and respirable fraction. It is a reasonable aim that TLV:s for the term total dust gradually are converted to the size fractions defined by the standard. Occupational Safety and Health have previously carried out comparative study of paper dust and found that the sampler for inhalable dust sampled considerably higher dust concentrations than did the sampler for total dust. The objective of the present study was to obtain better information on the relation between inhalable dust fraction and dust sampled with open-faced cassettes by personal parallel sampling in a soft paper mill. A total of 59 parallel personal samples were carried out. Workers in the converting halls and paper machine workers were selected for sampling. Parallel samplers were attached close to the operator's collar, one on each side, in the breathing zone. The sampling time was eight hours, with a flow rate of 2,0 l·min^{-1}. The result from the parallel samplings is presented in the figure below and shows the correlation obtained between inhalable dust concentrations and the total dust concentrations. The slope of the regression line is presented with and without forcing the intercept through the origo.



The results from the present study confirm that the IOM sampler measures much higher dust concentrations than the open face cassette. The ratio of inhalable/total dust was 3,26. The large differences between inhalable and total dust concentrations may be due to several factors such as particle size and different location of the sampler, IOM cassette is pointing outward while the open face cassette is pointing downward.

Poster presentation

A NEW NON-INVASIVE WAY OF SAMPLING POTENTIAL BIOMARKERS FOR INFLAMMATION IN THE DISTAL AIRWAYS

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Introduction: We exposing our respiratory system to air pollutants and pathogens that can produce various health effects. However, in spite of the relative accessibility of the respiratory system in comparison with other organs, direct assessment of ongoing biochemical changes can currently only be performed using invasive procedures that are not applicable for repeated measurements in the same individual. Measurement of biomarkers in exhaled air is a very attractive method since the air originates from the target organ and can easily be sampled non-invasively.

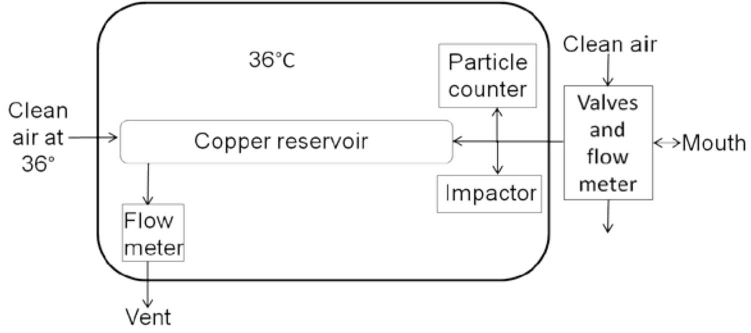
A new method to sample endogenously formed particles in exhaled breath has recently been developed at the Department of Occupational and Environmental Medicine, University of Gothenburg. The origin of the majority of the exhaled particles is likely to be the respiratory lining fluid (RTLF) in the small airways, when using a special breathing manoeuvre involving airway closure and re-opening. Our hypothesis is that early inflammatory changes in the RTLF can be detected by changes in the composition and quantity of exhaled particles. Application of modern analytical techniques such as MS and LC-MS for identification of molecular composition could reveal novel biomarkers and therapeutically targets for various respiratory diseases.

Methods: The apparatus for collecting particles in exhaled air, (Figure 1). The atmosphere in the apparatus maintained at 36°C in order to keep the exhaled particles intact in size. The particles are collected on a silica plate/teflon filter by means of a 3-stage impactor Particles in the size range 0.5-2.0 µm are estimated to be collected on the bottom stage. Expiratory flow is visualized on a computer screen to facilitate control of breathing for subjects. Concentration of particles (0.3-20 µm) is recorded by means of an optical particle counter, Grimm. Collected sample are ready for direct analysis by TOF SIMS, or can be extracted from the silica plates/teflon filter for analysis using other modern analytical techniques.

Conclusions: The developed sampling method has high potential for detection of new biomarkers in exhaled air and monitoring of respiratory disease. We will use the method for screening and monitoring of occupational groups exposed to irritants and allergens as well as in large population groups to identify markers for prediction of respiratory disease.

Sampling principle

Figure 1. Apparatus for studying exhalation aerosols



Poster presentation

NEW DEVELOPMENT IN ONLINE AIR QUALITY MONITORING

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Together with other small European companies, DERENDA, has developed a new online-monitoring device based on X-Ray Diffraction. In the past the XRD technology has been used on rare occasions to analyze ambient air. The main reasons for this were the lack of appropriate and easy to use software and the lack of appropriate hardware for in-situ measurements. If these two points resolved the air quality community can use the multitude of proven possibilities of the XRD-technology.

We have produced an autonomous working prototype on-site and continuous collection of ultra fine dust particles (below 0,2µm) with real-time analysis of these particles by using X-ray diffraction. The system works fully automatically, meaning that the sampling and analyzing does not need any manual assistance.

The system consists of a sampling and storage system (60 samples) combined with a handling arm, and the XRD – System.

The XRD system can detect crystalline structures, meaning that for instance not only the elemental composition (As, Pb …) but the chemical composition (for example PbO, Pb_3O_4, $Pb(NO_3)_2$ …). Quantitative analysis is also possible. This is done by the Rietveld method, which with the recent increase of computing power, has become a tool for real-time analysis. Our system works with automated Rietveld software package which is a major step into “banalisation”. Trained lab-operators will be able to understand the results without additional manual mathematical refinement of the displayed results.

By using a XRD-SAXS (Small Angle X-Ray Diffraction) it is possible to determine parameters such as average particle size, shapes, distribution and surface-volume ratio. This method has a couple of advantages over established methods such as microscopy:

1. Sample preparation is easy
2. The smaller the structure the better it can analyzed
3. It gives the broader picture (with one sample you get all information about shape, distribution and size)

The prototype has been tested in different places within a ceramics factory to determine what kind of particles are present. Results will be presented on the poster.

The final version of the new device will be ready by the end of the year. It will not require watercooling for the X-Ray source and will be less then 1m³ in volume. It will undergo the necessary validation within a European Reference Laboratory and will be available by Summer 2012.

Poster presentation

HYDROGEN SULFIDE EMISSION RATES AT SEVERAL WASTEWATER TREATMENT PLANTS IN THE VALENCIAN COMMUNITY (SPAIN)

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The management and operation of wastewater treatment plants (WWTP's) usually involve the release into the atmosphere of substances that cause bad odors, which can potencially reduce quality of life for the surrounding population. In this type of facility, anaerobic processes contribute to the generation of hydrogen sulfide (H_2S) at often quite high concentrations, consequently, the presence of this chemical compound in the atmosphere may be a good indicator of the ocurrence and intensity of the olfactory impact.

The olfatory impact can be analyzed using many perspectives and methodologies (psychometry, field inspections, dynamic olfactometry, electronic nose ...). An interesting approach is to regard it as a typical pollutant dispersion problem in which chemical compounds are transported and diffused from the emission zones to the potential receptors via atmospheric dispersion mechanisms. In this context one of the most critical aspects of source-receptor relationships involves determining the applicable source terms. This is a complicated task in most situations due to the great diversity of existing foci and the largely fugitive and unchanneled nature of emissions, which make it difficult to know a priori the emission rates (H_2S in particular). For these reasons the use of indirect estimation methods represents an interesting approach.

The present paper describes part of the experimental and modeling work carried out by CEAM-UMH in the surroundings of several WWTPs located in Valencia (Spain). This work has permitted the estimation of H_2S emission rates at different wastewater treatment plants under different environmental and operating conditions. Our methodological approach for highlighting relevant aspects that characterizing the olfactory impact consisted of several experimental campaigns involving intensive field measurements using passive samplers, in the neighborhood of several WWTPs, in combination with numerical simulation results from a diagnostic dispersion model.

A meteorological tower on each site provided the input values for the dispersion code, ensuring the fit of the simulated environmental conditions. Comparisons between simulated and experimental H_2S concentrations yielded estimates of global emission rates for this substance in several plants and in different periods of time.

The results obtained show a certain degree of temporal and spatial (between-plant) variability (possibly due both to operating and to environmental conditions). Nevertheless, and more importantly: in spite of this variability, the results show a high degree of uniformity in their estimates and consistently stay within the same order of magnitude.

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