New method to measure the mechanical collection mechanisms of full-scale air filters

Plenary & Keynote Lectures

Prof. Kuo-Lun Tung
National Taiwan University
Taiwan

Nature-inspired separation membranes: Geomimicry versus biomimicry

PL

Prof. Markus Lehner
Montanuniversität Leoben
Austria

Industrial gas cleaning processes – Trends and perspectives

K1

Prof. Dietmar Lerche
L.U.M. GmbH
Germany

Sedimentation and consolidation behavior of stable and flocculated suspensions. In situ visualization and analysis

K2

Prof. Urs Peuker
TU Bergakademie Freiberg
Germany

Separation and classification in the size range below 10 µm – Challenges and new approaches

K3

Dr. Anthony Stickland
The University of Melbourne
Australia

Compressibility effects in solid-liquid separation

K4

Prof. Bhaskar Narayan Thorat
Institute of Chemical Technology – India

Solid-liquid separation – An Indian Perspective

K5

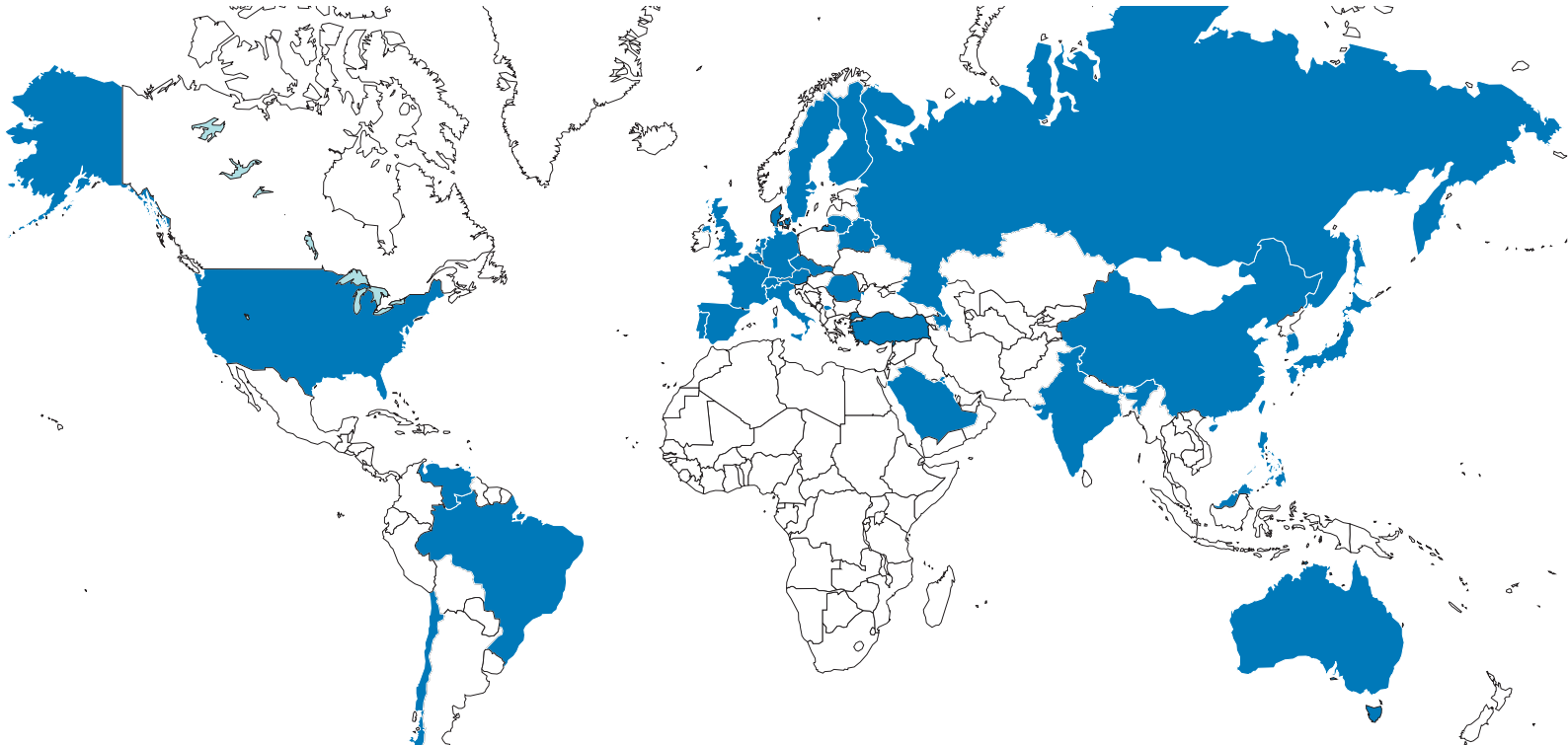
Prof. Mônica Lopes Aguiar
Universidade Federal de São Carlos – Brazil

Separation of particles out of gases by fabric filtration

K6

International Participation

Where FILTECH Speakers come from...



Session Overview

Tuesday, 22.10.2013

08:30 – 09:45	Registration				
09:45 – 11:30	Opening Session	PL Plenary Lecture – Prof. Kuo-Lun Tung **Nature-inspired separation membranes: Geomimicry versus biomimicry**			
11:30 – 12:15	Walk Around – Fair				
12:15 – 13:15	Lunch – Fair				
13:15 – 14:30	K1 Keynote Lecture 1 Prof. Markus Lehner	L1 Cake Filtration-Influences on Cake Properties I	L2 Filtration of Metal Melts	L3 Classification/ Sorting	M1 Ceramic Membranes
14:30 – 15:00	Coffee Break – Fair				
15:00 – 16:15	K2 Keynote Lecture 2 Prof. Dietmar Lerche	L4 Cake Filtration-Influences on Cake Properties II	G1 Filter Test Systems I	G2 Nano Particle Separation	M2 Special Membranes
16:15 – 16:45	Coffee Break – Fair				
16:45 – 18:00	K3 Keynote Lecture 3 Prof. Urs Peuker	L5 Cake Filtration-Desaturation	G3 Filter Test Systems II	G4 Airborne Molecular Contaminations	M3 Membrane Characterization

Wednesday, 23.10.2013

08:30 – 09:45	L6 Electric / Thermal Separation Enhancement	L7 Poster Session I	G5 Poster Session I	M4 Poster Session I
09:45 – 11:00	Poster Viewing	Poster Viewing	Poster Viewing	
11:00 – 12:15	L8 Hydrothermal / Encymatic Separation Enhancement	L9 Slurry Concentration / Thickening	G6 Surface Filtration I	M5 Layer Formation
12:15 – 13:15	Lunch – Fair			
13:15 – 14:30	K4 Keynote Lecture 4 Dr. Anthony Stickland	L10 Filter Media Cleaning	G7 Surface Filtration II	M6 Cross Flow Techniques
14:30 – 15:00	Coffee Break – Fair			
15:00 – 16:15	K5 Keynote Lecture 5 Prof. Bhaskar Narayan Thorat	L11 In-Situ Analysis of Slurry Separation Properties	G8 Automotive Application I	M7 Ultra Filtration
16:15 – 16:45	Coffee Break – Fair			
16:45 – 18:00	K6 Keynote Lecture 6 Prof. Mônica Lopes Aguiar	L12 Continous Cake Filters	G9 Automotive Application II	M8 Membrane Bio Reactor

Thursday, 24.10.2013

08:30 – 09:45	L13 New Filter Testing Procedures and Apparatus	L14 Poster Session II	G10 Poster Session II	G11 Monitoring and Control
09:45 – 11:00	Poster Viewing		Poster Viewing	
11:00 – 12:15	L15 Components for improved Filter Performance	L16 Functionalized Filter Media I	G12 Particle Deposition	G13 Industrial Gas Cleaning
12:15 – 13:15	Lunch – Fair			
13:15 – 14:30	L17 Monitoring of Separation Processes	L18 Functionalized Filter Media II	G14 Numerical Filter Simulation I	G15 Cabin Air Filters
14:30 – 15:00	Coffee Break – Fair			
15:00 – 16:15	L19 Microscreens / Strainers	L20 Depth Filtration in Granular Media	G16 Numerical Filter Simulation II	G17 Pleated Filter Media
16:15 – 16:45	Coffee Break – Fair			
16:45 – 18:00	L21 Coalescer	L22 Backwash Filters	G18 Numerical Filter Simulation III	G19 Special Filter Media

Programme is subject to ammendments. Up-to-date Programme available at www.Filtech.de

Tuesday, October 22, 2013

Plenary Lecture PL
10:30-11:30 h

Nature-inspired separation membranes: Geomimicry versus biomimicry
Prof. Kuo-Lun Tung
National Taiwan University, Taiwan

Keynote Lecture 1 K1
13:15-14:30 h

Industrial gas cleaning processes – Trends and perspectives
Prof. Markus Lehner, Montan University Leoben, Austria

Cake Filtration-Influences on Cake Properties I L1
13:15-14:30 h

Evaluation of filter cake properties in microfiltration of microbial suspensions, N. Katagiri*, H. Kawahara, E. Iritani, Nagoya University, Japan

Influence of lysozyme crystal morphology on extent of crystal breakage during filter cake compression, B. Cornehl*, A. Schwab, P. Büser, H. Nirschl, Karlsruhe Institute of Technology, Germany

Influence of ionic strength on the local filtration properties of TiO_2, T. Mattsson, J. Wetterling, J. Durruty*, H. Theliander, Chalmers University of Technology, Sweden

Filtration of Metal Melts L2
13:15-14:30 h

Modeling and simulation of metal melt filtration process, E. Werzner*, M.A.A. Mendes, S. Ray, D. Trimis, Technical University Bergakademie Freiberg, Germany

Development of a model system to investigate the filtration efficiency of ceramic foam filters used in metal melt filtration, F. Heuzeroth*, U.A. Peuker, Technical University Bergakademie Freiberg, Germany

The influence of particle agglomeration on the filtration efficiency of ceramic foam filters, J. Fritzsche*, U.A. Peuker, Technical University Bergakademie Freiberg, Germany

Classification / Sorting L3
13:15-14:30 h

Classification of zinc sulfide nanoparticles by using size selective precipitation method, Y. Mori*, S. Komada, K. Tsuchiya, Doshisha University, Japan; D. Segets, W. Peukert, University Erlangen-Nuremberg, Germany

Advances in semi-continuous centrifugal processes for classification of colloidal particles, M. Konrath*, H. Nirschl, Karlsruhe Institute of Technology, Germany

Magnetically enhanced centrifugation with a longitudinal permanent magnet, J. Lindner*, K. Menzel, H. Nirschl, Karlsruhe Institute of Technology, Germany

Ceramic Membranes M1
13:15-14:30 h

Enhanced oil recovery monitoring for oilfield produced water treatment using rotating ceramic membranes, B. Schnabel*, M. Ebrahimi, O. Schmitz*, S. Kerker, J. Hild, P. Czermak, University of Applied Sciences Mittelhessen; C. Gutman, M. Aden, Faudi Aviation Sensor GmbH, F. Liebermann, Novoflow, Germany

Assessment of the process performance of produced water treatment with ceramic membranes through integration of online oil-monitoring, S.J. Kerker*, M. Ebrahimi, J. Hild, P. Czermak, University of Applied Sciences Mittelhessen; A.A. Schmidt, DECKMA HAMBURG GmbH, Germany

Microfiltration of waxy maize starch hydrolysate to isolate starch nanocrystals, A. Romdhane*, M. Aurousseau, A. Guillet, E. Mauret, Grenoble INP-Pagora; J. Yao, N. Hengl, S. Baup, F. Pignon, University Joseph Fourier Grenoble, France

Keynote Lecture 2 K2
15:00-16:15 h

Sedimentation and consolidation behavior of stable and flocculated suspensions. Direct in situ visualization and analysis, Prof. Dietmar Lerche, L.U.M. GmbH, Germany

Cake Filtration-Influences on Cake Properties II L4
15:00-16:15 h

Cake formation and particle rejection in filtration of binary mixtures of particles with different sizes, E. Iritani*, N. Katagiri, Y. Ishikawa, Nagoya University, Japan

A new filtration law for fiber suspensions based on the random rod packings, A.P. Philipse*, Utrecht University, Netherlands

The Blaine index measurement and correlation to average specific cake resistance, M. Huhtanen*, R. Salmimies, D. Safonov, A. Kraslawski, A. Häkkinen, Lappeenranta University of Technology; J Palmer, B. Ekberg, Outotec Filters, Finland

Filter Test Systems I G1
15:00-16:15 h

Influence on the clean gas volume on the transient differential pressure during jet pulse cleaning in a filter media testing rig, O. Kurtz*, G. Kasper, J. Meyer, Karlsruhe Institute of Technology, Germany

Semi-automated gas turbine inlet filter testing according ARAMCO standard or for performance optimization, D. Renschen*, J. Schamberg, DMT GmbH & Co. KG; N. Guttenbrunner, N. Schneider, Bilfinger-Gerber GmbH, Germany

New method to measure the mechanical collection mechanisms of full-scale air filters, P. Tronville*, Politecnico di Torino, Italy; R. Rivers, EQS Inc., USA

Nano Particle Separation G2
15:00-16:15 h

Evaluation of the behaviour and performance of a polypropylene filter in removing nanoparticles, P.M. Barros*, M.L. Aguiar, Federal University of São Carlos, Brazil

Influences on the fractional separation efficiency determination of air filter media in the size range of 5 nm up to 1 µm, M. Schmidt*, Palas® GmbH, Germany

Intensification of nanoparticles collection efficiency in a bubble column, M.-C. Cadavid-Rodriguez*, D. Bémer, INRS - Institut National de Recherche et de Sécurité; A. Charvet, D. Thomas, LRGP - Laboratoire Réactions et Génie des Procédés, France

Special Membranes M2
15:00-16:15 h

Wet chemicals ultrapurification for the electronic industry by reverse osmosis membrane cascades, R. Abejón*, A. Garea, A. Irabien, University of Cantabria, Spain

Relationship between preparation conditions of nanofiber membrane and filtration performances of Particle Suspensions, Y. Mukai*, K. Takiguchi, E. Amano, Nagoya University, Japan

Tubular membrane filtration for lime softening water treatment, D. Frick*, POREX Filtration, USA

Keynote Lecture 3 K3
16:45-18:00 h

Separation and classification in the size range below 10 µm – Challenges and new approaches, Prof. Urs Peuker, Technical University Bergakademie Freiberg, Germany

Cake Filtration-Desaturation L5
16:45-18:00 h

Desaturation and/or consolidation – Limits of mechanical demoisturing of filter cakes, H. Anlauf*, Karlsruhe Institute of Technology, Germany

Dryness limit: A useful parameter to assess sludge dewatering, P. Ginisty*, F. Guei, IFTS International Filter Testing Services; J. Olivier, J. Vaxelaire, Université de Pau et des Pays de l'Adour; R. Girault, J. Tosoni, IRSTEA, France

Dewatering mechanisms of compressible filter cakes, S. Strubel*, H. Anlauf, H. Nirschl, Karlsruhe Institute of Technology, Germany

Filter Test Systems II G3
16:45-18:00 h

Air filter testing under overpressure up to 10 bar and isobaric conditions in accordance with ISO 12500, S. Schütz*, L. Mölter, Palas® GmbH, Germany

Not all air filters class F7 to EN 779:2012 are created equal, J. H. Wenzek*, FT & C BV; L. Delfs, J. Verlaan, AFPRO Filters B.V., Netherlands

Comparison of the particle penetration through personal protection filter media using three different test methods, H.-G. Horn*, TSI GmbH, Germany; T. Johnson, TSI Inc., USA

Airborne Molecular Contaminations
16:45-18:00 h **G4**

Filtration for advanced AMC control for leading-edge microelectronics manufacturing, C. Muller*, R. van Dijke, A. Edeling, Purafil, Inc, USA

Performance of adsorptive materials - Test line based on FT-IR as an analytical method, M. Puutio*, S.-L. Jäppinen, Defence Forces Technical Research Centre, Finland

Assessment of gas cleaning systems for removing AMC and TIC / TIM, H. Finger*, U. Schneiderwind, W. Mölter-Siemens, S. Haep, D. Bathen, Institute for Energy and Environmental Technology (IUTA), Germany

Membrane Characterization
16:45-18:00 h **M3**

Capillary flow porometry a tool for the characterisation of pore size distribution of through pores in filters and membranes, C. Agarwal, A.K. Pandey, A. Goswami, Bhabha Atomic Research Centre, India; D. Pattyn*, A. Cano-Odena, Porometer, N.V., Belgium

Empirical evaluation of measurement uncertainty of vickers hardness of ceramic filter media, M. Mannila*, A. Häkkinen, Lappeenranta University of Technology, Finland

Application of ceramic multi-channel flat membranes for filtration of digestate sewage, H. Heymer, H.-J. Richter, O. Scheithauer*, B. Fassauer, J. Adler, Fraunhofer-Institute for Ceramic Technologies and Systems, Germany

Wednesday, October 23, 2013

Electric / Thermal Separation Enhancement 08:30-09:45 h **L6**

Electrodewatering of wastewater sludge: Factors affecting kinetics and energy consumption, J.-B. Conrardy*, J. Olivier, J. Vaxelaire, Université de Pau et des Pays de l'Adour, France

Optimisation of the mineral sludge pressure electrodewatering: Combination of flocculation, electric treatment and cake heating, M. Citeau, M. Loginov*, N. Lebovka, O. Larue, E. Vorobiev, University of Compiègne, France

Dehydration: Coupling centrifuge drainage with microwave drying operation, X. Apaolaza, P. Ginisty*, IFTS International Filter Testing Services; M. Valat, W. Jomaa, A. Sommier, Bordeaux et Arts et Métiers ParisTech, France

Poster Session I
08:30-09:45 h **L7**

BASP Star Filter to replace cartridge filters - In continuous operating large chemical plants, B. Patil*, BASP Industries, India

Filtration of emulsified polymer waste water, B. Patil*, V. Patil, BASP Industries, India

Flocculation behaviour of colloidal suspension by use of inorganic and polymer flocculants in powder form, H. Kadooka*, Y. Kiso, T. Tanaka, M. Iwata, Osaka Prefecture University, Japan; M.S. Jami, Islamic University Malaysia, Malaysia

Simplified flocculation model for inorganic and polymer flocculants, H. Kadooka*, T. Tanaka, M. Iwata, Osaka Prefecture University, Japan; M.S. Jami, Islamic University Malaysia, Malaysia

Analysis of solid concentration distribution in batch sedimentation for viscous Newtonian and Non-Newtonian fluids, B.A. Moreira, F.O. Arouca, J.J.R. Damasceno*, Federal University of Uberlândia, Brazil

Antisolvent crystallization and pressure filtration of salicylic acid: Influence of mixing conditions, S. U. Deulgaonkar*, B. N. Thorat, Institute of Chemical Technology (Formerly UDCT), India; A. Häkkinen, Lappeenranta University of Technology, Finland

Determination of permeability characteristics of solid/liquid separation using simplex algorithm, T. Tanaka*, H. Kato, R. Fukuyama, N. Hayashi, M. Iwata, Osaka Prefecture University, Japan; M.S. Jami, Islamic University Malaysia, Malaysia

Flushing - filter cake washing with miscible and immiscible fluids, M. Wilkens, M. Burisch*, U.A. Peuker, Technical University Bergakademie Freiberg, Germany

Analysis of centrifugal dewatering: Consolidation behaviour with and without supernatant, R. Fukuyama*, T. Tanaka, M. Iwata, Osaka Prefecture University, Japan; M.S. Jami, Islamic University Malaysia, Malaysia

Preparation of activated carbon eletrodes for water purification, N. Hoda*, E. Bayram, B. Uysal, Akdeniz University, Turkey

Electrosorption of aromatic organic compounds onto activated carbon electrodes for water purification, B. Uysal, M. B. Adanali, F. Sakliyan, E. Bayram*, Akdeniz University, Turkey

Poster Session I
08:30-09:45 h **G5**

Analysis of the effect of the filtration velocity in hot gas filtration, B. Alonso-Fariñas*, M. Lupion, M. Rodriguez-Galan, V. J. Cortes, B. Navarrete, University of Seville, Spain

Evaluation of cake porosity behaviour under high pressure conditions, E.H. Tanabe*, Federal University of Santa Maria; B.J.C. Castro, M.L. Aguiar, Federal University of São Carlos, Brazil

Simulation of the dust cake build-up on surface filters, S.M.S. Rocha, E.R. Nucci*, Federal University de São João Del Rei; M.L. Aguiar, Federal University de São Carlos, Brazil

Behaviour of the number of cycles of filtration and pulse-jet cleaning on polypropylene fabric filter, S.S.R. Cirqueira, P.M. Barros*, M.L. Aguiar, Federal University de São Carlos; Brazil

A comparative assessment of existing gas-solid filtration systems and a novel pulse-less filter, S.D. Sharma*, K. McLennan, M. Dolan, A.Ilyushechkin, CSIRO Energy Technology, Australia

New development in fabric filter design leading to lower CAPEX, L. Gamborg*, K. Skriver, C.-V. Rasmussen, K. Poulsen, FLSmidth A/S, Denmark

Filtration of dust particulates using a granular bed filter, Y.-S. Chen*, Y.-P. Chyou, S.-C. Li, Atomic Energy Council; S.-S. Hsiau, National Central University, Taiwan

Evaluation of the efficiency in the bioaerosols eradication of filters doped with silver nanoparticles, P.F. Rosa, A. Bernardo, M.L. Aguiar*, Federal University of São Carlos, Brazil

Nanofibre structures in bacteria deactivation and removal from wastewater and polluted air, D. Kimmer*, I. Vincent, SPUR a.s., J. Lev, ASIO spol. s r.o.; L. Kalhotka, Mendel University of Brno; P. Mikula, Institute of Botany of the ASCR; R. Korinkova, COC s.r.o.; M. Zatloukal, Tomas Bata University in Zlin, Czech Republic

Separation of particles out of air by individual flat movable collectors, G. Reznik*, E. Schmidt, University of Wuppertal, Germany

Poster Session I
08:30-09:45 h **M4**

Simulation of FIB-SEM images for segmentation of porous microstructures, T. Prill, K. Schladitz*, Fraunhofer Institute for Industrial Mathematics ITWM, Germany

Analysis and modelling of the microstructure of ceramic foams, J. Kampf, C. Redenbach*, University of Kaiserslautern, Germany

A reliable method for approximating the PPI value of foams, A. Moghiseh*, J. Ohser, University of Applied Sciences Darmstadt; C. Redenbach, University of Kaiserslautern, Germany

Ceramic nanofiltration membranes in chemical and pharmaceutical applications, S. Duscher*, Inopor GmbH, Germany

Preparation and properties of thin film composite membranes by a spin coating method, M. Karthik*, A.K. Suresh, Indian Institute of Technology Bombay, India

Treatment of textile effluents using membrane provided from FP7 collaborative project (BioNexGen), E.A. Abdel-Aal*, Central Metallurgical Research and Development Institute, Egypt

Removal of cesium from contaminated water using affinity membrane prepared by combining nanofiber with iron ferrocyanide, A. Mizuno*, Y. Mukai, Nagoya University, Japan

New ways of mobile drinking water purification for disaster response and military, M.K. Saygin, J. Raiser*, R. Schönfeld, Blücher GmbH, INC Leipzig, Germany

Compact module for simultaneous particle filtration and disinfection of aqueous media in chilling units, B. Gemende*, A. Gerbeth, R. Hahn, N. Pausch, S. Röhlig; University of Applied Sciences Zwickau; J. Bossert, Friedrich Schiller University Jena; W. Schellbach, A. Werner, OFS Online Fluid Sensoric GmbH, Germany

Separation of gentamicin C_1 from biosynthetic gentamicins by facilitated pertraction for increasing antibiotic activity, A.C. Blaga*, D. Cascaval, L. Kloetzer, Technical University of Iasi; A.I. Galaction, University of Medicine and Pharmacy of Iasi, Romania

Study on separation of folic acid by synergic reactive extraction, L. Kloetzer*, A.C. Blaga, D. Cascaval, Technical University of Iasi; A.I. Galaction, University of Medicine and Pharmacy of Iasi, Romania

Operations of direct contact membrane distillation and vacuum membrane distillation on seawater desalination, T.W. Cheng*, K.-L. Yeh, Tamkang University, Taiwan

Simulation and experimental studies of multi-effect air gap membrane distillation on saline water desalination, C.-D. Ho*, C.-H. Cheng, T.-J. Yang, Tamkang University, Taiwan

Hydrothermal / Encymatic Separation Enhancement 11:00-12:15 h L8

Effect of hydrothermal reaction conditions on filtration performance of sewage sludge, N. Kobayashi*, K. Nakayama, S. Tachibana, Y. Tanabe, Nagoya University; Y. Itaya, Gifu University, Japan

Reduction of fiber size during enzymatic hydrolysis of biomass and determination of filtration properties of biomass suspensions, T. Kinnarinen*, A. Häkkinen, Lappeenranta University of Technology, Finland

Use of filter aids for improving the filterability of biomass suspensions, M. Golmaei*, T. Kinnarinen, A. Häkkinen, Lappeenranta University of Technology, Finland

Slurry Concentration / Thickening 11:00-12:15 h L9

Reducing energy footprint of a waste water treatment plant by increasing harvesting efficiency of solids during primary clarification, A.R. Völkel*, H.B. Hsieh, N. Chang, A. Kole, K. Melde, M. Stephenson, M. Sheridan, D. Johnson, Palo Alto Research Center, Inc., USA

Optimisation of throughput of a dynamic cross flow filter by adding course particles to the retentate, G. Grim*, Andritz KMPT GmbH, Germany

Properties of the lautering filter cake structure evaluated by x-ray microtomography, M. Kuhn*, K. Mathmann, J. Engstle, P. Först, H. Briesen, Technical University Munich, Germany

Surface Filtration I 11:00-12:15 h G6

Filter performance under non-uniformly distributed cake, M. Koch, G. Krammer*, Graz University of Technology, Austria

Dust emission and operation performance of pulse cleaned needle felts in a pilot-size bag house filter for different operation parameters, O. Kurtz*, J. Meyer, G. Kasper, Karlsruhe Institute of Technology, Germany

Characterization of industrial surface filter in pulse-jet filtration, A.K. Choudhary, A, Mukhopadhyay*, National Institute of Technology Jalandhar, India

Layer Formation 11:00-12:15 h M5

Investigation of the filterability of beer using different layer formation in the static and dynamic membrane filtration, M. Kupetz*, M. Zarnkow, T. Becker, Technical University Munich, Germany

Effects of membrane morphology on the performance of cross-flow microfiltration of protein/polysaccharide mixtures, K.-J. Hwang*, Y.-C. Chiang, Tamkang University, Taiwan

Validation of a long channel membrane test cell (LCMTC) for investigation of fouling in RO systems, W. Uhl*, N. Siebdrath, W. Ding, A. Lerch, E. Pietsch, Technische Universität Dresden, Germany; H. Vrouwenvelder, Delft University of Technology, Netherlands

Keynote Lecture 4 13:15-14:30 h K4

Compressibility effects in solid-liquid separation, Dr. Anthony Stickland, The University of Melbourne, Australia

Filter Media Cleaning 13:15-14:30 h L10

Cleaning of filter media in solid liquid separation, H. Nirschl*, C. Weidemann, Karlsruhe Institute of Technology, Germany

Chemical regeneration of a ceramic filter medium used in hematite dewatering, R. Salmimies*, M. Matveinen, A. Häkkinen, Lappeenranta University of Technology; B. Ekberg, Outotec (Filters) Oy, Finland

Influence of magnetic fields on the adhesive behaviour of magnetizable particles – Simulation and verification, J. Knoll*, H. Nirschl, Karlsruhe Institute of Technology; A. Haarmann*, E. Schmidt, University of Wuppertal, Germany

Surface Filtration II 13:15-14:30 h G7

Modeling the pressure drop of cleanable dust filter media during aging in laboratory test rigs, M. Stecher*, G. Mauschitz, W. Höflinger, Vienna University of Technology, Austria

Multiple-use of precoat materials for the fine dust filtration of a baghouse filter for wood-fired heaters, S. Schiller*, H.-J. Schmid, University of Paderborn, Germany

Drum filter with cleanable filter media for the separation of fibrous dust including nano particles, J. Wolfslehner*, T. Laminger, W. Höflinger, Vienna University of Technology, Austria

Cross Flow Techniques 13:15-14:30 h M6

The role of an electrical field for the fractionation of milk peptides, A. Holder*, J. Weik, J. Hinrichs, University of Hohenheim, Germany

Dynamic polishing filter in metallurgical water treatment, P. Rantala, V. Hakala*, Sofi Filtration Ltd., Finland

Application of Si_xN_y-microsieves in laboratory scale filtration for a rapid detection of microorganisms in beverage industries, R. Novy*, J. Tippmann, T. Becker, Technical University Munich, Germany

Keynote Lecture 5 15:00-16:15 h K5

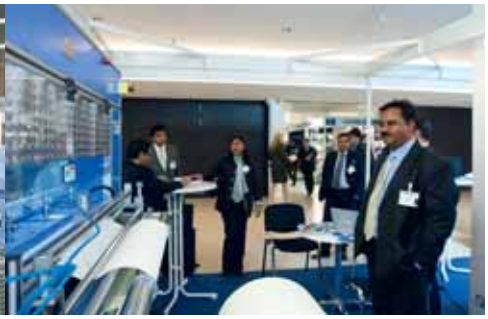
Solid-liquid separation – An Indian perspective, Prof. Bhaskar Narayan Thorat, Institute of Chemical Technology Mumbai, India

In-Situ Analysis of Slurry Separation Properties 15:00-16:15 h L11

Multistage centrifugation (MC): A new method for quantitative evaluation of filterability using the analytical photocentrifuge, M. Loginov*, M. Citeau, N. Lebovka, E. Vorobiev, University of Compiègne, France

Experimental determination of velocity distributions at gravity: In-situ measurement by STEP-Technology, T. Sobisch, H. Woehlecke, D.Lerche*, LUM GmbH, Germany

In-situ characterization of separation behaviour of aqueous metal oxide dispersions as function of pH and electrolyte, T. Sobisch, D. Lerche*, LUM GmbH, Germany



01.10.2013

Automotive Application I
15:00-16:15 h **G8**

Small cause – Large effect: Nanofiber technology for engine air filtration, I. Poljak*, A. Kilian, M. Heim, M. Lehmann, MANN + HUMMEL GmbH, Germany

High performance air intake module for trucks: Combination of high efficient nanofiber filter medium and innovative filter element concept, B. Renz*, A. Enderich, C. Feuchter, M. Steppe, M. Traub, MAHLE Filtersystems GmbH, Germany

Morphology of particle deposits on oil treated model filter fibers and the associated impact on efficiency evolution, T.K. Müller*, J. Meyer, G. Kasper, Karlsruhe Institute of Technology; E. Thébault, MANN+HUMMEL GmbH, Germany

Ultra Filtration
15:00-16:15 h **M7**

Development of ultrafiltration processes for recovery of hemicelluloses from wood extracts, M. Kallioinen*, E. Koivula, T. Nevalainen, M. Al-Manasrah, T. Sainio, M. Mänttäri, Lappeenranta University of Technology, Finland

Selective separation of bio-compounds by biological membranes permeabilized by pulsed electric field: a new way for "green" purification technologies, E. Vorobiev*, Technical University of Compiègne, France

Micellar enhanced ultrafiltration: More than water treatment, M. Schwarze*, L.A.T. Nguyen, M. Schmidt, M. Göttker, M. Kraume, R. Schomäcker, Berlin Technical University; A. Drews, HTW Berlin University of Applied Science, Germany

Keynote Lecture 6
16:45-18:00 h **K6**

Separation of particles out of gases by fabric filtration, Prof. Mônica Lopes Aguiar, Federal University of São Carlos, Brazil

Continous Cake Filters
16:45-18:00 h **L12**

Separation and washing of fatty acids from acetone on a BHS belt filter in pressure tight design, S. Ahlert*, BHS-Sonthofen GmbH, Germany

Hi-Bar filtration with large filters units, R. Bott*, T. Langeloh, BOKELA GmbH, Germany

Applicability of filter cake steam conditioning in hyperbaric disk filters, K. Hausharter, R. Raberger, G. Krammer*, Andritz AG, Austria

Automotive Application II
16:45-18:00 h **G9**

A new type of compact aerosol centrifuge, M. Junker*, M. Piesche, University of Stuttgart, Germany

Study and development of synthetic composite non-woven filter media using specialty fibres dedicated to dust filtration application, W. Jabri*, P. Vroman, A. Perwuelz, University Lille Nord de France, France

Size and rate consideration of entrainment from oil-mist filters for different operating conditions, S. Wurster*, D. Kampa, J. Meyer, G. Kasper, Karlsruhe Institute of Technology, Germany; B. Mullins, Curtin University of Technology, Australia

Membrane Bio Reactor
16:45-18:00 h **M8**

Intensification of a fermentation process for producing lactic acid in a ceramic membrane combined bioreactor system, R. Fan*, M. Ebrahimi, P. Czermak, University of Applied Sciences Mittelhessen; M. Aden, Faudi Aviation Sensor GmbH, Germany

Anaerobic membrane reactor (AMBER) for industrial wastewater treatment – Comparative operation of different membrane types, U. Theilen*, S. Herbert, University of Applied Sciences Mittelhessen; U. Witte, U. Austermann-Haun, J. F. Meier, University of Applied Sciences Ostwestfalen-Lippe, Germany

Sustainable process water treatment with membrane bioreactors, C. Hoffmann*, A. Rach, Microdyn-Nadir GmbH, Germany

Thursday, October 24, 2013

New Filter Testing Procedures and Apparatus 08:30-09:45 h **L13**

New international standard test methods of aerospace filters, C. Peuchot*, IFTS International Filter Testing Services, France

How to compare performances of domestic pools and spas filters, C. Peuchot*, H. Saidani, IFTS International Filter Testing Services, France

Hi pressure filterability and compressibility test cell, J. P. Féraud*, D. Bourcier*, D. Ode, CEA Marcoule; F. Puel, Université de Lyon, France

Poster Session II
08:30-09:45 h **L14**

An experimental approach to get high performance in coal filtration with filter press, E. Babini, D. Collini*, A. Grosso, F.Kaswalder, L. Tozzola, Bilfinger Water Technologies srl, Italy

Removal of emulsion droplets by immobilization in calcium alginate gel, N. Hayashi*, T. Tanaka, R. Yamada, M. Iwata, Osaka Prefecture University, Japan; M.S. Jami, Islamic University Malaysia, Malaysia

Material and equipment for water purification from lead, G.V. Medyak, V.I. Sokolova, A.A. Shunkevich, A.V. Bildyukevich*, V.P. Sokol, A.P. Polikarpov, National Academy of Sciences of Belarus, Belarus

Pigment separation by adsorption on coconut shell triturated, D.B. Soto, M.P. Gomes, P.S.S. Porto, S. M.S. Rocha*, Federal University of Espírito Santo, Brazil

Using biosorbent filters for removal of cupper from water, S. M. Alfadul*, Mohammad A. Khiyami, King Abdulaziz City for Technology, Saudi Arabia

Disinfection of secondary effluents by using slow sand filtration combined with electric fields – Contribution for direct reuse of domestic wastewater, D. Haaken, V. Schmalz, T. Dittmar*, E. Worch, Technische Universität Dresden, Germany

Feasibility of modeling by adsorption the low gradient magnetic separation of iron nanoparticles, F. Lancellotti, H.K. Hansen*, P. Núñez, F. Retamal, Technical University Federico Santa Maria, Chile

Chemical measurements of boiler acid cleaning, N.S. Al-Deffeeri*, Ministry of Electricity & Water, Kuwait

Nordson adhesive application technology - Save overall production cost and enhance sustainability by integrating future technology, S. Müller*, J. Klein, Nordson Deutschland GmbH, Germany

Poster Session II
08:30-09:45 h **G10**

Saving energy with lower-pressure-drop filtration media, I. Parker*, Ahlstrom, Filtration LLC, USA; S. Chavan, Ahlstrom Research Services, France; G. Costa, Ahlstrom Italy s.p.a., Italy

Particle deposition within fiber filters using OpenFOAM, N. Riefler*, U. Fritsching, IWT Institute; M. Becker, U. Heck, DHCAE Tools GmbH, Germany

A new approach in modeling the porous-fluid interface for CFD simulations of pleated filter elements, A. Traut*, Graduate School of Excellence in advanced Manufacturing Engineering Stuttgart; A. Beck, M. Lehmann, MANN+HUMMEL GMBH, Germany; M. Ali, Indian Institute of Technology Kanpur, India

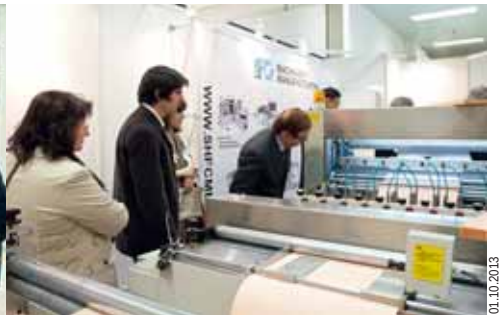
The applicability investigation on two models for porous airfilters, Y. Sun, J.J. Lu, China North Vehicle Research Institute, China; L.-P. Cheng*, Fraunhofer Institute for Industrial Mathematics ITWM, Germany

A CFD preliminary study of filtration of gases at high pressures, G.C. Lopes*, M.L. Aguiar, Federal University of São Carlos, Brazil

Computational fluid dynamics (CFD) study of air flow and deposition of particles in bifurcated ducts resembling human lungs, L.L.X Augusto, C.C.C. Silva, J.A.S. Gonçalves*, Federal University of São Carlos , Brazil

Numerically optimized cyclones for value-added product recovery, , J. Paiva, P. Araujo*, Advanced Cyclone Systems, R. Salcedo, LEPAE, Portugal

Evaluation of pendular liquid bridge formation in an environmental scanning electron microscope, F. Schröter*, E. Schmidt, University of Wuppertal, Germany



The study of gas effluent inlet layout over the performance of an industrial fabric filter: A CFD approach, K. Simon, F.B. Marques, F.A.R. Pereira, D.C. Ribeiro, S. M.S. Rocha*, Federal University of Espírito Santo, Brazil

Monitoring and Control G11
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Setup and validation of a novel coded ring sensor to detect charged particles, W. Moelter-Siemens*, S. Opiolka, A. Bankodad, S. Haep, Institute for Energy and Environmental Technology (IUTA), Germany

IPhone application for energy saving of filter replacement and maintenance routines, P. Ödling*, Dinair Group; L. Ekberg, CIT Energy Management AB; D. Broman, Sweden

Instrumental and methodological complex for monitoring inhalation intake radioactive aerosols, A. G. Tsovyanov, E. A. Karev*, Federal Medical-Biophysical Center - A.I. Burnazyan FMBA; E. A. Kramer-Ageev, National Research Nuclear University MEPhI, Russia

Components for Improved Filter Performance L15
11:00-12:15 h

RBG - High-corrosion-resistant filtersystem made of glass alternative to coated housings, B. Wenninger*, H. Duderstadt, A. Lock, adfiltec GmbH, Germany

Adhesives and sealants for filter manufacturing applications - Adhesion - Prospects, F. Steegmanns*, Stockmeier Urethanes, Germany; B. Blundell, Greenfield Polymenrs Ltd, UK

Fast and safe filter cloth fixing on drum filters and pan filters with BOKELA FrameTrak, R. Bott*, T. Langeloh, BOKELA GmbH, Germany

Functionalized Filter Media I L16
11:00-12:15 h

New material for water purification from natural organic matters, G.V. Medyak, V.I. Sokolova, A.A. Shunkevich, A.V. Bildyukevich*, National Academy of Sciences of Belarus, Belarus

Innovative filtration textiles for the adsorption and recovery of dissolved metals, T. Mayer-Gall*, P. Schuchardt, K. Opwis, J.S. Gutmann, Deutsches Textilforschungszentrum Nord-West GmbH (DTNW), Germany

Environmentally friendly low pressure plasma nanocoatings for filtration and separation, E. Rogge*, P. Legein, Europlasma B.V., Belgium

Particle Deposition G12
11:00-12:15 h

Impaction of spherical particles on an array of parallel bare filter fibers: A CFD study of collision probabilities and velocities upon contact, T.K. Müller*, J. Meyer, G. Kasper, Karlsruhe Institute of Technology, Germany

Characterization of open-pored foams with respect to aerosol deposition by means of measurement and simulation, A. Hellmann*, K. Schmidt, S. Ripperger, Kaiserslautern University of Technology, Germany

Surface dust-loading of pleated filters: Comparison of simulation with experiment, P. Hettkamp*, J. Meyer, G. Kasper, Karlsruhe Institute of Technology, Germany

Industrial Gas Cleaning G13
11:00-12:15 h

"Down Stream" bag house filter for industrial gas and air filtration, K.R.K. Schumann*, G.F.L. Schumann, Schumann Kompaktfilter, Germany

Effect of inlet dust concentration and pulse cleaning pressure on pulse jet filtration performances, A.K. Choudhary*, A. Mukhopadhyay, National Institute of Technology Jalandhar, India

High performing felts for industrial filtration, D. De Angelis*, E. Galletta, L. Cattaneo, M. Motta, Testori S.p.A., Italy

Monitoring of Separation Processes L17
13:15-14:30 h

Online measurement of centrate solids content for centrifugation process monitoring and control, M. Konrath*, H. Nirschl, Karlsruhe Institute of Technology, Germany

An electrical resistance tomography analysis on the behaviour of industrial filter press, F. Kaswalder*, L. Tozzola, D. Collini, Bilfinger Water Technologies srl; S. Ansaloni, A. Paglianti, G. Montante, F. Magelli, University of Bologna, Italy

Wax precipitation assessment of gas condensate in Haradh gas plant, B. Fadhel, N. Al-Qahtani, N.A. Alkhazam*, Saudi Aramco, Saudi Arabia

Functionalized Filter Media II L18
13:15-14:30 h

Viscose speciality fibres for filtration applications, P. Wimmer*, Kelheim Fibres GmbH, Germany

Advanced cellulosic mutilayer filter media to maximise fine particle filtration, A. Slater*, M. Gallo, Lenzing Fibers, Austria

Ion exchange characteristics of functionalised filter sheets, S. Lösch*, U.A. Peuker, Technical University Bergakademie Freiberg, Germany

Numerical Filter Simulation I G14
13:15-14:30 h

Modeling of NaCl aerosol deposition at electrically charged microfibers, K. Schmidt*, A. Hellmann, M. Pitz, S. Ripperger, Technical University Kaiserslautern, Germany

Flow simulations of air filter media containing nanofibers, C. Feuchter*, A. Stief, Aalen University; R. Handel, G. Baelz, A. Enderich, B. Renz, Mahle Filtersysteme GmbH, Germany; K. Langfeld, University of Plymouth, UK

Theoretical prediction of the filtration resistance across glass fiber filter media, M. Tang*, Y. Liang, J. Hu, Z. Yang, South China University of Technology, China

Cabin Air Filters G15
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Conclusions of a project how to interpret standardized lab tests versus olfactory tests for the characterization of the filter performance for the reduction of odors and gaseous substances, S. Trnetschek*, fiatec GmbH, Germany

Improving the air permeability and peel strength of supported meltblown cabin air filter media, S. Jarrett, M. Tipper*, S.J. Russell, Nonwovens Innovation & Research Institute Ltd, UK; L. Van der Molen, Bonar, Netherlands

Advantages of using nanofibers on downstream, F. Lybrand*, Emarco, Inc., USA; C. Tekmen, Elmarco s.r.o., Czech Republic

Microscreens / Strainer L19
15:00-16:15 h

High capacity micro filter belts – A new concept and new opportunities, C. Maurer*, Sefar AG, Switzerland

Importance of initial design of horizontal strainers - Liquid petroleum product pipeline - Project engineering, B. Patil*, V. Patil, BASP Industries, India

Cloth characteristics: Air and liquid permeability and pore size distribution, M. Shakhanova*, R. Salmimies, A. Häkkinen, Lappeenranta University of Technology, Finland

Depth Filtration in Granular Media L20
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Removal of pharmaceutical residues in drinking water, R. Schönfeld, J. Raiser*, BLÜCHER GmbH, Germany

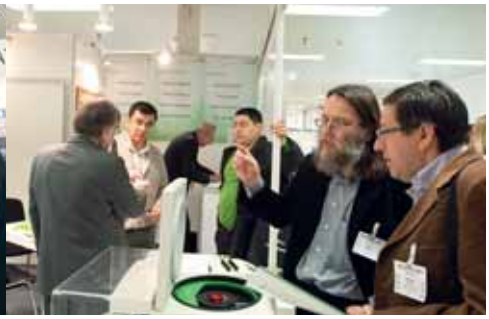
Activated carbon honeycombs - Function, advantages, application, M. Hartmann, O. Schmolinski*, helsatech GmbH, Germany

Assessment of filter backwash in deep bed filtration on basis of drinking water productivity, I. Slavik*, A. Jehmlich, W. Uhl, Technische Universität Dresden, Germany

Numerical Filter Simulation II G16
15:00-16:15 h

Simulating the compression of filter materials, M. Kabel*, H. Andrä, Fraunhofer Institute for Industrial Mathematics ITWM, F. Hahn, M. Lehmann, MANN+HUMMEL GmbH, Germany

New simulation tool embedded in the MAHLE filter media development process to generate new innovative media solutions in short time to market, A. Enderich*, B. Renz, C. Feuchter, M. Steppe, MAHLE Filtersystems GmbH, Germany



Modelling and simulation of fluid-porous structure interaction (FPSI) on the filter element scale, D. Iliev, O. Iliev, R. Kirsch*, Fraunhofer Institute for Industrial Mathematics ITWM; M. Dedering, IBS FILTRAN GmbH, Germany; A. Mikelic, Université Claude-Bernard Lyon, France

Pleated Filter Media G17
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An experimental protocol to analyze the structure of nanoparticles deposit in pleats of industrial HEPA filters, S. Bourrous*, L. Bouilloux, Institut de Radioprotection et de Sûreté Nucléaire (IRSN); J.-C. Appert-Collin, D. Thomas, Université de Lorraine; D. Bemer, Institut National de Recherche et de Sécurité (INRS); L. Tampère, Camfil, et al., France

Synthetic pleatable filter media – New nonwoven materials set standards, U. Hornfeck, A. Burger*, Sandler AG, Germany

Combination of HVAC filter media development and pleating process design for optimum performance, A. Seeberger*, A.Jung, T. Ertl, IREMA-Filter GmbH, Germany

Coalescer L21
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Numerical simulation of the electrostatic coalescence process for an ideal water-in-crude-oil emulsion using a numerical approach, R. Olea-Pérez*, H. Nirschl, Karlsruhe Institute of Technology, Germany

Innovative coalescence media and water removal applications in fuels and oils, R. Chen*, Kaydon Filtration Corp; T. Ramsey, Purafil, Inc, USA

Backwash Filters L22
16:45-18:00 h

Removal of fine particles from karst spring water by means of an automatic backwash filter and micro filter mesh, M. Hochedlinger*, P. Stimpfl, E. Hawle Armaturenwerke GmbH; A. Kavazovic, R. Sulzbacher, G. Gruber, Graz University of Technology; S. Strasser, S. Schöpf, Lenzing Technik GmbH, Austria

Automatic backwash filter improves performance in pharmaceutical process, S. Schöpf*, S. Strasser, Lenzing Technik GmbH, Austria

Filtration of cleaning baths with automatic filtration system, J. Wögerer*, S. Strasser, A. Wimmer, Lenzing Technik GmbH, Austria

Numerical Filter Simulation III G18
16:45-18:00 h

Improved modeling of filter efficiency in life-time simulations on fibrous filter media, J. Becker*, A. Wiegmann, Math2Market GmbH; F. Hahn, M. Lehmann, Mann+Hummel GmbH, Germany

Numerical simulation of non Darcy flow using filter element simulation toolbox (FiltEST), O. Iliev, R. Kirsch, Z. Lakdawala*, Fraunhofer Institute for Industrial Mathematics ITWM, Germany; V. Starikovicius, Vilnius Geiminias University, Lithuania

PleatLab: a pleat scale simulation environment for filtration simulation, L. Cheng*, A. Wiegmann, Math2Market GmbH; R. Kirsch, Fraunhofer Institute for Industrial Mathematis ITWM, Germany; D. Tomas, N. Bardin-Monnier, P.C. Gervais, CNRS LRGP, France

Special Filter Media G19
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Technostat® Plus as a value adding proposition in respiratory equipment, B. Keil*, P. Lindblom, J. Mills, J. Manns, H&V, Germany

GEA Delbag Firetex® - A new grade of fire-resistant synthetic filter media, T. Stoffel*, M. Sauer-Kunze, GEA Air Treatment GmbH, Germany

Effect of nucleating agents on the performance of electret filters, A. Kilic*, Istanbul Technical University, Turkey; E. Shim, B. Pourdeyhimi, B.-Y. Yeom, North Carolina State University, USA

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NEW METHOD TO MEASURE THE MECHANICAL COLLECTION MECHANISMS OF FULL-SCALE AIR FILTERS

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ABSTRACT

Air filters are chosen for the minimum particle-capture efficiency they can provide in a specific application. Some media can achieve high efficiencies at low resistance to air flow by adding electrostatic charges on fairly coarse fibers. However, prolonged filter exposure to fine particles reduces the electrostatic enhancement effect. The filter efficiency must then rely mainly on mechanical collection mechanisms, and can fall well below the initial value. It is useful to test filter media when the effect of electrostatic charges is eliminated.

To estimate the efficiency drop that may occur, air filter test standards include filter conditioning procedures to inhibit the effect of electrostatic charges. These treatments should leave only particle capture effects from mechanical collection mechanisms such as sieving, aerodynamics and diffusion, but not reduce or enhance these effects. EN779:2012 and ISO 21220:2009 describe such a conditioning treatment for filter media, and ASHRAE 52.2-2012 describes one for full-scale filters.

The ASHRAE 52.2-2012 optional treatment suggests that air filters be exposed to a potassium chloride aerosol having approximately 35 nm count mean diameter. Following the charge-elimination treatment, procedures measuring efficiency as a function particle size are performed. In ISO/TS 21220:2009 and EN779:2012 the discharging treatment is also mandatory, but is performed on samples of the media used to manufacture the filter. This treatment requires a 2 minute soak in essentially pure isopropyl alcohol (IPA), after which the media samples are dried for 24 hours before further tests. This method presents problems, namely, that soaking in a liquid may alter the mechanical efficiency of media, and that samples of media may not be representative of the media used in the full-scale filter.

A new approach, developed by T. Hayashi in Japan, eliminated electrostatic effects in electret-enhanced media sheets by exposure to IPA vapor for 16 hours or longer. This procedure was successfully duplicated by J. Cai in China, and at the Politecnico di Torino. ISO/TC142/WG9 in 2010 ran an inter-laboratory comparison to assess this procedure, and in 2011 organized another comparison which extended the method to full-scale filters. The full-scale tests have included three different types of air filters, comparing the results with the other approaches previously mentioned. These results will be useful for revising the current ISO 29461-1 test method and also for developing the new ISO 16890 series for general ventilation applications. Here we summarize the data obtained at the Politecnico di Torino, and describe the new test protocol that could be adopted by future international filter test standards.

KEYWORDS:
Filter test, Filter Efficiency, Electrostatic Charges, Service life, ISO standards, EN 779:2012, ASHRAE

1. Introduction

Fibrous air filter media composed of polymer fibers carrying relatively permanent electrostatic charges (electrets) have widespread use in air filters because they provide substantially improved particle capture efficiency without increasing the pressure drop (resistance) of the fibrous media in such filters. Many studies present examples of particle capture improvement by electret-enhanced media. Indeed, studies of electret-media degradation from various exposures are testimonies to the efficiency improvement which is obtained by electret-enhancement.
Electrostatic forces may also enhance the efficiency of fibrous media which have not been intentionally charged, for both natural and test aerosols may carry randomly-distributed charges (Hoppel, 1990). These charges induce “image” charges in dielectrics, such as the glass and polymer fibers in filter media. The resultant electrostatic forces on charged aerosol particles are directed toward fibers, hence enhance particle capture. Image-force phenomena are described in Brown (1993, p 158-166). In addition, the adhesion of particles to fibers, which influences efficiency, depends in part on electrostatic effects (Zimon, 1969).
Many studies have shown, however, that electrostatic effects decline under various conditions met in actual filter service. Examples of efficiency degradation with exposure to ambient and workroom aerosols are described by Brown (1980, 1988), Chen (1993), Janssen (2003), Ji (2003), Raynor (2004), and Hanley (2005). Filter applications require knowledge of worst-case performance, rather than average or best-case performance. For this reason, experimenters and standards-writing committees have sought media treatments which eliminate electrostatic effects from filter media, while leaving the aerodynamic and diffusional effects unchanged. The choice of an agent to do this in a repeatable, reliable manner for all forms of electrified fibers is not simple. Such treatment could degrade some media and not others, and therefore should be applied to all media before performance tests. It should be applicable to full-scale filters as well as media samples without undue testing burdens.

2. Media Discharging / Neutralization Methods

2.1 Discharging Mechanisms

The physical mechanisms that suppress the electrostatic charges on electret fibers are not agreed upon by those who have made these studies. These general mechanisms have been proposed:

- Neutralization by gaseous ions and charged particle contact;
- Shielding by a layer of conductive particles or conductive liquid film;
- Dissolution of fiber surface layer by a solvent;
- Chemical reactions with the fiber surface;
- Conduction between charged patches by ions of a liquid coating.

The understanding of electret suppression is further complicated by the fact that some treatments of some media have improved, rather than degraded, particle-capture efficiency. Particle-based treatments, for example, may improve mechanical capture mechanisms as they suppress electrostatic effects. Treatments can alter the structure of media, and hence its flow resistance. An example of this is possible clumping of fibers after media immersion in a liquid. An examination of past charge suppression studies is helpful in evaluating which method is likely to be effective in

charge suppression and yet minimally alter media mechanical particle capture mechanisms.

2.2 Discharge by Exposure to Ion Clouds and X-Rays

The obvious way to neutralize an electret would seem to be to add ions to the air passing through the medium. Ions of sign opposite to the charge on the medium could be added, to neutralize the charges on the fibers. Ions can be added by X-rays and corona-discharge generators. Studies of these procedures (Brown, 1980; Fjeld, 1988; Lee, 2004; Agranovski, 2006; Chazelet, 2011) have shown that they usually increase, rather than decrease, particle capture efficiency. This is apparently because ions attach themselves to the aerosol particles, and because the charge patches on the fibers are tightly bound. Charging particles brings coulombic electrostatic forces into action, which substantially improves particle capture for electret media. Improvement was observed for both ion-cloud polarities. Intentional charging of particles ahead of an electret filter may, however, lead to unexpected effects. If the particle capture capability of the dust-loaded electret media decreases (perhaps from high humidity), the charged particles will be captured on downstream surfaces, with clearly visible deposit patterns.
Exposing the media itself to X-rays, however, is another matter. Janssen (2003) found that even quite soft X-rays directed toward electret media overcame the energy barriers binding electret charges, and eliminate the electrostatic properties. The charge reduction was, however, less pronounced than that produced by dipping the media in IPA, and given the difficulties of X-ray media exposure, especially for full-scale filters, does not seem to be a suitable method.

2.3 Discharge by Exposure to Elevated Temperature and Prolonged Storage

Tsai (1999) describes the rapid efficiency decline resulting from increasing corona-enhanced electret media temperature above 120 °C for a few minutes. Huang (2001) studied thermal degradation of electret media experimentally, and provides a theoretical basis for it. Some studies showed only minor declines in efficiency from prolonged storage at ambient temperatures, even with relative humidity up to 100%, for example Viscusi (2009), while others (Tsai, 1999) showed substantial declines from 9 months storage. The methods used to form electrets in the media used in these tests may not have been alike.

2.4 Discharge by Particulate Loading

Several studies using aerosols to eliminate electrostatic effects have been undertaken. Aerosols used for this purpose have included: ambient natural aerosol; soot and other carbon forms; Diesel engine exhaust fumes; stearic acid, “oil”, Di-octyl Sebacate (DOS), Di-Octyl Phthalate (DOP), and NaCl and KCl micro- and nano-particles. Of these, air filter preconditioning with KCl nano-particles has been included in ASHRAE 52.2 test standard. Exposure of full-scale filters is easily implemented with a small diesel engine and a test duct with outdoor discharge. The ASHRAE 52.2-2012 standard uses nanoparticles for charge suppression, but requires rather more additional test equipment (see section 3 below). In general, initial accumulations of nanoparticles reduce the efficiency of electret media, apparently by shielding the electrostatic fields of the electrets. As larger particles accumulate, mechanical filtration mechanisms grow stronger, and efficiency improves, especially for exposure to solid particles. Simultaneously, however, media

pressure drop rises. These effects are documented by Biermann (1982); Blackford (1986); Chen (1993); Walsh (1998); Barrett (1998); Hanley (2005); and Plebani (2012).

2.5 Discharge by Liquid Immersion

Studies of charge suppression by immersion of electret media in liquids, or “dipping”, have produced mixed results. Pure water is reported (Biermann, 1982) to have had minimal discharging ability, but water with ionic additives which fully wet the fibers, such as NaCl plus surfactants, did decrease efficiency markedly. Immersion in the organic solvents hexane, heptane, iso-octane, benzene, toluene, and a methylethyl ketone/acetone mixture have been tried, with varying levels of charge suppression (Biermann, 1982; Jasper, 2005, 2007; Kim 2007,2009). Immersion in liquid isopropyl alcohol (IPA) has been studied extensively, and adopted as a discharging method for the EN779 (CEN, 2012) filter test standard, and ISO/TS 21220 (ISO, 2009). The results of these tests indicate that to be effective, the liquid must wet the fibers, and be ionic. It is not clear to what extent fiber rearrangement – clumping – might explain some of the reduction in efficiency from immersion and drying of the media samples. Some studies have examined the fiber surfaces after discharge by immersion, using scanning electron microscope images, and found no evidence of surface changes.

2.6 Discharge by Surfactants

Surfactants can to some degree energize water to discharge electrets (Biermann, 1982). However, a surfactant can also be used to convert an uncharged polymer into an electret (Yang, 2004). The choice of a preconditioning agent must be made carefully to avoid unforeseen behavior.

2.7 Discharge by Exposure to Vapors

The effects of high relative humidity, with condensation of pure water vapor on electret fibers, appear to be limited (Moytl, 2006; Moyer, 1989). Vapors of organic liquids are altogether different. Studies of the effect of organic vapor exposure on electret filter media have been reported by investigators interested in the reliability of face masks employing such media. Jasper (2005, 2006) reported significant efficiency loss with exposure to toluene and xylene vapors. A combination of vapors of methylethyl ketone and acetone decreased electret media efficiency, but the effect of ethylbenzene vapors was minimal (Biermann, 1982). Isopropyl alcohol (IPA) vapor has been stated to eliminate charge even more effectively than liquid IPA, according to Hayashi and Cai (ISO 2010). Again, ionic properties of the condensed vapor and the length of exposure time seem to be essential for successful charge suppression.

3. Standardized Test Procedures to Obtain Discharged Filter Media and Filters

3.1 Filter media

EN 779:2012 and ISO/TS 21220:2009 required that filter media undergo a procedure intended to nullify electrostatic effects. This procedure began with measurement of initial efficiency followed by immersion of flat-sheet samples of media in liquid IPA. After immersion the samples are drained, allowed to dry for 24 hours, then tested for particle capture efficiency using the standard’s diethyhexyl-sebacate (DEHS) aerosol.

3.2 Full-scale filters

While almost all tests of the immersion (“dipping”) procedure report significant efficiency decreases for electret-fiber media, and relatively small changes in efficiencies for non-electrified media, the standards merely assume that the mechanical filtration mechanisms for the media are not affected by immersion in IPA and drying. The immersion procedure has been applied to full-scale filters, but the large amount of liquid IPA needed is hazardous, and troublesome from the environmental impact of its disposal.

The ASHRAE 52.2 Air Filter Test Standard originally essentially ignored charge-suppression procedures, but in 2000-2004 a study was funded by ASHRAE to provide a standardized, normative procedure. In 2007 an addendum to the Standard (ASHRAE, 2008) incorporating the results of this study was approved. The procedure can be applied to full-scale pleated or extended-media filters, but its use is voluntary, not normative. The suppression agent is an aerosol of potassium chloride (KCI) particles with approximate count-mean diameter of 35 nm, considerably finer than the aerosol specified for testing the particle-size-efficiency of filters. This aerosol is produced in the needed quantity for full-scale filters by using a few Laskin-nozzle generators and a very diluted solution of KCI in water. A condensation nucleus counter (CNC) is required to demonstrate conformity of this charge-suppression aerosol with the specifications in the ASHRAE standard. Details of the procedure are given in Hanley (2005). The procedure described in ASHARE 52.2 may take a long time to be completed and the testing lab must proceed very carefully to avoid clogging the filter instead of neutralizing it. The consequence is that the cost of the test would be much higher than in the case of the IPA immersion. At the same time laboratories and filter manufacturers were reluctant to invest in the generators and CNC needed for the ASHARE 52.2 procedure, and other solutions were sought by ISO/TC142/WG9.

4. IPA Vapor Charge Suppression

A promising method for electret charge suppression for both full-scale filters and small media samples was proposed to ISO/TC142/WG9 early in 2010 by Toshiaki Hayashi of Toyobo Co. Ltd. in Japan. He had found that electret media charge could be fully suppressed by exposure to IPA vapor for a period of at least 24 hours. Some charge suppression by IPA vapor had been observed earlier, exposures were shorter. In July 2010, Jie Cai, of the Chinese Contamination Control Society informed WG9 that he and a group at the Dongguan Hengyong company had confirmed Hayashi’s results on two types of polypropylene electret media, one thin and pleatable, the other suitable for bag filters (ISO, 2010).

The procedure for media samples was the subject of a round-robin study in 2010 by eight laboratories from several different countries under the supervision of ISO Technical Committee 142, Working Group 9. The method was deemed reliable and reproducible, and is now included in ISO 29461-1:2013. The procedures and results of that inter-laboratory effort are described in Tronville (2011).

5. ISO Round-Robin IPA Vapor Conditioning Study: Full-Scale Filters

The members of ISO/TC142/WG9 recognized that the IPA vapor charge-suppression procedure could be extended to full-scale filters by use of a sealed exposure chamber large enough to accommodate such filters. A design for the chamber was

proposed, and a round-robin test program organized. The test program included four full-scale filter designs which were distributed to the participants along with samples of the media used in the full-scale filters. Test equipment and procedures and data-reporting requirements were stated in detail (ISO 2012a, b, c).
Efficiency measurements followed the existing ISO 29461-1 procedure, using a polydisperse aerosol of (DEHS). Optical aerosol spectrometer results for the complete aerosol size spectrum were included, with a requirement for a measurement in a reasonably narrow range centered at 0.4 µm diameter. At least six efficiency runs at each test condition were required, and the uncertainty of each set required to be calculated. One important purpose of these tests was to determine, for each of the filter types, the duration of IPA vapor exposure required to reach a steady state minimum efficiency level, which should represent the efficiency due to mechanical filtration mechanisms alone. Hence data was required showing the decline in efficiency, if any, until essentially steady-state conditions were reached. Pressure drops for all efficiency measurement conditions were to be reported, along with air temperature and relative humidity.
The vapor exposure chamber has two compartments. The smaller contains a vertical rack to hold several plastic trays about 30 mm deep, into which liquid IPA is poured just prior to the start of a filter exposure. The larger compartment can hold either panel filters or bag filters with face areas up to 610 x 610 mm in their normal operating position. The cabinet has a gasket-sealed door. The entire chamber is designed to be operated inside a laboratory hood having an outdoor exhaust. The hood fan is operated whenever IPA is present, for fire safety and operator health.
In the ISO round-robin tests, the full-scale filters tested had face dimensions 595 x 595 mm, and were designated Types A, B, C and D. The descriptions of each are:

- Type A: Panel filter, with a relatively thin pleated media made of glass fibers (media area: 8.86 m^2).
- Type B: Panel filter, with a relatively thin pleated media formed of fibers made from an organic polymer, often referred to as “synthetic media” (media area: 1.6 m^2).
- Type C: Bag filter, with a thicker media than A or B. The media for this filter was formed from fibers of an organic polymer (media area: 7.5 m^2).
- Type D: Bag filter, with a thicker media than A or B. The media for this filter was formed from glass fibers (media area: 7.5 m^2).

6. Electret Charge-Suppression Studies at the Politecnico di Torino

Samples of the four filters and their media were supplied to the Politecnico in 2012, and the test protocol described in Section 5 followed in the DENERG laboratory. The tests showed, as had been the case for media samples exposed to IPA vapors, that exposure durations well in excess of eight hours are needed for a steady-state reduced efficiency to be reached. Figure 1 is a plot of the 0.4 µm diameter DEHS particle efficiencies and pressure drops measured for the filters of Types A and C at different stages in the vapor-exposure cycle. These curves depict the performance at 5.3 cm/s media velocity on Type A and C filters. The efficiency values for the runs at 11 cm/s on the same filters were slightly lower (Fig. 2). For filter C – presumably an electret-fiber filter – the efficiency at 4 hours exposure was greater than the efficiency at 24 hours, confirming the need for a 24-hour exposure. Similar results were obtained for the other filters and their media samples.

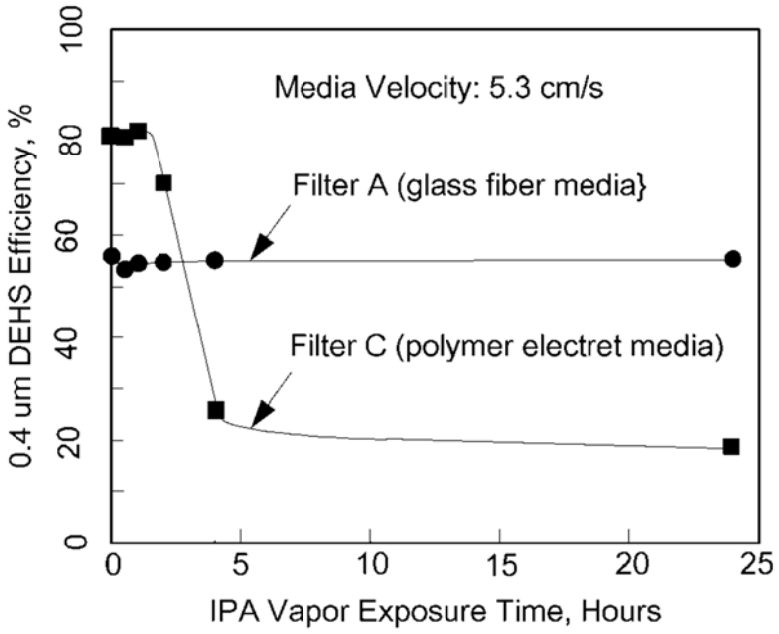

Fig. 1. Efficiency for 0.4 µm DEHS Particles at 5.3 cm/s Media Velocity vs. IPA Vapor Exposure Time

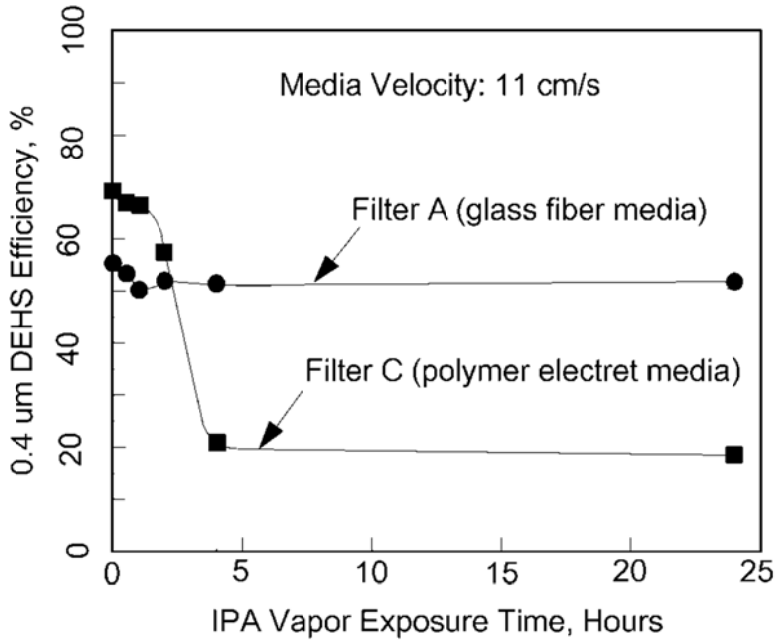

Fig. 2. Efficiency for 0.4 µm DEHS Particles at 11 cm/s Media Velocity vs. IPA Vapor Exposure Time

Tables 1 and 2 compare the efficiencies of the media samples before and after treatment by IPA dipping and by IPA vapor exposure to the full-scale filter efficiencies before and after IPA vapor treatment.

Table 1. Politecnico Tests: 0.4 µm DEHS Particle Efficiencies at 5.3 cm/s (10.4 ft/min) Media Velocity

		Data for Media Sample Tests				Data for Full-Scale Filter Tests	
Media Code	Filter - Sample Description	IPA Liquid Treatment 2- Minute Dip & Dry		IPA Vapor Treatment 24-hour Exposure		IPA Vapor Treatment 24-hour Exposure	
		Efficiency Before Treatment,%	Efficiency After Treatment,%	Efficiency Before Treatment,%	Efficiency After Treatment,%	Efficiency Before Treatment,%	Efficiency After Treatment,%
A	Pleated - glass	53.8	52.8	56.2	55.4	55.4	55.5
B	Pleated – polymer	69.2	7.6	68.6	6.3	56.4	6.1
C	Bag Filter - polymer	82.4	25.0	82.5	18.7	78.8	18.4
D	Bag Filter - glass	63.7	61.8	64.1	60.8	70.6	65.6

Table 2. Politecnico Tests: 0.4 µm DEHS Particle Efficiencies at 11 cm/s (21.7 ft/min) Media Velocity

		Data for Media Sample Tests				Data for Full-Scale Filter Tests	
Media Code	Filter - Sample Description	IPA Liquid Treatment 2- Minute Dip & Dry		IPA Vapor Treatment 24-hour Exposure		IPA Vapor Treatment 24-hour Exposure	
		Efficiency Before Treatment,%	Efficiency After Treatment,%	Efficiency Before Treatment,%	Efficiency After Treatment,%	Efficiency Before Treatment,%	Efficiency After Treatment,%
A	Pleated - glass	52.1	51.7	52.4	51.7	52.6	51.3
B	Pleated - polymer	64.6	4.8	54.9	2.9	32.0	6.2
C	Bag Filter - polymer	74.3	18.7	73.8	18.2	69.2	18.6
D	Bag Filter - glass	61.0	60.9	60.1	60.7	70.4	64.5

7. Conclusions

At the laboratory of Politecnico di Torino the full-scale results of vapor treatment matched the sample results well, and the efficiency reduction by vapor treatment was similar to that obtained by liquid IPA treatment of the media samples.
It will be interesting to study the reproducibility of the data shown here with the data measured by the other laboratories participating in the round robin exercise.
It will be also important to define the requirements to be met by the discharging cabinet.

8. References

Agranovski I.E., R. Huang, O.V. Pyankov, I.S. Altman, and S.A. Grinshpun, 2006. Enhancement of the performance of low-efficiency HVAC filters due to continuous unipolar ion emission. *Aerosol Science & Tech.* 40: 963-968.

ASHRAE, 2012. Standard 52.2-2012 Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size. ASHRAE, Atlanta GA USA.

ASHRAE, 2008. Standard 52.2-2007 Addenda Supplement Package, www.ashrae.org.

Barrett L.W., and A.D. Rousseau, 1998. Aerosol loading performance of electret filter media. *Amer. Industrial Hygiene Assoc. J*. 59: 532-539.

Biermann A., B. Lum, and W. Bergman, 1982. Evaluation of permanently charged electrofibrous filters. In *Proc. 17th DOE Nuclear Air Cleaning Conf*. Vol 1: 523-547.

Blackford D.B., G.J. Bostock, R.C. Brown, R. Loxley, and D. Wake, 1986. Alteration in the performance of electrostatic filters caused by exposure to aerosols. *Proc. 4th World Filtration Cong.*

Brown R.C., 1980. The behaviour of fibrous filter media in dust respirators. *Annals of Occupational Hyg*. 23: 367-380.

Brown R.C., 1988. Effect of industrial aerosols on the performance of electrically charged filter material. *Annals of Occupational Hyg*. 32: 271-294.

Brown R.C., 1993. *Air Filtration: An Integrated Approach to the Theory and Applications of Fibrous Filters.* Pergamon Press, Oxford, U.K.

Cai J., 2010. Comparison of the dipping and fumigation methods for the discharge of electret filtration media. ISO TC142 WG9 committee correspondence.

CEN, 2012. Comité Européen de Normalisation. EN779-2012 “Particulate air filters for general ventilation: Determination of filtration performance”.

Chazelet, S., D. Bemer, and F. Bemer, 2011. Effect of test aerosol charge on penetration through electret filter. *Separation and Purification Tech.* 79: 352-356.

Chen C.C., M. Lethimäki, and K. Willeke, 1993. Loading and filtration characteristics of filtering facepieces. *Amer. Indust. Hygiene Assoc. J*. 59: 227-233.

Fjeld R.A., and T.M. Owens, 1988. The effect of particle charge on penetration in an electret filter. *IEEE Transactions: Industry Applications* 24: 725-731.

Hanley J.T., and M.K. Owen, 2005. Development of a new conditioning aerosol for testing electret filters. *ASHRAE Transactions 111-Pt1*: 1115-1125.

Hoppel W.A., and G.M. Frick, 1990. The nonequilibrium character of the aerosol charge distribution produced by neutralizers. *Aerosol Sci. & Tech.* 12: 471-496.

Huang H.Y., 2001. *Characterization of Factors that Affect Charge Decay in Fibrous Electrets.* PhD dissertation, University of Tennessee, Knoxville, TN USA

ISO, 2009. International Organization for Standardization. ISO/TS 21220:2009. “Particulate air filters for general ventilation: Determination of filtration performance”.

ISO, 2013. International Organization for Standardization. ISO 29461-1:2013. “Air intake filter systems for rotary machinery - Test methods - Part 1: Static filter elements”.

ISO-TC142-WG9, 2010. *ISOTC142-WG9-N085-Testplan for IPA vapour treatment.*

ISO-TC142-WG9, 2011. *ISOTC142-WG9-N061-IPARR-COMP.*

ISO-TC142-WG9, 2012a. *ISOTC142-WG9-N091-IPARR-COMP. Evaluation of filter media testing method using “IPA vapour” and “IPA dipping” methods.*

ISO-TC142-WG9, 2012b. *ISOTC142-WG9-N115-Test plan for IPA vapour treatment on filters.*

ISO-TC142-WG9, 2012c. *ISOTC142-WG9-N116-Test cabinet and method for IPA vapour treatment on filters.*

Janssen L.L., J.O. Bidwell, H.E. Mullin, and T.J. Nelson, 2003. Efficiency of degraded electret filters: Part I – Laboratory testing against NaCl and DOP before exposure to workplace aerosols. *J. Int’l. Soc. for Respiratory Protection* 20: 71-80.

Jasper W., J. Hinestroza, A. Mohan, D. Thompson, and R. Barker, 2005. Effect of phase of toluene on filtration performance of electret filter media against dioctyl phthalate aerosols. *J. Int’l. Soc. for Respiratory Protection* 22: 97-105.

Jasper W., J. Hinestroza, A. Mohan, J. Kim, B. Sheils, M. Gunay, D. Thompson, and R. Barker, 2006. Effect of xylene exposure on the performance of electret filter media. *J. Aerosol Sci*. 37: 903-911.

Jasper W., A. Mohan, J. Hinestroza, and R. Barker, 2007. Degradation processes in corona-charged electret filter media with exposure to ethyl benzene. *J. Engineered Fibers and Fabrics* 2: 1-6.

Ji J.H., G.N. Bae, S.H. Kang, and J. Hwang, 2003. Effect of particle loading on the collection performance of electret cabin air filter for submicron aerosols. *J. Aerosol Sci*. 34: 1493-1504.

Kim J.Y., W. Jasper, and J. Hinestroza, 2007. Direct probing of solvent-induced charge degradation pf polypropylene electret fibers via electrostatic force microscopy. *J. Microscopy* 20: 1-8.

Kim J., J. Hinestroza, W. Jasper, and R. Barker, 2009. Effect of solvent exposure on filtration performance of electrostatically charged polypropylene filter media. *Textile Research J.* 79: 343-350.

Moyer E.S., and G.A. Stevens, 1989. Worst case aerosol testing parameters: 2. Efficiency dependence of commercial respirator filters on humidity pretreatment. *Amer. Industrial Hygiene Assoc. J*. 50: 265-270.

Moytl E. and B. Lowkis, 2006. Effect of air humidity on charge decay and lifetime of PP electret nonwovens. *Fibers & Textiles in Eastern Europe* 14: 39-42.

Plebani C., S. Listrani, G. Tranfo, and F. Tombolini, 2012. Variation in penetration of submicronic particles through electrostatic filtering facepieces during exposure to paraffin oil aerosol. *J. Occupational Environmental Hyg*. 9: 556-561.

Raynor P.C., and S.J. Chae, 2004. The long-term performance of electrically charged filters in a ventilation system. *J. Occupat. and Environ. Hygiene* 1: 463- 471.

Tronville P., R. Rivers, and G. Di Giusto, 2011. Charge-depletion effects from isopropyl alcohol treatment of electret filter media. *Proc. AFS 2011 Annual Meeting* 31-46.

Tsai P.P., H.Y. Huang, and L.C. Wadsworth, 2000. Electrostatic decay of corona-enhanced meltblown electret filters at ambient and elevated temperatures. In *Proc. TAPPI 1999 Nonwovens Conf.* p. 67-73.

Viscusi D.J., M. Bergman, E. Sinkule, and R.E. Shaffer, 2009. Evaluation of the filtration performance of 21 N95 filtering facepiece respirators after prolonged storage. *Amer. J. Infect. Control* 37: 381-386.

Walsh D.C., and J.I.T. Stenhouse, 1998. Parameters affecting the loading behavior and degradation of electrically active filter media. *Aerosol Sci. & Tech*. 29: 419-432.

Wang C.S., 2001. Electrostatic forces in fibrous filters: A review. *Powder Technology* 118: 166-170.

Yang S.H., and G.W.M. Lee, 2004. Filtration characteristics of a fibrous filter pretreated with anionic surfactants for monodisperse solid aerosols. *J. Aerosol Sci.* 36: 419-437.

Zimon A.D. (M. Corn, tr.), 1969. *Adhesion of Dust and Powders*, Plenum Press, New York.