Particle capture by air filter media having truncated log-normal fiber diameter distributions and random spacing of fibers

WFC10 Discover the Future of Filtration & Separation

10th World Filtration Congress April 14–18, 2008 Leipzig, Germany

CONGRESS PROCEEDINGS

VOLUME III – G-Sessions

CONTENT VOLUME III **G-Sessions**

hosted by

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WORLD FILTRATION CONGRESS 2008

WFC10

SESSION SURVEY

Monday, 14.04.2008

08:00 – 09:00	Registration for Short Courses
09:00 – 18:00	Short Courses
16:00 – 18:00	Registration + Poster Installation

Tuesday, 15.04.2008

08:00 – 10:00	Registration						
10:00 – 11:00	**Opening Ceremony**						
11:00 – 12:00	**Plenary Lecture**						
12:00 – 13:15	Lunch						
13:15 – 14:30	**Invited Lecture 1**		**M 1**	**M 2**	**M 3**	**G 1**	**G 2**
14:30 – 15:00	Coffee Break						
15:00 – 16:15	**L 1**	**L 2**	**L 3**	**Invited Lecture 2**		**G 3**	**G 4**
16:15 – 16:45	Coffee Break						
16:45 – 18:00	**L 4**	**L 5**	**L 6**	**M 4**	**M 5**	**G5**	**G6**
18:00	Welcome Reception in the Exhibition Hall						

Wednesday, 16.04.2008

08:30 – 09:45	**L 7**	**L 8**	**L 9**	**M 6**	**M 7**	**G 7**	**G 8**
09:45 – 10:15	Coffee Break						
10:15 – 11:30	**PL 1**	**PL 2**	**L 10**	**PM 1**	**PM 2**	**PG 1**	**PG 2**
11:30 – 12:15	Poster Session	Poster Session		Poster Session	Poster Session	Poster Session	Poster Session
12:15 – 13:15	Lunch						
13:15 – 14:30	**L 11**	**L 12**	**L 13**	**M 8**	**M 9**	**Invited Lecture 3**	
14:30 – 15:00	Coffee Break						
15:00 – 16:15	**Invited Lecture 4**		**M 10**	**M 11**	**M 12**	**G 9**	**G 10**
16:15 – 16:45	Coffee Break						
16:45 – 18:00	**L 14**	**L 15**	**L 16**	**M 13**	**M 14**	**G 11**	**G 12**

SESSION SURVEY

Thursday, 17.04.2008

08:30 – 09:45	L 17	L 18	L 19	M 15	M 16	G 13	G 14
09:45 – 10:15	Coffee Break						
10:15 – 11:30	L 20	L 21	L 22	PM 3	PM 4	PG 3	PG 4
11:30 – 12:15				Poster Session	Poster Session	Poster Session	Poster Session
12:15 – 13:15	Lunch						
13:15 – 14:30	L 23	L 24	L 25	Invited Lecture 5		G 15	G 16
14:30 – 15:00	Coffee Break						
15:00 – 16:15	L 26	L 27	L 28	M 17	M 18	Invited Lecture 6	
16:15 – 16:45	Coffee Break						
16:45 – 18:00	L 29	L 30	L 31	M 19	M 20	G 17	G 18

Friday, 18.04.2008

08:30 – 09:45	L 32	L 133	M 21	M 22	M 23	G 19	G 20
09:45 – 10:15	Coffee Break						
10:15 – 11:30	L 34	L 35	M 24	M 25	M 26	G 21	G 22
11:45 – 12:15	**Closing Session**						
12:30 – 13:15	Lunch						
13:30– 18:00	**Post Congress Plant Tours**						

Tuesday – April 15, 2008

Opening Ceremony 10:00-11:00

Plenary Lecture 11:00-12:00

Filtration in the Framework of Globalisation and Technical Innovation, Prof. Richard J. Wakeman, Loughborough University, Great Britain **(I-19)**

Invited Lecture 1 13:15-14:30

Solid-Liquid-Separation by Cake Filtration - State of the Art and Future Expectations, Dr. Harald Anlauf, Karlsruhe University, Germany **(I-21)**

M1 Gas Separation and Pervaporation 13:15-14:30

Gas separation with supported ionic liquid membranes, A. Seeberger*, C. Kern, A. Jess, University of Bayreuth, Germany **(II-40)**

Alternative permeate recovery systems for pervaporation, D. Shanahan*, C. O'Suilleabnain, I. O'Sullivan, Cork Institute of Technology, Ireland **(II-45)**

Concentration and dewatering of ethanol by organophilic and hydrophilic zeolite membranes, M. Weyd*, H. Richter, G. Fischer, P. Puhlfürß, I. Voigt, HITK Hermsdorfer Institute for Technical Ceramics; J. Kühnert, inocermic GmbH, Germany **(II-50)**

M2 Potable Water 13:15-14:30

Safe drinking water for everybody?! Membrane technology from small scale to large scale and vice versa, H. Futselaar*, J. Geluk, L. Broens, Norit Process Technology B.V.; J. Jacobs, Norit Membrane Technology B.V., Netherlands **(II-55)**

Two years experience with Germanys largest two stage ultrafiltration plant for drinking water production (7,000 m³/h), S. Panglisch*, R. Gimbel, IWW Water Center; W. Dautzenberg, WAG Nordeifel mbH, Germany **(II-59)**

Potable water production by membrane processes: Effect of bacterial deformation on microorganisms' removal, N. Lebleu*, C. Causserand, C. Roques, P. Aimar, University of Toulouse, France **(II-64)**

M3 New Fibrous Membranes 13:15-14:30

Functionalized and doped nanofiber filtration media with Ionex and antimicrobial properties, J. Marek*, J. Svobodova, M. Juklickova, Elmarco Ltd.; L. Jelinek, Institute of Chemical Engineering, Czech Republic **(II-69)**

The development of an enhanced surface filtration medium based on short metal fibres for applications in food & beverage, chemical & pharmaceutical industry, I. Schildermanns*; D. Santens, NV Bekaert SA, Belgium **(II-74)**

Commercial applications for Disruptor™ alumina nanofiber filter media, R. Komlenic*, Ahlstrom Filtration Inc.; F. Tepper, Argonide Corp., USA **(II-79)**

G1 Surface Filtration I 13:15-14:30

Assessment of the cleanable dust filtration behaviour of surface treated needle felts by characterisation parameter determined by image analysis, W. Höflinger*, G. Mauschitz, H. Rud, J. Schuberth, Vienna University, Austria **(III-37)**

Characteristics of bag filter pressure drop profiles, M. Koch*; G. Krammer, NTNU University, Norway **(III-42)**

Comparing gas and Liquid filtration of nonwovens transitional capacity and energy consumption, H. Kleizen*, IDEGO, Delft University, Parker Filtration B.V., Netherlands **(III-47)**

G2 Electrostatic Precipitation 13:15-14:30

Charge emission characteristics of a drained DBD electrode apparatus for nano-particle charging and precipitation, M. Wild, J. Meyer*, G. Kasper, Karlsruhe University, Germany **(III-52)**

Separation of oil mists from air flow by a space-charge electrostatic precipitator, A. Bologa*, H. Paur, H. Seifert, K. Woletz, Forschungszentrum Karlsruhe, Germany **(III-57)**

WeLo /MultiTron Premium – The new electrostatic precipitator, M. Sauer-Kunze*, GEA Delbag Lufttechnik GmbH, Germany **(III-62)**

L1 Vacuum and Pressure Cake Filtration Fundamentals I 15:00-16:15

Suspension typology and computer aided characterization of the suspension filterability, I. Nicolaou*, FOS Ltd., Cyprus **(I-37)**

Filter media resistance on continuous solid liquid filters, J. Tichy*, BHS-Sonthofen, Germany **(I-42)**

Experimental design and evaluation of filtration experiments allowing for superposed sedimentation, M. Longerich*, A. Damm, Bayer Technology Services GmbH, Germany **(I-47)**

L2 Sedimentation Fundamentals-Analytical Centrifugation I 15:00-16:15

Acquisition of compression-permeability data of soft and hard colloids based on centrifugation experiments, E. Iritani*, N. Katagiri, K. Aoki, M. Shimamoto, Nagoya University, Japan **(I-51)**

Separation behaviour of suspensions in polymer solutions studied by multisample analytical centrifugation, T. Sobisch*, T. Detloff, D. Lerche, L.U.M. GmbH, Germany **(I-56)**

Application of analytical centrifugation for studying solid-liquid separation in papermaking, H. Liimatainen*, J. Niinimäki, University of Oulu, Finland **(I-61)**

L3 Optimization of Solid-Liquid Separation Processes I 15:00-16:15

A multi-scale approach to solid-liquid separation task: a paradigm shift, T. Sheikhzeinoddin*, P. Sharratt, University of Manchester, Great Britain **(I-66)**

A product-centred approach to a multi-stage task in pharmaceuticals: isolation, T. Sheikhzeinoddin*, P. Sharratt, University of Manchester, Great Britain **(I-71)**

Continuous treatment and scrubbing of bottom ash from thermal waste treatment to produce improved granulate quality, R. Koralewska*, Martin GmbH; R. Grönnert, R. Hausdorf, Hans Huber AG, Germany; G. Zellinger, Kärntner GmbH; H. Gschaider, Binder+Co AG, Austria **(I-76)**

Invited Lecture 2	15:00 - 16:15

Advances relating to Filter Media Developments Prof. Richard P. Lydon, Clear Edge Group, Great Britain **(II-19)**

G3	Surface Filtration II	15:00 - 16:15

Effects of PPS fibre intermixture on the surface structure and the filtration behaviour of PI needle felts for cleanable dust filters, G. Mauschitz*, J. Schuberth, W. Höflinger, Vienna University, Austria **(III-67)**

Effect of operating parameters on stability of jet pulsed bag filter - an experimental study, M. Saleem*, A. Ijaz, University of the Punjab, Pakistan; G. Krammer, NTNU University, Norway **(III-72)**

Experimental study of cake detachment in cake filtration and electrostatic enhanced cake filtration, H. Xu*, G. Xiong, Q. Yao, Tsinghua University, P.R. China **(III-77)**

G4	Mist and Droplet Separation	15:00 - 16:15

Development of a standardised test method on metalworking fluid mist collector elements, P. Wlaschitz*, W. Höflinger, Vienna University, Austria **(III-82)**

Filtration of liquid aerosols with a horizontal fibrous filter, A. Charvet*, Y. Gonthier, A. Bernis, E. Gonze, University of Savoie, France **(III-87)**

Numerical and experimental investigations on the development of oil droplet separators in crankcase ventilation systems, S. Schütz*, G. Gorbach, A. Zink, K. Kissling, M. Piesche, Stuttgart University, Germany **(III-92)**

L4	Vacuum and Pressure Cake Filtration Fundamentals II	16:45 - 18:00

Utilization of statistical design of experiments for improving the efficiency of test filtration tasks, A. Häkkinen*, M. Huhtanen, J. Kallas, Lappeenranta University; B. Ekberg, Larox Corp., Finland **(I-81)**

Study on the scalability of pressure filtration in pilot and bench scale test equipment, J. Palmer*, Larox Corp., Finland **(I-86)**

Layout of rotary filters on the basis of laboratory results, E. Ehrfeld*, R. Bott, T. Langeloh, Bokela GmbH, Germany **(I-91)**

L5	Sedimentation Fundamentals- Analytical Centrifugation II	16:45 - 18:00

Theoretical and experimental approach to the settling behaviour of particle-fiber-mixtures, M. Feist*, H. Nirschl, Karlsruhe University; J. Wagner, G. Hirsch, Darmstadt University, Germany **(I-96)**

Equation for fitting dispersed systems gravity & centrifuge settling data, A. Yelshin*, M. Mota, University of Minho, Portugal; I. Yelshyna, Polotsk University, Belarus **(I-101)**

Measurement of settling velocity enhancement by magnetic flocculation using manometric sedimentation centrifugation, M. Stolarski*, C. Eichholz, H. Nirschl, Karlsruhe University, Germany; B. Fuchs, DuPont, USA **(I-106)**

L6	Optimization of Solid-Liquid Separation Processes II	16:45 - 18:00

Life-cycle Cost Analysis for the Selection of the Optimal Equipment for Solid-Liquid Separation, S. Ripperger*, Kaiserslautern University, Germany **(I-111)**

Commercial aspects of solid liquid separations in salt separation applications, D.E. Keller*, KMPT AG, Germany **(I-116)**

Performance increase in solid-liquid separation, D. Steidl*, BHS-Sonthofen; J. Tichy, Consulting Engineer, Germany **(I-121)**

M4	Raw/Sea Water Pre-Treatment	16:45 - 18:00

Seawater intake and pre-filtration with Neodren®, T. Peters*, Consulting for Membrane Technology, Germany; D. Pinto, E. Pinto, Catalana de Perforacions S.A., Spain **(II-83)**

Comparison of options for seawater pre-treatment for SWRO plants, T. Peters*, Consulting for Membrane Technology; O. Schuster, B. von Harten, M. Ulbricht, Membrana GmbH; E. Schmidt, Wuppertal University, Germany; D. Pinto, E. Pinto, Catalana de Perforacions S.A., Spain **(II-88)**

Application of automatic backflushfilter to improve raw water pre-treatment of reverse osmosis desalination plants, B. Schlichter*, P. Mehlem, R. Wnuk, HYDAC Process Technology GmbH, Germany; M. Parker, HYDAC Technology Corp., USA **(II-93)**

M5	New Membranes	16:45 - 18:00

Composite membranes fabricated by plasma polymerization using organic compounds, D.-T. Tran*, L.V. Kim Ba, Hanoi University, Vietnam; S. Mori, M. Suzuki, Tokyo Institute of Technology, Japan **(II-98)**

Functional polymer materials to remove ions in conjunction with ultrafiltration membranes, B. Rivas*, A. Pooley, A. Maureira, E. Peireira, M. del Carmen Aguirre, University of Conception, Chile **(II-103)**

Clean edge micro sealing of filtration modules – the cut&weld method, A. Korz*, K. Herzer, A. Hubrich, Textile Fusion Technologies GmbH, Germany **(II-106)**

G5	Clogging of Candles and Cartridges	16:45 - 18:00

Modelling of the clogging of pleated filter for gas filtration, M. Rebai*, M. Prat, IMFT; M. Meireles, University of Toulouse; P. Schmitz, INSA; R. Baclet, S. Demeulemeester, Mecaplast Group, France **(III-97**

Study of pressure drop and aerosol penetration during clogging of mini-pleated air filters, A. Joubert*, S. Artous, L. Bouilloux, IRSN; S. Calle-Chazelet, D. Thomas, J. Remy, Nancy University, France **(III-102)**

Experimental study on flow through concentric porous filter candle, A. Ijaz*, M. Saleem, University of the Punjab, Pakistan **(III-107)**

G6	Fine Particle Precipitation	16:45 - 18:00

Fine dust precipitation in a Bayer-Reither venturi scrubber, M. Theis*, Bayer Technology Services GmbH; K. Reither, Reither Venturiwäscher GmbH, Germany **(III-112)**

Filtration of silver nanoparticle agglomerates, D.Y.H. Pui*, S.-C- Kim, J. Wang, M. Emery, University of Minnesota, USA **(III-117)**

Enhancement of the thermophoretic aerosol particles deposition efficiency in a turbulent annular flow configuration, B. Sagot*, F. Buron, ESTACA; G. Antonini, University of Compiègne, France **(III-122)**

Wednesday – April 16, 2008

L7	Vacuum and Pressure Cake Filtration Fundamentals III	08:30 - 09:45

Influence of synthetic suspension components on its physical behaviour, P. Ginisty*, N. Ahoyo, IFTS; J. Baudez, Cemagref, France; L. Spinosa, CNR, Italy **(I-126)**

Filtration properties in solvent-water mixtures, S. Neubauer*, U.A. Peuker, Clausthal University, Germany **(I-131)**

The influence of morphology and size on constant pressure filtration for two crystallizing systems, R. Beck*, D. Malthe-Sorenssen, J.-P. Andreassen, NTNU University, Norway; A. Häkkinen, M. Louhi-Kultanen, Lappeenranta University, Finland **(I-136)**

L8	Technical Centrifugal Filtration- Selection and Optimization	08:30 - 09:45

Systematic of filter centrifuges, P. Stelter*, HEINKEL Process Technology GmbH, Germany **(I-141)**

Selection of screen- and filter-centrifuges based on material and filtration properties, U. Esser*, D. Mrotzek, Bayer Technology Services GmbH, Germany **(I-146)**

Computer aided optimization of batch filtering centrifuges, I. Nicolaou*, FOS Ltd., Cyprus **(I-150)**

L9	Filter Media Cleaning	08:30 - 09:45

DEECOM™: A new eco-technology for cleaning metal filters, B. Longworth, J.P. Millington, J. Norris, P. Norris, C. Reid, B&M Longworth Ltd., Great Britain; S.L. Reynolds*, Carolina Filters, Inc., USA **(I-155)**

Process strategies avoiding impurities adhering to woven filter media used in inverting filter centrifuges, S. Stahl*, H. Nirschl, Karlsruhe University, Germany **(I-160)**

Comparison of regeneration methods for ceramic filter media, J. Puranen*, A. Häkkinen, J. Kallas, Lappeenranta University; B. Ekberg, Larox Corp., Finland **(I-165)**

M6	Process/Waste Water Treatment	08:30 - 09:45

Membrane technology for recycling and recovery of resources in industrial water and waste water applications – from lab testings to production experiences, C. Bohner*, EnviroChemie GmbH, Germany **(II-111)**

Field experiences with membrane filtration for reuse of biological wastewater effluents, T. Baum*, S. Theiss, H. Eipper, Pall GmbH, Germany **(II-115)**

Impacts of the influent toxicity on the efficiency of tertiary filtration of wastewater from petroleum industry, S. Heng*, N. Lesage, Q. Su, Total Petrochemicals, France **(II-120)**

M7	Reverse Osmosis	08:30 - 09:45

Investigations of silica scaling on reverse osmosis membranes, G. Braun*, T. Harrer, T.- Götz, Cologne University; W. Hater, C. zum Kolk, C. Dupoiron, BKG Water Solutions - BK Giulini GmbH, Germany **(II-125)**

Reverse osmosis pilot plant studies regarding a novel electrochemical method to control $CaCO_3$ scaling, M. Meinardus*, Grünbeck Wasseraufbereitung GmbH, Germany **(II-130)**

Characeterisation of reverse osmosis (RO) membrane fouling by autopsy – A case study, I. M. El-Azizi*, R. G. Edyvean, Sheffield University, Great Britain **(II-135)**

G7	Depth Filtration & Particle Deposition	08:30 - 09:45

Simulation studies of deposition mechanisms for aerosol particles in fibrous filters including slip flow, A. Wiegmann*, K. Schmidt, S. Rief, L. Cheng, A. Latz, Fraunhofer Institute for Industrial Mathematics ITWM, Germany **(III-127)**

Particle capture by air filter media having truncated log-normal fiber diameter distributions and random spacing of fibers, P. Tronville*, Torino University, Italy; R. Rivers, EQS Inc., USA; Z. Bin, Tongji University, P.R. China **(III-132)**

Comparison of calculated and MRI determined 1-dimensional profiles of deposited particle material in depth filter media with ongoing loading, J. Hoferer*, S. Schollmeier, J. Meyer, G. Kasper, Karlsruhe University, Germany **(III-137)**

G8	Measurement Techniques	08:30 - 09:45

Evaluation of filter test rigs for fractional efficiency measurements according to filter test standards, S. Schütz*, M. Schmidt, L. Mölter, Palas GmbH, Germany **(III-142)**

Real time tunnel ventilation and filter control systems, F. Schneider*, Grimm Aerosol Technik GmbH, Germany **(III-147)**

Dust measuring technology for the monitoring of particulate emissions, H. Födisch*, P. Schengber, Dr. Födisch Umweltmesstechnik AG, Germany **(III-151)**

PL1 – Poster Session	10:15 - 12:15

Deep Bed Filtration for Water and Wastewater

Water depuration by means of fibrous filter medium, A. Budyka*, A. Shepelev, V. Rykunov, K. Lukanina, Karpov Institute of Physical Chemistry, Russia **(I-553)**

Rice hull ash and its filtration and separation applications, W. Li, C. Berthold*, C. Kiser, Q. Richard, Agrilectric Research Company, USA **(I-557)**

Filter Aids - Press Filtration

Influences on the wort flow in the lautering process during beer production, J. Tippmann*, J. Voigt, K. Sommer; Munich University, Germany **(I-562)**

Sedimentation Fundamentals-Analytical Centrifugation

Stability prediction of concentrated suspensions: Comparison of NMR and analytical centrifuge measurements, S. M. Pancera*, N. Nestle, V. Boyko, Y. Liu, BASG AG, Germany **(I-567)**

Centrifugal Sedimentation and Filtration

CFD multiphase flow simulation of a solid bowl centrifuge with radial compartments, X. Romaní Fernández*, H. Nirschl, Karlsruhe University, Germany **(I-572)**

Modelling of centrifugal drainage: effect of filter medium resistance, B. Leger, M. Valat, W. Jomaa, J.-R. Puigali, University Bordeaux 1; S. Couturier, P. Ginisty*, IFTS, France **(I-577)**

Hydrocyclones

Multiphase flow simulation of a hydrocyclone, R.-M. Wu*, C.-Y. Hsu, Tamkang University, Taiwan **(I-582)**

Particle Measurement - Contamination Control

Granulometry and morphology by microscopy and image analysis, O. Huin*, Microvision Instruments SAS, France **(I-586)**

Microbes verification on oxygen consumption rate measurement of biofilm in drinking water, L.-F. Chen*, W.-L. Lai, Shu-Te University, Taiwan **(I-591)**

Separation Enhancement by Magnetic Forces

Using Magnetic Filtration for Removal of Heavy Metals from Water by Nanomagnetic Extractants, S. M. Alfadul*, King Abdulaziz City for Science Technology, Saudi Arabia; A. W. Apblett, Oklahoma State University, USA **(I-596)**

Separation of pharmaceutical products with reverse micelles, S.H. Mohd-Setapar, R.J. Wakeman, E.S. Tarleton, Loughborough University, Great Britain **(I-601)**

PL2 – Poster Session 10:15 - 12:15

Separation Enhancement by Electric Forces

Electrofiltration of PHB, G. Gözke*, I. Perner-Nochta, C. Posten, Kalrsruhe University, Germany **(I-606)**

Separation Enhancement by Chemical Additives

Charge effects determine the filtration resistance in cake filtration and crossflow filtration experiments, H. Saveyn*, D. Curvers, P. Van der Meeren, Ghent University, Belgium **(I-611)**

Laboratory Vacuum and Pressure Cake Filtration

Miniaturisation of filtration processes - A necessity for the pharmaceutical industry, A. Schreiner*, R. Schneeberger, Novartis Pharma; S. Jerman, ETH Zurich, Switzerland **(I-615)**

Are standards in designing industrial filters for solid liquid filtration wisely and necessary?, J. Tichy*, H.-P. Schmid, BHS-Sonthofen GmbH; S. Ripperger, Kaiserslautern University, Germany **(I-616)**

Filtration Properties in Organic Solvents, S. Neubauer*, U.A. Peuker, Clausthal University, Germany **(I-620)**

Technical Vacuum and Pressure Cake Filtration

Study on parameters affecting belt filtration of a metal precipitate suspension, S. Hirvisaari*, A. Häkkinen, J. Kallas, Lappeenranta University; B. Ekberg, Larox Corp.; A. Rautanen, Tamfelt Corp.; S. Storbacka, OMG, Finland **(I-625)**

Development of an automated online quotation tool, O. Sieking, E. Eenovaara, S. Henttu, Larox Corp., Finland; H. Brezina*, Larox GmbH, Germany **(I-630)**

Technical Vacuum and Pressure Cake Filtration – Media and Components

Easy installation and improved performance with a new filter press cloth design for applications in e.g. waste water, B. Maurer*, R. Gaiser, H. Dür, Sefar AG, Switzerland **(I-633)**

Press Filtration Fundamentals

Mass transfer from porous particles during the pressing of biological materials, M. Petryk, Ternopil University, Ukraine; E. Vorobiev*, University of Compiègne, France **(I-636)**

Slurry Pretreatment by Precipitation and Crystallization

Enhancing phosphogypsum filtration with sorbitan sesquioleate additive: Theory and practice, E.A. Abdel-Aal*, M.M. Rashad, CMRDI, Egypt; H. El-Shall, University of Florida, USA **(I-641)**

Boron recovery from the clay wastes of boron industry by solid-liquid extraction, I. Kipcak*, M. Özdemir, Eskisehir Osmangazi University, Turkey **(I-646)**

Boron recovery from borax sludge using solid-liquid extraction followed by precipitation, I. Kipcak*, M. Özdemir, Eskisehir Osmangazi University, Turkey **(I-651)**

L10 Filter Media Blockage – Initial Stage of Cake Filtration 10:15 - 11:30

Pore fouling behaviors in constant pressure and constant flux filtration of very dilute suspension, E. Iritani*, N. Katagiri, Y. Sugiyama, Nagoya University; K. Yagishita, Sanshin Mfg. Co., Ltd., Japan **(I-170)**

Zeta potential of filter media and its influence on the initial stages of cake filtration, C. Schnitzer*, S. Ripperger, Kaiserslautern University, Germany **(I-175)**

Fouling of filter media: Solubility of oxalate solutions, R. Salmimies*, M. Louhi-Kultanen, A. Häkkinen, J. Kallas, M. Huhtanen, Lappeenranta University; Bjarne Ekberg, Larox Corp., Finland **(I-180)**

PM1 Membrane Fouling 10:15 - 12:15

Resonance pulsed flow in cross flow filtration, C. Pflieger*, D. Lisicki, D. Beckmann, Institute for Bioprocessing and Analytical Measurement Techniques; J. Briesovsky, BB ResoPuls; E. Flindt, T. Reischl, membraPure GmbH; U. Metzler, Dingslebener Privatbrauerei Metzler GmbH, Germany **(II-416)**

Analysis of particle fouling in different kinds of membranes during microfiltration, K.-J. Hwang*, C.-Y. Liao, Tamkang University, Taiwan **(II-421)**

Application of electric field to reduce the fouling in crossflow microfiltration, C.-J. Chuang* , C.-C. Hsiung, Z.-H. Cheng, Chung Yuan University, Taiwan **(II-426)**

Flow Manipulation for Performance Enhancement in Crossflow Filtration, B. Olayiwola*, P. Walzel, Technical University of Dortmund, Germany **(II-431)**

Effect of membrane material-cum-morphology on the dead-end micro-filtration of protein solution during filtration cycles, K.-L. Tung*, S. Wang, D. Nanda, C.-C. Hu, C.-L. Li, Y.-L. Li, Chung Yuan University; J. Huang, Yeu Ming Tai Chemical Industrial Co. Ltd., Taiwan **(II-436)**

Modified UF/NF membranes by LBL polyelectrolytes films for easy handling biofouling, M. Pontié*, E. Joudren, Angers University, France **(II-441)**

Relative effect of osmotic pressure and fouling on flux decline in nanofiltration of whey and skimmed milk, B. Chaufer, H. El Khabbaze, B. Balannec, M. Rabiller-Baudry*, University Rennes 1, France; K. Elkacemi, University Mohamed V-Agdal, Morocco **(II-442)**

Performances of an out-of-basin MBR for treating TFT-LCD wastewater, C.-H. Hsieh*, C.-M. Feng, C. Chou, S. Tan, Topco Scientific Co., Ltd.; C.-Y. Chung, J. C. Liu, Taiwan University, Taiwan **(II-447)**

PM2	Mechanism, Modellling Simulation, Design	10:15 - 12:15

Modelling of the mass transfer in a hollow fiber dialyzer coupled with ultrafiltration operations, C.-D. Ho*, J.-W. Tu, Tamkang University, Taiwan **(II-452)**

Investigation of mass transport in membrane-based separation of aqueous protein mixture, O. Trifunovic*, P. M. Bongers, Unilever, Netherlands **(II-xxx)**

Lattice Boltzmann simulation on flow in porous medium of ceramic filter, Z. Ji*, M. Sun, H. Chen, University of Petroleum Beijing, P.R. China **(II-457)**

CFD simulation of a flat membrane module as a tool to explain fouling distribution, M. Rabiller-Baudry*, B. Balannec, D. Delaunay, University Rennes 1, France; J.M. Gozálvez-Zafrilla, University of Valencia, Spain **(II-462)**

Investigation of dynamic filters using CFD, L. Steinke*, Y. Taamneh, S. Ripperger, Kaiserslautern University, Germany **(II-467)**

Mathematical modeling of the simultaneous absorption of CO2 and H2S in a hollow fiber membrane contactor, J. Fathikalajahi*, P. Keshavarz, S. Ayatollahi, Shiraz University, Iran **(II-477)**

Using fractional factorial design to determine the effect of the operational parameters on water flux in ultrafiltration, W.-L. Lai*, S.-W. Liao, J.-J. Chen, Tajen University; Li-Fu Chen, Shu-Te University, Taiwan **(II-482)**

PG1	Surface Filtration	10:15 - 12:15

Filtration performance characteristics of high temperature pleatead filters which operated in conventional bag filter and Cybag filter, Y.-O. Park*, N. Hasolli, KIER; H.-J. Roh, Chung-Nam University, Korea **(III-362)**

Efficient and economic particulate collection from the flue gas by the advanced hybrid particulate collectors, Y.-O. Park*, N. Hasolli, H.-K. Choi, KIER; Korea **(III-367)**

Particle layer detachment under consideration of transient kinetic effects, Q. Zhang*, E. Schmidt, University of Wuppertal, Germany **(III-372)**

Aspects of nozzle effect on the pulse-jet cleaning of a ceramic filter, J.-H. Choi*, K.-M. Sakong, Gyeongsang University, Korea; H. Chi, Z. Ji, University of Petroleum , P.R. China **(III-378)**

Permeability of ceramic filters for high temperature gas filtration, G.M.C. Silva, E.A. Moreira, M.D.M. Innocentini, J.R. Coury*, University of Sao Carlos; C.R. Rambo, D. Hotza, University of Santa Catarina, Brazil **(III-383)**

Performance evaluation of cellular ceramic membranes for hot aerosol filtration, M.D.M. Innocentini, V.P. Rodrigues, University of Ribeirao Preto; G.M.C. Silva, R.C.O. Romano, J.R. Coury*, University of Sao Carlos; R.G. Pileggi, University of Sao Paulo, Brazil **(III-388)**

Gas filtration: Influence of operational variables on cake formation and detachment in different filter types, M.L. Aguiar*, P.A. Paschoal, University of Sao Carlos, Brazil **(III-393)**

Study on gas-solid filtration using cellulose fiber filtering media, D.F. Torre, M.L. Aguiar*, E.H. Tanabe, University of Sao Carlos, Brazil **(III-398)**

Study of the profundity of particles penetration in different fabric filters, M.L. Aguiar*, E.H. Tanabe, E.J. Ricco, K.B. Rodriguez, University of Sao Carlos, Brazil **(III-403)**

Effects of corona electrified solid particles on the efficiency and pressure drop of a fabric filter, M.V. Rodriguez*, M.A.S. Barrozo, University of Uberlandia; J.R. Coury, University of Sao Carlos, Brazil **(III-408)**

PG2	Solid Gas Separation	10:15 - 12:15

Investigations into the collection of fine dust by plants, D. Bracke*, G. Reznik, H. Mölleken, E. Schmidt, University of Wuppertal, Germany **(III-413)**

Development of a model equation for dust suppression by using a water-spraying system, W. Höflinger*, P. Grundnig, G. Mauschitz, J. Gao, Vienna University, Austria **(III-418)**

Use of water sprays for reduction of airborne dust pollution, U. Klenk*, E. Schmidt, University of Wuppertal, Germany **(III-423)**

Experimental study on the multi-orifice injection of liquid in a venturi scrubber, J.A.S. Goncalves*, V.G. Guerra, J.R. Coury, University of Sao Carlos, Brazil **(III-428)**

Trace heavy metals emission control through enhanced submicrometer range filtration: Experimental determination of performance, C. Gutierrez-Canas*, J.A. Legarreta, University of the Basque Country; Sapin; D.Y.H. Pui, S.-C- Kim, University of Minnesota, USA **(III-433)**

Experimental study of gas-solid two-phase flow in the guide vane cyclone tube, J.-J. Wang*, Y. Guo, Y.-H. Jin, University of Petroleum Dongying, P.R. China **(III-438)**

Personal impactor to measurements aerosol inhalation dose, D.A. Pripachkin*, A.K. Budyka, Karpov Institute of Physical Chemistry; A.G. Tsovyanov, Institute of Biological Physics, Russia **(III-443)**

L11	Technical Vacuum and Pressure Cake Filtration	13:15 - 14:30

Optimizing industrial filters at Pyhäsalmi mine in Finland, P. Rantala*, S. Lähteenmäki, Helsinki University, Finland **(I-185)**

Advanced filtration of PTA (Pure Terephthalic Acid): Separation, washing and demoisturing in a single process unit with the hi-bar filtration R. Bott*, T. Langeloh, M. Schiessl, Bokela GmbH, Germany **(I-190)**

The multi-purpose rotary drum filter, T. Langeloh*, R. Bott, Bokela GmbH, Germany **(I-195)**

L12 Technical Centrifugal Sedimentation for Ultrafine Particles 13:15 - 14:30

Centrifugal separation in biopharmaceutical processing, W.-F. Leung*, The Hong Kong Polytechnic University, Hong Kong **(I-200)**

A case study - from lab-scale testing to industrial scale processing using a disk stack centrifuge, B. Fuchs*, A. Trasatti, S. Reddell, T. Pryor, DuPont Engineering, USA **(I-205)**

Fine solids separation within biodiesel process, M. Kopf*, G. Bergjohann, Pieralisi Deutschland GmbH, Germany **(I-210)**

L13 Filter Media Characterization – Porometry – Integrity Testing I 13:15 - 14:30

Homogeneity of commercial filter cartridges, K. Gupta*, A. Jena, Pourous Materials, Inc., USA **(I-215)**

Bubble point and pore size distribution measurements of filter papers, wovens and nonwovens using a pore size meter PSM 165, S. Große*, A. Rudolph, Topas GmbH, Germany **(I-220)**

Filter media pore size comparison between porometry and glass bead challenge testing, G. Rideal*, Whitehouse Scientific Ltd., Great Britain; E. Mayer, DuPont Engineering, USA **(I-225)**

M8 Produced Water Treatment 13:15 - 14:30

Feasibility of using ceramic ultra- and nanofiltration membranes for efficient treatment of produced water, P. Czermak*, M. Ebrahimi, K. Shams Ashaghi, University of Giessen-Friedberg; P. Mund, Atech Innovations GmbH, Germany **(II-140)**

Crossflow microfiltration of oil from synthetic produced water, Y.H.D. Alanezi*, R.J. Wakeman, R.G. Holdich, Loughborough University, Great Britain **(II-145)**

Preparation of nano-sized particles modified PVDF/Al_2O_3/TiO_2 ultrafiltration membrane and study on its performances for oilfield wastewater treatment, S.-L. Yu*, Q. Zhao, H. Lu, J. Yang, D. Wang, Harbin Institute of Technology, P.R. China **(II-150)**

M9 Nanofiltration 13:15 - 14:30

Nanofiltration: A method for solute removal from non-aqueous solvents, E.S. Tarleton*, Loughborough University, Great Britain **(II-155)**

Organophilic nanofiltration by polymeric membranes, T. Beeskow*, GMT Membrantechnik GmbH; J. Stegger, Borsig Membrane Technology GmbH, Germany **(II-160)**

Pre-oxidation effect on TOC removal in surface water treatment by nanofiltration, G.H.R. Nabi Bidhendi*, A.Torabian, H. Etemadi, A.A. Ghadimkhani, Tehran University, Iran **(II-165)**

Invited Lecture 3 13:15 - 14:30

Gas Cleaning Technology, Prof. Gernot Krammer NTNU - University of Science and Technology, Norway **(III-19)**

Invited Lecture 4 13:15 - 14:30

Solid-Liquid-Separation by Deep Bed Filtration, Prof. Rolf Gimbel University of Duisburg Essen, Germany **(I-29)**

M10 Characterisation by SAXS 15:00 - 16:15

Modifying a small-angle X-ray scattering-camera for a time-reduced characterisation of nanoparticles, V. Goertz*, H. Nirschl, Karlsruhe University, R. Wengeler, BASF AG, Germany **(II-170)**

Spatial and temporal in-situ evolution of concentration profile probed by SAXS during ultrafiltration of casein micelles, C. David, F. Pignon*, A. Magnin, University of Grenoble; M. Sztucki, European Synchrotron Radiation Facility; G. Gésan-Guiziou, INRA Agrocampus Rennes, France **(II-175)**

In-situ characterization of anisotropic colloids deposition by SAXS during crossflow ultrafiltration, F. Pignon*, C. David, A. Magnin, University of Grenoble; M. Sztucki, European Synchrotron Radiation Facility, France **(II-180)**

M11 Dynamic Filtration 15:00 - 16:15

Rotation filtration with ceramic membrane discs: presentation of industrial and municipal applications, C. Münch*, F. Koppe, Kerafol GmbH, Germany **(II-185)**

Dynamic cross-flow filtration of biological suspensions, e.g. bakers yeast, S. Neubauer*, U.A. Peuker, Clausthal University, Germany **(II-190)**

Classification using dynamic filtration, Y. Taamneh*, S. Ripperger, Kaiserslautern University, Germany **(II-195)**

M12 Dairy Products I 15:00 - 16:15

Impact of physico-chemical feed properties on deposit layer formation and filtration in the microfiltration of milk proteins, W. Kühnl*, A. Piry, A. Tolkach, U. Kulozik, Munich University; T. Grein, S. Ripperger, Kaiserslautern University, Germany **(II-200)**

Effect of physico-chemical changes on critical hydrodynamic conditions and protein transmission during microfiltration (0.1 µm) of skimmed milk, G. Gésan-Guiziou*, F. Garnier, F. Rousseau, INRA Agrocampus Rennes; A. Jimenez, SOREDAB SAS, France **(II-204)**

Role of physico-chemical environment on limiting and critical fluxes in ultrafiltration, nanofiltration and reverse osmosis of modified skim milks, M. Rabiller-Baudry*, H. Bouzid, L. Paugam, University Rennes 1, France **(II-209)**

G9 Depth Filtration & Nanofibre Layers 15:00 - 16:15

Experimental investigation on air filtration of submicron particulates by nanofiber filter, W.-F. Leung*, C.-H. Hung, The Hong Kong Polytechnic University, Hong Kong **(III-156)**

Investigation of filters with a single nanofiber layer on a substrate, J. Wang*, D.Y.H. Pui, S.C. Kim, University of Minnesota, USA **(III-161)**

Filtration properties of cellulose filter media with polymer nanofiber layer, M. Maly*, S. Petrik, J. Duchoslav, L. Plistil, Elmarco Ltd.; J. Hruza, University of Liberec, Czech Republic **(III-166)**

G10 Hot Gas Cleaning 15:00 - 16:15

Predicting the long term filtration behaviour on the basis of cycle times measured over a limited number of filtration cycles: Problems and approaches in high temperature gas filtration, N. Döring*, J. Meyer, G. Kasper, Karlsruhe University, Germany **(III-171)**

Blow back system for hot gas filter installations using sintered metal fibre filter elements, I. Schildermans*, V. Kuijken, S. Vandendijk, A. Aust, NV Bekaert SA, Belgium **(III-176)**

High temperature granular bed filtration of biomass gasification gas, D. Stanghelle*, A. Norheim, O.K. Sonju, J. Hustad, NTNU University, Norway **(III-181)**

L14 Large Scale Treatment of Water and Wastewater 16:45 - 18:00

Large scale experiences in wastewater filtration: A practical insight, M. Barjenbruch*, Berlin University, Germany **(I-230)**

Experience from world's largest sea water filtration plant for oil reservoir injection, M.H. Al-Ghamdi*, N.P. Isaias, Saudi Aramco, Saudi Arabia **(I-235)**

The impact of wastewater quality on receiving water bodies in Eastern Cape, South Africa, A.N. Osode, University of Fort Hare; M. Sibewu; M.N.B., Tshwane University, South Africa **(I-240)**

L15 Centrifugal Filtration Fundamentals 16:45 - 18:00

Advances in mathematical models and numerical methods for gravity and centrifugal sedimentation and filtration of polydisperse suspensions, R. Bürger*, University of Conception; A. Garcia, University del Norte, Chile **(I-245)**

Steam enhanced centrifugation of compressible products, U.A. Peuker*, Clausthal University, Germany **(I-250)**

Purification of particulate solids on centrifuges, F. Ruslim*, H. Nirschl, W. Stahl, Karlsruhe University, Germany; P. Carvin, Rhodia, France **(I-255)**

L16 Filter Media Characterization Porometry – Integrity Testing II 16:45 - 18:00

A study of the mechanism of wet and dry filtration using NIST traceable glass microspheres, G.R. Rideal*, E.A. Roberts, A. Stewart, J. Storey, Whitehouse Scientific Ltd., Great Britain **(I-260)**

Monitoring of cleanliness level in hydraulic and lube fluids using the mesh blockage technique, H. Karl*, Pall GmbH, Germany; M.J. Day, Pall Europe Ltd., Great Britain **(I-265)**

Filterability of mineral based gear lubrication oils, K. Farooq*, Pall Corporation, USA **(I-270)**

M13 Dynamic Filtration II 16:45 - 18:00

Dynamic cross flow microfiltration of viscous suspensions, S. Mirza*, Somicon AG, Switzerland; R. Bott, E. Ehrfeld, Bokela GmbH, Germany **(II-214)**

Dynamic cross-flow filtration with ceramic filter membranes, B. Hegnauer*, KMPT AG, Germany **(II-219)**

Influence of different parameters on membrane flux and nutrient retention of digester effluent filtrate in a single-shaft-disk-filter, R. Maas*, V. Bagehorn, E. Friedrich, H. Friedrich, Fraunhofer Institute for Ceramic Technologies & Systems IKTS, Germany **(II-224)**

M14 Dairy Products II 16:45 - 18:00

Microfiltration for the reduction of microorganisms in complex food systems: Effect of operating conditions and ingredient interactions, V. Kaufmann*, V. Schmidt, S. Scherer, U. Kulozik, Munich University, Germany **(II-229)**

Effect of membrane length, membrane resistances and process conditions on the fractionation of milk proteins by microfiltration, A. Piry*, W. Kühnl, A. Tolkach, U. Kulozik, Munich University, T. Grein, S. Ripperger, Kaiserslautern University, Germany; A. Heino, University of Helsinki, Finland **(II-233)**

Membrane adsorption chromatography – A novel hybrid technology for the separation of high value bioactive molecules such as glycosylated peptides, M. Kreuß*, U. Kulozik, Munich University, Germany **(II-238)**

G11 Depth Filtration & Modelling 16:45 - 18:00

Simulation of dust filtration in consideration of the incident flow using a coupling of analytical filtration models with CFD code, P. Kopf*, M. Piesche, Stuttgart University, Germany **(III-186)**

Initial collection efficiency of neutral aerosol particles in bipolarly charged fibrous filters, A. Podgorski*, Warsaw University, Poland; A. Balazy, Cummins Filtration, Inc., USA **(III-191)**

Nonsteady-state performance of mechanical fibrous filters, A. Balazy*, Cummins Filtration, Inc., USA; A. Podgorski, Warsaw University, Poland **(III-196)**

G12 Industrial (Hot) Gas Cleaning 16:45 - 18:00

Star-BagsTM – Application of an advanced filter media construction for greater filtration efficiency and production capacity, M.J. Neate*, Albany International Pty Ltd, P.R. China; B. Currwell, Albany International Pty Ltd, Australia **(III-201)**

Backpulse cleaned filtration system for the retention of alumina particles in NOx-gas streams, I. Schildermans*, H. Verbauwhede, S. Vandendijk, NV Bekaert SA, Belgium **(III-206)**

Recent advances in particulate filtration technologies for coal gasification based power generation plants, S.D. Sharma*, D. Chase, M. Dolan, A. Ilyusheckin, K. McLennan, T. Nguyen, CSIRO Energy Technology, Australia **(III-211)**

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L17 Deep Bed Filtration – Modelling, Test and Simulation I 08:30 - 09:45

Basic model for suspension transport in porous media (for petroleum and environmental engineering), A. Shapiro*, University of Denmark DTU, Denmark; P. Bedrikovetsky, University of Rio de Janeiro/Petrobras, Brazil **(I-275)**

Optimization of non-woven metallic filter media based on probability model, S. Ishikawa*, Kansai Wire Netting Co., Ltd.; A. Shimosaka, Y. Shirakawa, J. Hidaka, Doshisha University, Japan **(I-280)**

On coupled micro- and macro simulation for filtration processes, Z. Lakdawala*, O. Iliev, A. Wiegmann, Fraunhofer Institute for Industrial Mathematics ITWM, Germany **(I-285)**

L18 Technical Vacuum and Pressure Cake Filtration – Media & Components 08:30 - 09:45

Sefar hybrid technology (SHT) - A new approach to extend durability of filter fabrics, K.-U. Hömann*, C. Maurer, Sefar AG, Switzerland **(I-290)**

Latest developments in woven filter media for gypsum dewatering in modern FGD, A. Aust*, O. Steffen, C. Gurtner, C. Maurer, Sefar AG, Switzerland **(I-291)**

Pigments getting finer and finer - A new answer to this challenge, C. Maurer*, Sefar AG, Switzerland **(II-296)**

L19 Separation Enhancement by Electric Forces 08:30 - 09:45

Comparative analysis of electro-osmotic dewatering and electroforced sedimentaion, M.S. Jami,* Islamic University Malaysia; Malaysia; M. Iwata, Suzuka National College, Japan **(I-301)**

Electrohydrodynamic transport in nanoporous filter cakes, B. Schäfer*, H. Nirschl, Karlsruhe University, Germany **(I-306)**

Solid-liquid expression enhancement from plant tissues by pulsed electric fields, E. Vorobiev*, N. Grimia, N. Lebovka, University of Compiègne; J. Vaxelaire, ENSGTI, France **(I-311)**

M15 Modelling of Membrane Processes 08:30 - 09:45

Modelling and optimization of multi-stage membrane filtration processes, Z. Kovacs*, W. Samhaber, University of Linz, Austria **(II-241)**

Dynamical modelling and optimization of wastewater filtration process by submerged membrane bioreactors, C. Albasi*, A. Zarragoitia, S. Schetrite, U. Jauregui, University of Toulouse, France **(II-246**

Modelling the separation of protein solutions by means of cross-flow filtration, T. Grein*, S. Ripperger, Kaiserslautern University; A. Piry, W. Kühnl, U. Kulozik, Munich University, Germany **(II-251)**

M16 Membrane Fouling 08:30 - 09:45

Determining fouling parameters from microfiltration tests, W.-F. Leung, The Hong Kong Polytechnic University, Hong Kong **(II-256)**

Core-shell particles as model compound for studying fouling, M.L. Christensen*, M.B.O. Andersen, T.B. Nielsen, K. Keiding, Aalborg University, Denmark **(II-261)**

Characterization of fouling membrane in different integrated microfiltration systems, X.-J. Yan, S.-L. Yu*, S.-T. Fu, X. Yang, Y.-T. An, Harbin Institute of Technology, P.R. China **(II-266)**

G13 Particles and Filter Tests 08:30 - 09:45

Filter test with soot generation from 7.5 nm up to 200 nm and a mass concentration from 100 mg/h up to 3 g/h, G. Lindenthal*, Consulting for Particle Technology; M. Schmidt, L. Mölter, Palas GmbH, Germany **(III-216)**

The influence of test aerosol parameters on the filtration efficiency of electret filters, I.L. Tuinman*, C. van Gulijk, TNO Defense Security and Safety, Netherlands **(III-221)**

Separation behaviour of airborne particles and bioaerosols on particulate respirators and respirator filter media, T. Voigt*, S. Ripperger, Kaiserslautern University; G. Helmke, B. Ahlert, Fulda University, K.W. Müller, BGN, Germany **(III-226)**

G14 Fibrous Filter 08:30 - 09:45

Experimental investigations concerning the origin of particle penetration during dust filtration with nonwoven filter media, T. Häusle*, H. Rieger, H. Sauter, Mahle Filtersysteme GmbH, Germany **(III-231)**

Collection of nanoparticles on fibrous media: Filtration efficiency and clogging effect, G. Mouret*, D. Thomas, S. Calle-Chazelet, Nancy University; D. Bemer, INRS, France **(III-236)**

Air filtration performance of fine to nano size fibrous materials formed from polymeric film stretch, K.-J. Choi*, AAF International, USA **(III-241)**

L20 Deep Bed Filtration – Modelling, Test and Simulation II 10:15 - 11:30

On new challenges for CFD simulation in filtration, O. Iliev*, Z. Lakdawala, Fraunhofer Institute for Industrial Mathematics ITWM; M. Dedering, W. Stausberg, IBS Filtran, Germany; R. Ciegis, V. Starikovicius, Vilnius University, Lithuania **(I-316)**

Importance of the CFD simulations for the design of efficient filters, W. Stausberg*, M. Dedering, IBS Filtran; O. Iliev, Z. Lakdawala, P. Popov, Fraunhofer Institute for Industrial Mathematics ITWM, Germany **(I-321)**

Setting a new milestone in filter media design: Simulating performance according multipass test based on 3D fiber structures, M.J. Lehmann*, H. Banzhaf, G.-M. Klein, M. Durst, Mann+Hummel GmbH; S. Rief, A. Wiegmann, Fraunhofer Institute for Industrial Mathematics ITWM, Germany **(I-326)**

L21 Press Filtration Fundamentals I 10:15 - 11:30

Describing the shear and compressive behavior of fine particulate filter cakes using characteristic solids volume fractions, A. Erk*, BASF AG, W. Stahl, H. Anlauf, Karlsruhe University, Germany **(I-331)**

Dewatering and flow behaviour of fine limestone particle packings, T. Mladenchev*, J. Tomas, University of Magdeburg, Germany **(I-336)**

Dewatering and fluidity behaviour of kaolin suspensions in the presence of a dispersant, O. Larue*, E. Vorobiev, University of Compiègne; M. Loginov, Nikolai Lebovka, Institute of Biocolloidal Chemistry, Ukraine **(I-341)**

L22	Separation Enhancement by Magnetic Forces	10:15 - 11:30

Existing and potential applications of magnetic fields in particle technology, C. Eichholz, M. Stolarski, H. Nirschl, Karlsruhe University, Germany; K. Keller*, Solae/Dupont, USA **(I-346)**

Magnetic filtration processes in selective bio separation, H. Nirschl*, M. Stolarski, C. Eichholz, Karlsruhe University, Germany **(I-351)**

Continuous selective high gradient magnetic bio separation using novel rotating matrix centrifugation, M. Stolarski*, C. Eichholz, H. Nirschl, Karlsruhe University, Germany; K. Keller, Solae; B. Fuchs, DuPont, USA **(I-356)**

PM3	Inorganic/Ceramic Membranes	10:15 - 12:15

Feasibility of ceramic ultra- and nanofiltration membranes for removal of endotoxins, P. Czermak*, M. Ebrahimi, University of Giessen-Friedberg; G. Catapano, University of Calabria, Italy **(II-487)**

Two stage integrated ceramic membrane reactor system for the continuous enzymatic synthesis of oligosaccharides, M. Ebrahimi*, L. Placido, L. Engel, K. Shams Ashagi, University of Giessen-Friedberg, Germany; P. Czermak, Kansas State University, USA **(II-492)**

MEMBRALOX® IC A new range of high compactness ceramic Crossflow filtration membranes, J. Guibaud*, P. Chanaud, J.M. Cayrey V. Lasserre, Pall Exekia, France **(II-497)**

Goat milk fractionation and protein concentration by ceramic and polymeric membranes, B. Cancino*, C. Astudillo, Pontificia Universidad Catolica de Valparaiso, Chile **(II-500)**

Filtration of BSA and ß-cyclodextrin solutions by using inorganic membrane, T.-W. Cheng*, K.-W. Lin, Y.-L. Chiu, Tamkang University, Taiwan **(II-505)**

Preparation of nano-sized alumina modified ultrafiltration membrane and its antifouling research , S.-L. Yu*, D. G. Wang, Y. Lu, W. X. SHi, H. Lv, Harbin Institute of Technology, P.R. China **(II-510)**

Adhesion of particles on ceramic membranes, T. Quadt*, E. Schmidt, University of Wuppertal, Germany **(II-515)**

PM4	Special Membranes and Complex Systems	10:15 - 12:15

Enhanced membrane separation process for biogas upgrading – Operating experiences of feeding biomethane into the Austrian gas grid, M. Harasek*, A. Makaruk, M. Miltener, R. Schlager, Vienna University, Austria **(II-520)**

Investigation of He/CO_2 selectivity in palladium composite membranes, M. Dogan*, O. Altinisik, G. Dogu, Gazi University, Turkey **(II-525)**

Ionic liquid recovery from aqueous solutions by cross-flow nanofiltration, J.F. Fernández*, E. Chilyumova, D. Waterkamp, J. Thöming, University of Bremen, Germany **(II-528)**

Linseed oil extraction by high voltage electrical discharges followed by separation oil-in-water emulsions by dynamic microfiltration, J.-L. Lanoisellé, L. Li, L. Ding, X. Liao, E. Vorobiev*, University of Compiègne, France **(II-533)**

Chromatography membrane reactor system (CMCRS) for the continuous synthesis of galactosyl-oligosaccharides, L. Engel*, M. Ebrahimi, K. Schams, P. Czermak, University of Giessen-Friedberg, Germany **(II-538)**

Homogeneous catalysts recycling by nanofiltration: one step further to the sustainable production, T. Renouard*, A. Keraani, M. Rabiller-Baudry, C. Fischmeister, University Rennes 1, France **(II-543)**

Nanofiltration membrane performances in concentrated and diluted phosphoric acid media, H. Diallo*, B. Chaufer, M. Rabiller-Baudry, University Rennes 1, France **(II-548)**

The effect of feed solution pH on membrane microstructure and performance: An inside understanding by PALS analysis and molecular dynamic simulation, K.-S. Chang*, K.-L. Tung, D. Nanda, J.Y.-C. Jean, Chung Yuan University, Taiwan **(II-553)**

Removing natural organic matters from raw water using PACl coagulation & membrane filtration, D.-J. Lee, B.N. Tsai, J.Y. Lai, National Taiwan University, Taiwan **(II-558)**

A MEMS-based wet-wet differential pressure sensor for aggressive media with integrated temperature sensor, G. Drews*, Grundfos GmbH, Germany **(II-560)**

PG3	Depth Filtration	10:15 - 12:15

Improved CFD modeling of fibrous media for air cleaning applications, P. Tronville*, Torino University, Italy; R. Rivers, EQS, Inc, USA; Z. Bin, Tongji University, P.R. China **(III-448)**

Influence of unevenness of porous structure of filtration papers on distributing of stream in pores, A.G. Denysenko*, Kharkiv University, Ukraine **(III-453)**

Dispersion of aerosol particles in inhomogeneous fibrous filter media, A. Podgorski*, A. Jackiewicz, Warsaw University, Poland; A. Balazy, Cummins Filtration, Inc., USA **(III-456)**

Deposition of charged submicron aerosol particles in fibrous filters, V.A. Kirsch*, Frumkin Institute of Physical Chemistry; A.K. Budyka, Karpov Institute of Physical Chemistry, Russia **(III-461)**

Orthogonal test and regression analysis on granular bed filter, H.-M. Fu*, X. Su, Z. Lo, X. Zhou, Donghua University, P.R. China **(III-466)**

Hot Cleaning of Fuel Gas from Biomass Gasification, S. Thomas*, A. Herrmann, E. Schotte, Fraunhofer Institute for Factory Operation and Automation, Germany **(III-471)**

PG4 Combined Processes 10:15 - 12:15

Examination of effectivity of the CRT- DPF based on Ti_4O_7, P. Fuc*, Poznan University, Poland **(III-474)**

High porosity sinters TiO 2-xNx as an active carrier used in DPF Filter, J. Merkisz*, P. Fuc, Poznan University; D. Oblakowska, Crakow University, Poland **(III-479)**

Non Pt catalyst group in active part of new PM filter, J. Merkisz*, P. Fuc, Poznan University; D. Oblakowska, M. Gramatyka, Crakow University, Poland **(III-484)**

Reliability of particle emissions measurement on engine test stand, J. Merkisz*, J. Pielecha, Poznan University, Poland **(III-489)**

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Transitional capacity and particle removal efficiency connecting novel performance parameters of nonwovens, H. Kleizen*, IDEGO, Delft University, Parker Filtration B.V., Netherlands **(I-366)**

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G15 Filter Test Systems 13:15 - 14:30

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Practice-relevant lifetime of cleanable filter media, M. Schmidt*, L. Mölter, Palas GmbH, Germany **(III-250)**

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Effect of particle size on particle capture performance of polypropylene non-woven fibrous filter, T. Oshita*, Yamashin-Filter Corp.; K. Nakamura, K. Matsumoto, Yokohama University, Japan **(I-410)**

Modification of diatomaceous earth-based depth filters with nanosized basic or amphoteric metal oxides to promote virus removal from water, B. Michen*, M. Wegmann, T. Graule, Swiss Federal Laboratories for Materials Testing and Research, Switzerland; C.G. Aneziris, Freiberg University, Germany **(I-415)**

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Hot filter presses - Industrial and international experiences with Rollfit®, A. Reisser*, Reisser Eilers & Partner AG, Switzerland **(I-425)**

Hot filter press - Filtration, washing & thermal drying in a filter press, D. Mrotzek*, U. Esser, M. Longerich, Bayer Technology Services GmbH, Germany **(I-429)**

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Sludge floccation: From laboratory to wastewater treatment plant, P. Ginisty*, C. Peuchot, IFTS, France **(I-439)**

Interaction of polyelectrolyte with sewage sludge and lignite in conditioning of flocculated sludge, K.B. Thapa*, E. Qi, A.F.A. Hoadley, A. Stevens, Monash University, Australia **(I-444)**

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Influence of extractant molar volume on the alkali metal membrane extraction in closed system, Z. Albaraka*, D. Trebouet, M. Burgard, Strasbourg University, France; J.M. Loureiro, University of Porto, Portugal **(II-281)**

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Measurement of water separation efficiency of diesel fuel filters, C. Peuchot*, N. Petillon, IFTS, France **(I-474)**

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Membrane separation processes assisted by in situ streaming potentials measurement in low pressure MF/UF immersed membranes, M. Pontié*, Angers University, France **(II-320)**

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Al2O3 microporous membranes prepared on wet substrate by plasma spray coating technology, C.-C. Hsiung*, K.-L. Tung, C.-J. Chuang, T.-C. Ling; Chung Yuan University, Taiwan **(II-335)**

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Micro filtration with silicon nitride micro sieves and high frequency back pulsing, C.N. Koh*, T. Wintgens, T. Melin, Aachen University, Germany; F. Pronk, B. Brocades, Fluxxion B.V., Belgium **(II-354)**

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G20 Simulation of Diesel Particulate Filters 08:30 - 09:45

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Numerical investigations of diesel particulate filter systems with 2D and 3D simulation models, T. Deuschle*, M. Piesche, Stuttgart University, Germany **(III-323)**

Computational fluid dynamics simulation of soot filtration in wall-flow diesel particulate traps for automotive applications, S. Bensaid*, D. Marchisio, D. Fino, G. Saracco, V. Specchia, Torino University, Italy **(III-328)**

L34 Water Separation from Biodiesel by Filtration and Coalescence 10:15 - 11:30

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The Effects of diesel fuel additives on water separation performance, S. Hutzler*, G.B. Bessee, Southwest Research Institute, USA **(I-529)**

Factors of influence in water separation from biodiesel-ultra low sulfur diesel blends, C. M. Stanfel*, Ahlstrom Engine Filtration LLC, USA **(I-534)**

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Removal of arsenic from wastewaters by batch air-lift electrocoagulation, H.K. Hansen*, P. Nunez, C. Jil, G. Technical University Federico Sta. Maria, Chile **(I-548)**

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Experimental study on the desalination of polymer-flooding oil-extraction wastewater with UF-EDR combined system, S.-L. Yu*, J. Xu, X. Zuo, D. Wang, J. Liu, H. Lu, Harbin Institute of Technology, P.R. China **(II-382)**

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Application of binary packing for polysaccharides separation by hydrodynamic chromatography, A. Yelshin*, M. Mota, J.A. Teixeira, A. Yelshin, University of Minho; R. Diash, University of Bragança, Portugal **(II-392)**

Improved virus retention assurance using novel high productivity parvovirus retentive filters, G. Tkacik*, M. Krishnan, Millipore Corp., USA; G. Kern, Millipore SAS, France **(II-397)**

M26 Membrane Bio Reactor II 10:15 - 11:30

Development and operation of a submerged flat sheet membrane system for wastewater treatment in MBR, W. Lamparter*, S. Krause, U. Meyer-Blumenroth, R. Voigt, Microdyn-Nadir GmbH, Germany **(II-401)**

Mechanism of enhanced biological nitrogen and phosphorus removal in ICAS-MBR System, Y. Wang, S.-L. Yu*, F. Zhao, D. Wang, Harbin Institute of Technology, P.R. China **(II-406)**

Effect of cyclophosphamide and its main metabolites on the performance of a membrane bioreactor, C. Albasi*, L.F. Delgado, V. Faucet-Marquis, A. Leszkowicz, University of Toulouse; M. Audran, Lapeyronie Hospital, M. Castegnaro, CDS, France **(II-411)**

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Low pressure plasma coatings allows to produce in an economical, environmental friendly way, M. Pauwels*, Europlasma N.V., Belgium **(III-338)**

High efficient cleanable depth filter media for process gas filtration and a inno-vative all-purpose compact filter apparatus, E. Schmalz*, STFI e.V., Germany **(III-343)**

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CFD numerical flow simulation of particulate-laden and bulk solid flows - A state of the art, M. Lotfey*, ANSYS Fluent Deutschland GmbH, Germany **(III-353)**

The design of electrostatic precipitators by use of physical models, P. Tronville*, Torino University; G. Bacchiega, R. Sala, IRS s.r.l.; I. Gallimberti, Padova University; F. Zatti, Area Impianti .s.p.a., Italy **(III-357)**

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Announcement of the Host of the next WFC.

Additional Paper

Effect filter performance under various contaminants, X. Tao*, Southwest Research Institute; P. Madhavan, L. Bensch, Pall Corporation, USA

The Programme lists countries and regions and is subject to amendments. Errors and obmissions excepted.

PARTICLE CAPTURE BY AIR FILTER MEDIA HAVING TRUNCATED LOG-NORMAL FIBER DIAMETER DISTRIBUTIONS AND RANDOM SPACING OF FIBERS

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ABSTRACT

Studies by present authors have detailed procedures for 2-D simulations of flows through air filter media having fibers with truncated log-normal distributions, these fibers being located at random positions. Flow simulation is the essential first step to enable calculation of the particle capture efficiency of a fibrous filter medium. In the present study both aerodynamic and diffusive effects on particle capture were investigated. Comparisons are given between efficiency measurements on media samples and values calculated by CFD simulations of the same media for spherical particles from approximately 0.4 μm to 10 μm diameter. Results show that pressure drop calculated with the slip boundary condition is closer to measured values, and also that Brownian motion is important for efficiency calculation for particles of diameter less than 1μm.

KEYWORDS

Fibrous air filter media, Particle fractional efficiency, CFD simulation,
Aerodynamic forces, Diffusion, Random fiber distribution

1. Introduction

To optimize the design of the filter media for any desired efficiency on any aerosol of known characteristics, it is necessary to develop methods to calculate the particle-capture efficiency of the media studied. For the prediction of filter performance, knowledge of the aerosol dynamic interaction with the flow between the fibers of the filter material is crucial. Computational fluid dynamics (CFD) allows achieving very detailed information about the complex flow pattern within the medium, and then calculating the paths of particles carried by this flow. For the studies reported here, the authors have simulated the actual 3D structures of the filter media by two dimensional (2D) patterns of circles having truncated log-normal diameter distributions, with centers located at random positions in the simulating CFD domain.

The separation of airborne particle by fibrous filters is due to the combination of several collection mechanisms (1) (2). Particles smaller than 1 μm are strongly affected by Brownian diffusion, large particles very little. The reverse is true of aerodynamic drag. In this study, both effects are included in the CFD simulation of particle capture. Particle bounce and re-entrainment are considered negligible; once a particle touches a fiber surface we assume that it is captured. This is a good approximation for a liquid aerosol which wets the fiber surfaces and spreads into a thin layer on them (2). The test aerosol used for efficiency measurements was generated from liquid DEHS, di(2-ethylhexyl) sebacate, which has these properties. We also limit ourselves to the case of essentially clean filter media, whence the air flow will not be influenced by the deposited particles.

2. Flow and CFD Considerations

In this study, we first explored the capabilities of a commercial CFD code solving the Navier-Stokes (N-S) equations for the gas flow and we made some trials using an open-source CFD code, OpenFOAM (3). Other approaches are possible, and may be necessary for inclusive solutions to this problem. These include the use of the Lattice-Boltzmann simulation (4) and the Direct Simulation Monte Carlo (5) methods.

In order to calculate the efficiency it is necessary to describe the air flow pattern through the medium. A critical element in this solution is the selection of boundary conditions at the impermeable surfaces within the computational domain – here, randomly placed circles. When the objects in the path of a gas flow are large relative to the gas mean free path, there are many simultaneous or nearly simultaneous collisions between gas molecules and surface, and the individual collisions are not apparent. Since there are so many collisions with each direction of impact equally probable, the gas at the body surface behaves as if the molecules there had zero tangential velocity, i.e. it is standing still. This is the condition of "continuum flow", and a force tangential to the surface, viscous drag, is generated. The condition is also called the "no slip" boundary condition.

For quite small bodies in the flowing gas, far fewer collisions between gas molecules and the surface of the body occur in a given time interval. The gas at the surface no longer behaves as if it were standing still; the tangential velocity at the surface is non-zero, and various degrees of "slip" are said to occur - the flow regime "slip flow".

The criterion determining the shift from one regime to another for a body in a flow is the Knudsen number (Kn), which is *λ/D*, [mean free path of air] divided by [object characteristic dimension]. In our case, the characteristic dimension is fiber diameter. Continuum flow is fully established at $Kn_f = 0.001$, and the N-S equations with no-slip boundary equations apply. For $0.001<Kn_f<0.1$, the N-S equations with "full slip" boundary conditions apply. For $Kn_f >10$, "molecular flow" conditions apply, and the N-S equations no longer describe the behavior at all. The range $0.1<Kn_f<10$ is a transition between slip and molecular flow, also requiring a set of flow equations different from N-S. The effect of Brownian diffusion and the influence of slip at the boundary for our model are discussed below.

We consider the flow through the CFD domain to be incompressible, steady state, 2D and viscous at very low Reynolds number. In the filter medium, fibers lay approximately in planes perpendicular to the flow (6), hence in 2D are represented by circles. The finite volume method is implemented to calculate the flow field (i.e. the computational domain is subdivided into many small control volumes). The governing differential equations are converted into their algebraic equivalents and numerically integrated over these control volumes. Through this process the flow field is solved.

The trajectory of a discrete phase particle (or droplet) in this flow field is predicted by integrating the force balance on the particle, which is written in a Lagrangian reference frame. This force balance equates the particle inertia with the forces acting on the particle, and can be written (for the x direction in Cartesian coordinates) as $\frac{\rho_p \pi d_p^3}{6}\frac{du_p}{dt} = F_D\left(u - u_p\right) + F_{b_i}$, where d_p is the particle diameter and ρ_p the particle density. $F_D\left(u - u_D\right)$ is the aerodynamic drag force on the particle and F_{b_i} represents the amplitude of the Brownian force component. u and u_p are the x-component of the local gas and particle velocity respectively. Similar equations are written for the y-components. In these equations for particle dynamics, gravitational force and electrostatic forces are all considered to be negligible.

An example of the computational domain to be solved is shown in Figure 1.

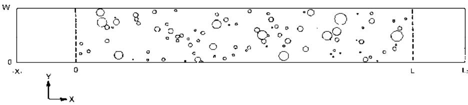


Figure 1 – Layout of simulated fibers generated randomly in computational domain

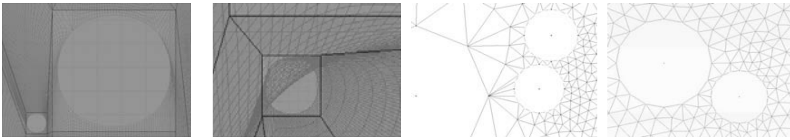
The gas flows from left to right in the direction of increasing x. Gas velocity is set uniform and parallel to the x axis at x = -X_1 (i.e. $v_x = V_0$ and $v_y = 0$). At $x = L_2$, the gradient of the pressure is set equal to zero. Boundaries at y = 0 and y = W are assigned symmetry conditions. Although there is no plane of symmetry in the actual fibrous structure, the lateral flow is probably negligible inside the media. On the symmetry boundary particles are not allowed to escape and are reflected.

Slip conditions at the circular boundaries applied in separate runs were either “no slip” (null tangential velocity at the wall) or “full slip” (no shear stress close to the wall). Theory suggests that these slip conditions should have been applied on the circle boundaries according to their diameters and hence Kn. The results of particle capture simulation (see below) suggest that Kn dependency should be implemented; it might not affect pressure drop results significantly, because the number of large diameter circles is small. The open source CFD code OpenFOAM will allow such modifications to boundary conditions in future studies.

Table 1 – Input data for air flow simulation and particle capture (F6 medium)

Max diameter of fiber (μm)	15.76	Solid fraction (%)	7.60
Min diameter of fiber (μm)	1.15	Average air temperature (K)	293
Media domain length (μm)	430	Inlet air velocity(m/s)	0.0617
Total domain length (μm)	670	Particle release rate (kg/s)	0.001
Media thickness (μm)	75	Particle density (kg/m^3)	912

If the mesh used is dense enough the discretization scheme of the first order gives results very similar to the second order discretization scheme. Because of the limit of the BlockMesh mesh generator in OpenFOAM for meshing our geometry, Blender, Calculix and Gmsh mesh generators were tried and compared. Blender requires the user to create rectangular cells first, link the vertices of rectangles, and then set the subsurface level to create circles, which control the mesh size. This is very labor-consuming. The generated rectangular mesh is then extruded into 3D in Calculix, where surfaces are selected to facilitate OpenFOAM boundary setting.



(a) (b) (c) (d)

Figure 2 - Comparison of the mesh around fibers - Blender (a),(b); Gmsh (c),(d)

In our model, there are regions where inter-fiber distance is small compared with dimensions of the domain. Therefore, the mesh in the gap needs to be small, while the mesh in other spaces is larger. As is shown in Figure 2 (a) and (b), rectangular meshes generated by Blender are smooth. But since criteria are difficult to set for linking rectangular cells in the open areas to the circular fiber boundaries, some mesh cells may extend into some circle boundaries.
Gmsh is an automatic 3D mesh generator for unstructured mesh and its mesh resolution is controlled by setting a characteristic length. A finer mesh could be generated in critical areas without generating too many cells elsewhere in the domain (Figure 3). For this reason, Gmsh was chosen as our preprocessor-mesh generator.

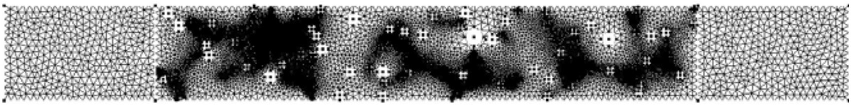


Figure 3 - The whole domain model mesh using Gmsh

3. Results and Discussions – Simulation of pressure drops

As one would expect, the predicted pressure drop with "full slip" boundary conditions implemented was lower than when "no slip" conditions were implemented (Figure 4).

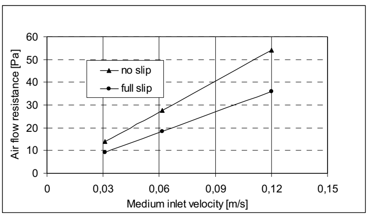


Figure 4- Simulated pressure drop as a function of air velocity

Experimental values of air flow resistance for the three media (F6, F8 and H13) are reported in (6). For the F6 medium, the measured pressure drop at 0.0617 m/s was 11 Pa. The simulation with full slip at 0.0617 m/s gives approximately 18.5 Pa. This difference could be due to several things: too many fine fibers in the simulated diameter distribution; blockage of too much of the domain by a single large circle; inapplicability of the N-S equations to flow in geometries of the present scale; and the difficulty of accurate measurement of such small pressure drops.

Simulation of particle-capture efficiency

When a particle touches an impermeable boundary (i.e. a circle representing a fiber) it is considered captured, hence eliminated from the computational process.

Fractional efficiency simulation results for 0.4 μm and 2.0 μm particle sizes are reported in Table 2.

Table 2 - Effect of slip boundary and Brownian motion on efficiency for different particle diameters (F6 medium)

		Implementation of conditions			
Condition combination:		1	2	3	4
Full Slip		no	yes	no	yes
Brownian motion		no	no	yes	yes
Simulated efficiency (%)	0.4 μm	2	30	10	36
	2.0 μm	6	51	16	53
Measured efficiency (%)	0.4 μm	15			
	2.0 μm	54			

For 2 μm diameter particles the experimental result is close to the simulated ones for combinations 2 and 4. The simulated efficiency is, as expected, very sensitive to Brownian diffusion. The poor agreement between measurement and simulation suggests that the simulation algorithm overestimates the effect of Brownian motion.

4. Conclusions

Simulation using the truncated log-normal fibrous model and the OpenFOAM CFD code with Gmsh as mesh generator gives good agreement with measured capture efficiency for 2 μm diameter particles. The simulation confirms the importance of Brownian motion for sub-micrometer particles. Further modification is needed to bring simulated and measured efficiencies together for the sub-micrometer diameter range.

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