MODEL 3340 LASER AEROSOL SPECTROMETER

BIBLIOGRAPHY

2009

Hofmann[1], W.; Winkler-Heil[1], R.; and McAughey[2], J. "Regional Lung Deposition of Aged and Diluted Sidestream Tobacco Smoke," *J. Phys.: Conf. Ser.* **151**, (2009) 1742–6596.

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Abstract: Since aged and diluted smoke particles are in general smaller and more stable than mainstream tobacco smoke, it should be possible to model their deposition on the basis of their measured particle diameters. However in practice, measured deposition values are consistently greater than those predicted by deposition models. Thus the primary objective of this study was to compare theoretical predictions obtained by the Monte Carlo code IDEAL with two human deposition studies to attempt to reconcile these differences. In the first study, male and female volunteers inhaled aged and diluted sidestream tobacco smoke at two steady-state concentrations under normal tidal breathing conditions. In the second study, male volunteers inhaled aged and diluted sidestream smoke labeled with ^{212}Pb to fixed inhalation patterns. Median particle diameters in the two studies were 125 nm (CMD) and 210 nm (AMD), respectively. Experimental data on total deposition were consistently higher than the corresponding theoretical predictions, exhibiting significant inter-subject variations. However, measured and calculated regional deposition data are quite similar to each other, except for the extra-thoracic region. This discrepancy suggests that either the initial particle diameter decreases upon inspiration and/or additional deposition mechanisms are operating in the case of tobacco smoke particles.

2008

Dart[1], Andrew; Thornburg[1], Jonathan. "Collection Efficiencies of Bioaerosol Impingers for Virus-Containing Aerosols," *Atmospheric Environment*, **42:4**, (Feb. 2008) 828–832.

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Abstract: Impingers are common bioaerosol sampling instruments. In the last 20 years, impinger performance for collection of viable and non-viable bioaerosols in the 0.1 to 10 μm size range has been well documented. An ideal impinger has high collection efficiency for particles >0.1 μm. This research explored how well the 500 ml Greenburg–Smith (G–S) impingers collected particles between 0.1 and 2 μm, simulating virus aerosols, with minimal fluid evaporation during sample collection intervals near 60 min. Various impingers have differing dimensions that come into play

when collecting viable samples of bioaerosols. The sampling environment can be modified to create optimum impingement conditions. Moderate differences in flow rate and impingement fluid volume may show distinct differences in the capture rate of viable samples within the bioaerosol impinger.

Yue[1,2], Wei; Stölzel[1,3], Matthias; Cyrys[1,4], Josef; Pitz[1,4], Mike; Heinrich[1,3], Joachim; Kreyling[3,5], Wolfgang G.; Wichmann[1,3,6], H.-Erich; Peters[1,3], Annette; Wang[7], Sheng; Hopke[8], Philip K. "Source Apportionment of Ambient Fine Particle Size Distribution using Positive Matrix Factorization in Erfurt, Germany," *Science of the Total Environment*, **398:1-3**, (July 2008) 133–144.

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Abstract: Particle size distribution data collected between September 1997 and August 2001 in Erfurt, Germany were used to investigate the sources of ambient particulate matter by positive matrix factorization (PMF). A total of 29,313 hourly averaged particle size distribution measurements covering the size range of 0.01 to 3.0 μm were included in the analysis. The particle number concentrations (cm^{-3}) for the 9 channels in the ultrafine range, and mass concentrations ($ng\ m^{-3}$) for the 41 size bins in the accumulation mode and particle up to 3 μm in aerodynamic diameter were used in the PMF. The analysis was performed separately for each season. Additional analyses were performed including calculations of the correlations of factor contributions with gaseous pollutants (O_3, NO, NO_2, CO and SO_2) and particle composition data (sulfate, organic carbon and elemental carbon), estimating the contributions of each factor to the total number and mass concentration, identifying the directional locations of the sources using the conditional probability function, and examining the diurnal patterns of factor scores. These results were used to assist in the interpretation of the factors. Five factors representing particles from airborne soil, ultrafine particles from local traffic, secondary aerosols from local fuel combustion, particles from remote traffic sources, and secondary aerosols from multiple sources were identified in all seasons.

2007

Hegg , Dean A.; Covert, David S.; Jonsson, Haflidi; Covert, Paul A. "An Instrument for Measuring Size-Resolved Aerosol Hygroscopicity at both Sub- and Super-Micron Sizes," *Aerosol Science and Technology*, **1521-7388**, **41:9**, (2007) 873–883.

Abstract: A new instrument to measure the size-resolved hygroscopic growth of both sub- and super-micron atmospheric aerosol is described. It consists of two white-light optical particle counters measuring the same sample aerosol simultaneously at two different controlled relative humidities. Calibration with aerosols of different refractive index confirms the expected relative insensitivity of the instrument to index of refraction. Data obtained in the field from airborne sampling support the utility of the instrument in measuring differences in size-resolved hygroscopicity in the marine boundary layer and also in addressing the issue of kinetic limitations to aerosol condensational growth.

Nagy, A.; Szymanski, W.W.; Gal, P.; Golczewski, A.; Czitrovszky, A. "Numerical and Experimental Study of the Performance of the Dual Wavelength Optical Particle Spectrometer (DWOPS)," *Journal of Aerosol Science*, **38**:**4**, (2007) 467–478.

Abstract: The intrinsic nature of elastic light scattering by aerosol particles—the non-monotonic dependence of the scattered intensity vs. size—influences the performance of practically all single optical particle spectrometers resulting frequently in substantial erroneous sizing of particles. As a possible solution for this problem we developed a measuring system and data reduction procedure allowing simultaneous determination of particle size and its complex refractive index. The system contains two laser sources with different wavelengths and four detectors collecting scattered light in four spatially separated angular ranges. The targeted size and refractive index ranges of this device cover the size from 0.1 to 10 µm, the real part of the refractive index from 1.1 to 2, and the imaginary part of refractive index between 0 and 1 corresponding to the properties of ambient aerosol particles. The numerical performance study shows that the sizing error of the method remains less than 10% independent of the refractive index of the particles. The assessment of the real and imaginary part of the refractive index is possible within about 15%. Experimental results verify the feasibility of this new instrumental approach showing the potential of the method to determine in real-time the size and complex refractive index of single aerosol particles without the necessity of instruments' recalibration for varying particle materials.

Sohn[1], Michael D.; Apte[1], Michael G.; Sextro[1], Richard G.; Lai[2], Alvin C.K. "Predicting Size-Resolved Particle Behavior in Multizone Buildings," *Atmospheric Environment*, **41:7**, (March 2007) 1473–1482.

[1]Indoor Environment Department, Lawrence Berkeley National Laboratory; One Cyclotron Road, Mail Stop: 90R3058, Berkeley, CA 94720, USA. [2]School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore 639798, Singapore.

Abstract: We compare model predictions to measurements of SF_6 and environmental tobacco smoke particle concentrations in a three-room chamber experiment. To make predictions of multi-room aerosol transport and fate, we linked a multizone airflow model (COMIS) with an indoor aerosol dynamics model (MIAQ4). The linked models provide improved simulation capabilities for predicting aerosol concentrations and exposures in buildings. In this application, we found that the multizone air flow model was vital for predicting the inter-room airflows due to temperature differences between the rooms and when air-sampling pumps were operating during the experiment. Model predictions agree well with measurements, as shown by several comparison metrics. However, predictions of airborne ETS concentrations are slightly lower than measurements. This is mostly attributable to under-stating the source release amount, which we specified independently from literature estimates. Model predictions of ETS particle-size distributions agree with measurements; size bins with the peak concentrations are slightly over-predicted initially, but agree thereafter.

2006

Bryant[1], C. ; Eleftheriadis[2], K.; Smolik[3], J.; Zdimal[3], V.; Mihalopoulos[4], N.; Colbeck[1], I. "Optical Properties of Aerosols over the Eastern Mediterranean," *Atmospheric Environment*, **40:32**, (Oct. 2006) 6229–6244.

[1]University of Essex, Department of Biological Sciences, Wivenhoe Park, Essex, UK. [2]N.C.S.R. Demokritos, 15310 Ag. Parakeui, Attiki, Greece. [3]Institute of Chemical Process Fundamentals, ASCR, Prague, Czech Republic. [4]Environmental Chemical Processes Laboratory (ECPL), Department of Chemistry, University of Crete, 71409 Heraklion, Greece.

Abstract: Measurements of aerosol optical properties, size distribution and chemical composition were conducted at Finokalia, a remote coastal site on the Greek island of Crete (35°19′N, 25°40′E) during July 2000 and January 2001. During the summer campaign the total scattering coefficient, σ_{SP}, (at a wavelength of 550 nm) ranged from 13 to 120 Mm^{-1} (mean=44.2 Mm^{-1}, standard deviation=17.5) whilst during the winter it ranged from 7.22 to 37.8 Mm^{-1} (mean=18.42 Mm^{-1}, standard deviation=6.61). A distinct diurnal variation in scattering coefficients was observed, with minima occurring during the early morning and maxima in the late afternoon during the summer and late evening during the winter. The mean value of the Ångström exponent was 1.47 during the summer and 1.28 during the winter, suggesting a larger fraction of smaller particles at the site during the summer. This was confirmed by continuous measurements of the aerosol size distribution. An

analysis of the single scattering albedo suggests that there is a more absorbing fraction in the particle composition in the summer than during the winter. An investigation of air mass origins on aerosol optical properties indicated that those from Turkey and Central/Eastern Europe were highly polluted with a corresponding impact on aerosol optical properties. A linear relationship was obtained between the total scattering coefficient and both the non-sea-salt sulphate concentrations and the fine aerosol fraction.

Lazaridis[1], M.; Eleftheriadis[2], K.; Smolik[3], J.; Colbeck[4], I.; Kallos[5], G.; Drossinos[6], Y.; Zdimal[3], V.; Vecera[7], Z.; Mihalopoulos[8], N.; Mikuska[7], P.; Bryant[4], C.; Housiadas[2], C.; Spyridaki[1], A.; Astitha[5], Marina; Havranek[9], V. "Dynamics of Fine Particles and Photo-Oxidants in the Eastern Mediterranean (SUB-AERO)," *Atmospheric Environment*, **40:32**, (Oct. 2006) 6214–6228.

[1]Technical University of Crete, Department of Environmental Engineering, GR-73100 Chania, Greece. [2]N.C.S.R. Demokritos, GR-15310 Ag. Paraskevi, Attiki, Greece. [3]Institute of Chemical Process Fundamentals, Academy of Sciences of the Czech Republic, Prague, Czech Republic. [4]Department of Biological Sciences, University of Essex, UK. [5]University of Athens, Department of Physics, Greece. [6]European Commission, Joint Research Centre, I-21020 Ispra (Va), Italy. [7]Institute of Analytical Chemistry, Academy of Sciences of the Czech Republic, Brno, Czech Republic. [8]Environmental Chemical Processes Laboratory, Department of Chemistry, University of Crete GR-71409 Heraklion, Greece. [9]Nuclear Physics Institute, Academy of Sciences of the Czech Republic, Rez at Prague, Czech Republic.

Abstract: As part of the European project SUB-AERO, comprehensive aerosol and gaseous pollutant measurement campaigns were performed at the Finokalia station (July 2000 and January 2001) on the island of Crete (Greece) in combination with boat measurements in the eastern part of the Mediterranean area. The measurements were performed with the participation of nine European research institutions. The objective of the measurement campaigns was to evaluate and assess the spatial and temporal variability of photochemical pollutants and fine particles. The current overview paper presents the framework and main results of the measurements and modeling studies performed during the project. Extensive measurements of gaseous and atmospheric-aerosol physical, chemical and optical characteristics were performed during the measurement campaigns in conjunction with detailed chemical analyses of the aerosol species. Along with the experimental work mesoscale modelling, using a combination of the UAM-AERO air quality model together with the RAMS prognostic meteorological model, was used to reveal the dynamics of particulate matter and photo-oxidants. Furthermore, regional chemistry transport models were applied to determine the background and initial conditions for the mesoscale modelling.

Valmari, Tuomas; Lehtimäki, Matti; Taipale, Aimo. "Filter Clogging by Bimodal Aerosol," *Aerosol Science and Technology*, **1521-7388**, **40:4**, (2006) 255–260.

Abstract: Pressure drop evolution during filtration of bimodal aerosol was studied experimentally. A low-pressure drop pre-filter upstream of the actual collection filter was demonstrated to significantly reduce the pressure drop growth rate, when the aerosol is dominated by coarse particles. The pressure drop evolution during depth-filtration, that took place mainly in a pre-filter, could be predicted by adding up the separately measured contributions from the unimodal fine and coarse aerosols. However, the cake filtration (pre-filter was not used) of coarse particles alone resulted in a faster clogging rate as compared to the same amount of coarse particles accompanied with fine particles (mass ratio coarse:fine 3:1). Apparently, fine particles deposited on coarse particles affect their surface properties and thus the porosity of the cake formed.

2005

He[1], Congrong; Morawska[1], Lidia; Gilbert[2], Dale. "Particle Deposition Rates in Residential Houses," *Atmospheric Environment*, **39**:**21**, (July 2005) 3891–3899.

[1]International Laboratory for Air Quality and Health, Queensland University of Technology, Brisbane, QLD 4001, Australia. [2]Built Environment Research Unit, Queensland Department of Public Works, Brisbane, QLD 4001, Australia.

Abstract: As part of a large study investigating indoor air in residential houses in Brisbane, Australia, the purpose of this work was to quantify the particle deposition rate of size classified particles in the size range from 0.015 to 6 μm. Particle size distribution resulting from cooking, repeated under two different ventilation conditions in 14 houses, as well as changes to particle size distribution and $PM_{2.5}$ concentration as a function of time, were measured using a Scanning Mobility Particle Sizer™ (SMPS™) spectrometer, an Aerodynamic Particle Sizer® (APS™) spectrometer, and a DUSTTRAK™ aerosol monitor. Deposition rates were determined by regression fitting of the measured size-resolved particle number and $PM_{2.5}$ concentration decay curves, and accounting for air exchange rate.

The measured deposition rates were shown to be particle size dependent and they varied from house to house. The lowest deposition rates were found for particles in the size range from 0.2 to 0.3 μm for both minimum (air exchange rate: 0.61±0.45 h^{-1}) and normal (air exchange rate: 3.00±1.23 h^{-1}) ventilation conditions. The results of statistical analysis indicated that ventilation condition (measured in terms of air exchange rate) was an important factor affecting deposition rates for particles in the size range from 0.08 to 1.0 μm, but not for particles smaller than 0.08 μm or larger than 1.0 μm. Particle coagulation was assessed to be negligible compared to the two other processes of removal: ventilation and deposition. This study of particle deposition rates, the largest conducted so far in terms of the number of residential houses investigated, demonstrated trends in deposition rates comparable with studies previously reported, usually for significantly smaller samples of houses (often only one). However, the results compare better with studies which, similarly to this study, investigated cooking as a source of particles (particle sources investigated in other studies included general activity, cleaning, artificial particles, etc).

Hinz, K.-P.; Trimborn, A.; Weingartner, E.; Henning, S.; Baltensperger, U.; Spengler, B. "Aerosol Single Particle Composition at the Jungfraujoch," *Journal of Aerosol Science*, **36:1**, (2005) 123–145.

Abstract: During the first Cloud and Aerosol Characterization Experiment (CLACE-1) in February and March 2000 various methods were used to characterize the aerosol at the high-alpine site Jungfraujoch, Switzerland (3580 m asl). One aim of the campaign was to perform the size-resolved chemical analysis of single particles under conditions of the free troposphere in real-time. Evaluation of single particle spectra measured predominantly in the size range between 0.5 and 5 μm and determination of spectra patterns of the most frequent particle classes showed a great variability ranging from pure carbon particles over carbon particles internally mixed with salts and/or secondary components to mineral dust particles. Such mineral particles sometimes showed internal mixtures with carbon indicating scavenging effects of carbonaceous material by minerals. This can be due to coagulation or condensation of organic molecules on the mineral particles. Observation of internally mixed carbon particles is an indication for atmospheric transformation processes of pure carbon particles. Such internally mixed particles can strongly influence cloud formation due to an increase in particle size and hygroscopicity.

High abundance of mineral and carbon-containing particles could be correlated to enhanced light absorption and light scattering coefficients, respectively. Semi-quantitative evaluation of mass spectra using relative sensitivity factors showed comparable ratios of selected ion pairs compared to bulk concentrations determined by ion chromatography.

2004

Fruin[1], Scott A.; Winer[1], Arthur M.; Rodes[2], Charles E. "Black Carbon Concentrations in California Vehicles and Estimation of In-Vehicle Diesel Exhaust Particulate Matter Exposures," *Atmospheric Environment*, **38:25**, (Aug. 2004) 4123–4133.

[1]Environmental Science and Engineering Program, Department of Environmental Health Sciences, School of Public Health, University of California, 61-295, Los Angeles 90095-1772, USA. [2]Center for Aerosol Technology, RTI International, Research Triangle Park, NC 27709, USA.

Abstract: This research assessed in-vehicle exposures to black carbon (BC) as an indicator of diesel particulate matter (DPM) exposures. Approximately 50 h of real-time Aethalometer BC measurements were made inside vehicles driven on freeway and arterial loops in Los Angeles and Sacramento. Video tapes of the driver's view were transcribed to record the traffic conditions, vehicles followed, and vehicle occupant observations, and these results were tested for their associations with BC concentration. In-vehicle BC concentrations were highest when directly following diesel-powered vehicles, particularly those with low exhaust pipe locations. The lowest BC concentrations were observed while following gasoline-powered passenger cars, on average no different than not following any vehicle. Because diesel vehicles were over-sampled in the field study, results were not representative of real-world driving. To calculate representative exposures, in-vehicle BC concentrations were grouped by the type of vehicle followed, for each road type and congestion level. These groupings were then re-sampled stochastically, in proportion to the fraction of statewide vehicle miles traveled (VMT) under each of those conditions. The approximately 6% of time spent following diesel vehicles led to 23% of the in-vehicle BC exposure, while the remaining exposure was due to elevated roadway BC concentrations. In-vehicle BC exposures averaged 6 μg m^{-3} in Los Angeles and the Bay Area, the regions with the highest congestion and the majority of the state's VMT. The statewide average in-vehicle BC exposure was 4 μg m^{-3}, corresponding to DPM concentrations of 7–23 μg m^{-3}, depending on the Aethalometer response to elemental carbon (EC) and the EC fraction of the DPM. In-vehicle contributions to overall DPM exposures ranged from approximately 30% to 55% of total DPM exposure on a statewide population basis. Thus, although time spent in vehicles was only 1.5 h day^{-1} on average, vehicles may be the most important microenvironment for overall DPM exposure.

Weijers[1], E. P.; Khlystov[2], A. Y.; Kos[1], G.P.A.; Erisman[1], J.W. "Variability of Particulate Matter Concentrations Along Roads and Motorways Determined by a Moving Measurement Unit," *Atmospheric Environment*, **38:19**, (June 2004) 2993–3002.

[1]Department of Air Quality, Energy research Centre of the Netherlands (ECN), P.O. Box 1, 1755ZG, Petten, The Netherlands. [2]Civil and Environmental Engineering, Duke University, Durham, NC, USA.

Abstract: The spatial variability of aerosol number and mass along roads was determined in different regions (urban, rural and coastal-marine) of the Netherlands. A condensation particle counter (CPC) and an optical aerosol spectrometer (LAS-X) were installed in a van along with a global positioning system (GPS). Concentrations were measured with high-time resolutions while driving allowing investigations not possible with stationary equipment. In particular, this approach proves to be useful to identify those locations where numbers and mass attain high levels ('hot spots'). In general, concentrations of number and mass of particulate matter increase along with the degree of urbanization, with number concentration being the more sensitive indicator. The lowest particle numbers and PM_1-concentrations are encountered in a coastal and rural area: <5000 cm^{-3} and 6 μg m^{-3}, respectively. The presence of sea-salt material along the North-Sea coast enhances $PM_{>1}$-concentrations compared to inland levels. High-particle numbers are encountered on motorways correlating with traffic intensity; the largest average number concentration is measured on the ring motorway around Amsterdam: about 160 000 cm^{-3} (traffic intensity 100 000 veh day^{-1}). Peak values occur in tunnels where numbers exceed 10^6 cm^{-3}. Enhanced PM_1 levels (i.e. larger than 9 μg m^{-3}) exist on motorways, major traffic roads and in tunnels. The concentrations of $PM_{>1}$ appear rather uniformly distributed (below 6 μg m^{-3} for most observations). On the urban scale, (large) spatial

variations in concentration can be explained by varying intensities of traffic and driving patterns. The highest particle numbers are measured while being in traffic congestions or when behind a heavy diesel-driven vehicle (up to 600×10^3 cm^{-3}). Relatively high numbers are observed during the passages of crossings and, at a decreasing rate, on main roads with much traffic, quiet streets and residential areas with limited traffic. The number concentration exhibits a larger variability than mass: the mass concentration on city roads with much traffic is 12% higher than in a residential area at the edge of the same city while the number of particles changes by a factor of two (due to the presence of the ultrafine particles (aerodynamic diameter <100 nm). It is further indicated that people residing at some 100 m downwind a major traffic source are exposed to (still) 40% more particles than those living in the urban background areas.

Yi, Seung-Muk; Ambs, Jeffrey L.; Patashnick, Harvey; Rupprecht, Georg; Hopke, Philip K. "Particle Collection Characteristics of a Prototype Electrostatic Precipitator (ESP) for a Differential TEOM System," *Aerosol Science and Technology*, **1521-7388, 38:12**, **Supplement 2**, (Sept. 2004) 46–51.

Abstract: A differential tapered element oscillating microbalance (TEOM) system that includes an electrostatic precipitator (ESP) that is alternately switched on and off has been developed to improve the measurement of airborne particulate matter mass. Preliminary results showed that it has the potential to overcome the difficulties inherent in PM mass measurement and holds the promise of the measurement of PM mass as it exists in ambient air at ambient temperature. A critical aspect of this device is that the ESP totally removes particles from the air stream. In this study a prototype ESP developed by Rupprecht and Patashnick (R&P) Co., Inc. was evaluated for particulate removal efficiency. Laboratory tests were conducted to determine the removal efficiencies for different-sized particles by generating ultrafine (<0.1 μm) and fine (>0.1 μm) particles. The ultrafine particles were generated using a 5% solution of sodium chloride, while the fine particles were generated with the different sizes (0.5 μm and 1 μm) of polystyrene latex particles. The discrete size intervals of generated ultrafine particles were obtained from an electrical differential mobility analyzer (DMA). The transmitted ultrafine and fine particles passing through the ESP were then detected using a condensation particle counter (CPC) and a LAS-X, respectively. The overall particle collection efficiency of the ESP was calculated from the differential particle collection efficiencies and the specific particle size distributions of the test aerosols. The results showed that the collection efficiencies of the ESP were essentially constant over the range of corona current levels tested, indicating that those were not strong functions of the applied potential if the field strength was sufficiently high.

2003

Cyrys[1,2], J.; Stölzel[1], M.; Heinrich[1], J.; Kreyling[3], W.G.; Menzel[4], N.; Wittmaack[4], K.; Tuch[5], T.; Wichmann[1,2], H. –Erich. "Elemental Composition and Sources of Fine and Ultrafine Ambient Particles in Erfurt, Germany," *The Science of the Total Environment*, **305:1–3**, (April 2003) 143–156.

[1]GSF, National Research Center for Environment and Health, Institute of Epidemiology, Geb. 56, O-85764, Neuherberg, Germany. [2]Ludwig-Maximilians-University of Munich, Institute of Medical Data Management, Biometrics and Epidemiology, Department of Epidemiology, Munich, Germany. [3]GSF, National Research Center for Environment and Health, Institute of Inhalation Biology, Neuherberg, Germany. [4]GSF, National Research Center for Environment and Health, Institute of Radiation Protection, Neuherberg, Germany. [5]Institute for Tropospheric Research, Leipzig, Germany.

Abstract: We present the first results of a source apportionment for the urban aerosol in Erfurt, Germany, for the period 1995 to 1998. The analysis is based on data of particle number concentrations (0.01 to 2.5 μm; mean 1.8×10^4 cm^{-3}, continuous), the concentration of the ambient gases SO_2, NO, NO_2 and CO (continuous), particle mass less than 2.5 μm ($PM_{2.5}$) and less than 10 μm (PM_{10}) (Harvard Impactor sampling, mean $PM_{2.5}$ 26.3 $\mu g/m^3$, mean PM_{10} 38.2 $\mu g/m^3$) and the size fractionated concentrations of 19 elements (impactor sampling 0.05 to 1.62 μm, PIXE analysis). We determined: (a) the correlations between (i) the 1- and 24-h average concentrations of the gaseous pollutants and the particle number as well as the particle mass concentration and (ii) between the 24-h elemental concentrations; (b) Crustal Enrichment Factors for the PIXE elements using Si as reference

element; and (c) the diurnal pattern of the measured pollutants on weekdays and on weekends. The highly correlated PIXE elements Si, Al, Ti and Ca having low enrichment factors were identified as soil elements. The strong correlation of particle number concentrations with NO, which is considered to be typically emitted by traffic, and the striking similarity of their diurnal variation suggest that a sizable fraction of the particle number concentration is associated with emission from vehicles. Besides NO and particle number concentrations other pollutants such as NO_2, CO as well as the elements Zn and Cu were strongly correlated and appear to reflect motor vehicle traffic. Sulfur could be a tracer for coal combustion, however, it was not correlated with any of the quoted elements. Highly correlated elements V and Ni have similar enrichment factors and are considered as tracers for oil combustion.

Howard-Reed[1], Cynthia; Wallace[2], Lance A.; Emmerich[1], Steven J. "Effect of Ventilation Systems and Air Filters on Decay Rates of Particles Produced by Indoor Sources in an Occupied Townhouse," *Atmospheric Environment*, **37:38**, (Dec. 2003) 5295–5306.

[1]National Institute of Standards and Technology, 100 Bureau Dr., MS 8633, Gaithersburg, MD 20899-8633, USA. [2]US Environmental Protection Agency, 11568 Woodhollow Court, Reston, VA 20191, USA.

Abstract: Several studies have shown the importance of particle losses in real homes due to deposition and filtration; however, none have quantitatively shown the impact of using a central forced air fan and in-duct filter on particle loss rates. In an attempt to provide such data, we measured the deposition of particles ranging from 0.3 to 10 μm in an occupied townhouse and also in an unoccupied test house. Experiments were run with three different sources (cooking with a gas stove, citronella candle, pouring kitty litter), with the central heating and air conditioning (HAC) fan on or off, and with two different types of in-duct filters (electrostatic precipitator and ordinary furnace filter). Particle size, HAC fan operation, and the electrostatic precipitator had significant effects on particle loss rates. The standard furnace filter had no effect. Surprisingly, the type of source (combustion vs. mechanical generation) and the type of furnishings (fully furnished including carpet vs. largely unfurnished including mostly bare floor) also had no measurable effect on the deposition rates of particles of comparable size. With the HAC fan off, average deposition rates varied from 0.3 h^{-1} for the smallest particle range (0.3 to 0.5 μm) to 5.2 h^{-1} for particles greater than 10 μm. Operation of the central HAC fan approximately doubled these rates for particles <5 μm, and increased rates by 2 h^{-1} for the larger particles. An in-duct electrostatic precipitator increased the loss rates compared to the fan-off condition by factors of 5 to 10 for particles <2.5 μm, and by a factor of 3 for 2.5 to 5.0 μm particles. In practical terms, use of the central fan alone could reduce indoor particle concentrations by 25–50%, and use of an in-duct ESP could reduce particle concentrations by 55–85% compared to fan-off conditions.

Ji, J.H.; Bae, G.N.; Kang, S.H.; Hwang J. "Effect of Particle Loading on the Collection Performance of an Electret Cabin Air Filter for Submicron Aerosols," *Journal of Aerosol Science*, **34:11**, (2003) 1493–1504.

Abstract: Electret filters are composed of permanently charged electret fibers and are widely used in applications requiring high collection efficiency and low-pressure drop. We tested electret filter media used in manufacturing cabin air filters by applying two different charging states to the test particles. These charging states were achieved by spray electrification through the atomization process and by bipolar ionization with an aerosol neutralizer, respectively. Polydisperse solid NaCl particles with 0.1%, and 1% solutions or liquid dicotyl sebacate (DOS) particles were generated from an atomizer, and they were loaded on the filter media. The amount of charge, the mean particle size, and the particle material significantly affected the collection performance of the electret filter media for submicron particles. The collection efficiency of the electret filter media degraded as more particles were loaded, and showed minimum efficiency at steady state. The electret filter media captured the highly charged particles more efficiently during the transient state. At steady state, the filter media loaded with smaller NaCl particles showed lower collection efficiency. The filter media loaded with liquid DOS particles showed collection efficiency much lower than those loaded with solid NaCl particles.

Palas® GmbH. "Accurate Particle Counting of Vacuum Cleaner Emissions," *Filtration & Separation*, **40:9**, (Nov. 2003) 28–31.

Abstract: In the following article, Leander Mölter and Sven Schütz present Palas® GmbH's latest aerosol spectrometer, the welas® system, and explain why its special design means it can accurately determine dust emissions and therefore the efficiency of filters for vacuum cleaners in accordance with IEC 60312.

2002

Ankilov[1], A.; Baklanov[1], A.; Colhoun[2], M.; Enderle[3], K. -H.; Gras[4], J.; Julanov[5], Yu.; Kaller[6], D.; Lindner[7], A.; Lushnikov[5], A.A.; Mavliev[1], R.; McGovern[2], F.; Mirme[8], A.; O'Connor[2], T.C.; Podzimek[8], J.; Preining, O.; Reischl, G.P.; Rudolf[9], R.; Sem[10], G.J.; Szymanski, W.W.; Tamm[8], E.; Vrtala[11], A.E.; Wagner, P.E.; Winklmayr[6], W.; Zagaynov[5], V. "Intercomparison of Number Concentration Measurements by Various Aerosol Particle Counters" *Atmospheric Research*, **62:3–4**, (June 2002) 177–207.

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Abstract: Total aerosol particle number concentrations, as measured by means of 16 different measurement systems, have been quantitatively compared during an international workshop at the Institute for Experimental Physics of the University of Vienna, Austria, which was coordinated within the Committee on Nucleation and Atmospheric Aerosols (ICCP-IUGG). The range of measuring instruments includes Pollak counters (PCO) in use already for several decades, presently available commercial particle counters, as well as laboratory prototypes. The operation of the instruments considered was based on different measurement principles: (1) adiabatic expansion condensation particle counter, (2) flow diffusion condensation particle counter, (3) turbulent mixing condensation particle counter, (4) laser optical particle counter, and (5) electrostatic particle measurement system. Well-defined test aerosols with various chemical compositions were considered: DEHS, sodium chloride, silver, hydrocarbons, and tungsten oxide. The test aerosols were nearly monodispersed with mean particle diameters between 4 and 520 nm, the particle number concentrations were varied over a range from about 4×10^{1} to 7×10^{6} cm^{-3}. A few measurements were performed with two-component aerosol mixtures.

For simultaneous concentration measurements, the various instruments considered were operated under steady state conditions in a linear flow system. A series of at least 10 single concentration measurements was performed by each individual instrument at each set of test aerosol parameters. The average of the concentration data measured by the various instruments was defined as a common reference. The number concentrations obtained from the various instruments typically agreed within a factor of about two over the entire concentration range considered. The agreement of the measured concentrations is notable considering the various different measurement principles applied in this study, and particularly in view of the broad range of measurement instruments used.

Significant deviations and nonlinear response were observed only in a few cases and are possibly related to calibration errors. For certain conditions, a dependence of aerosol counter response on particle composition has been found. The scatter of the number concentrations obtained from each individual instrument during measurements with constant test aerosol typically did not exceed 20% to 25%. At concentrations below 10^{3} cm^{-3}, however, several of the instruments, including electrostatic particle measurement systems, tend to show increased experimental scatter.

Held[1], Andreas; Wrzesinsky[1], Thomas; Mangold[1], Alexander; Gerchau[2], Jörg; Klemm[1], Otto. "Atmospheric Phase Distribution of Oxidized and Reduced Nitrogen at a Forest Ecosystem Research Site," *Chemosphere*, **48:7**, (Aug. 2002) 697–706.

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Abstract: Atmospheric concentrations of gaseous NH_3 and HNO_3 and of particulate NH_4^+ and NO_3^- were measured during various seasons at a forest ecosystem research site in the "Fichtelgebirge" mountains in Central Europe. Air masses arriving at this site were highly variable with respect to trace compound concentration levels and their concentration ratios. However, the distributions of NH_4^+ and NO_3^- within the aerosol particle size spectra exhibited some very consistent patterns, with the former dominating the fine particle concentrations, and the latter dominating the coarse particles range, respectively. Overall, the particulate phase (NH_4^++NO_3^-) dominated the atmospheric nitrogen budget (particulate and gas phase, NH_4^++NO_3^-+NH_3+HNO_3) by more than 90% of the median total mixing ratio in winter, and by more than 60% in summer. The phase partitioning varied significantly between the winter and summer seasons, with higher relative importance of the gaseous species during summer, when air temperatures were higher and relative humidities lower as compared to the winter season. Reduced nitrogen dominated over oxidized nitrogen, indicating the prevailing influence of emissions from agricultural activity as compared to traffic emissions at this mountainous site. A model has been successfully applied in order to test the hypothesis of thermodynamic equilibrium between the particulate and gas phases.

Ould-Dada, Zitouni. "Dry Deposition Profile of Small Particles within a Model Spruce Canopy," *The Science of the Total Environment*, **286:1–3**, (March 2002) 83–96.

Centre for Analytical Research in the Environment, (now EAS T.H. Huxley School), Imperial College of Science Technology and Medicine, Silwood Park, Ascot, Berkshire SL5 7TE, UK.

Abstract: Data on dry deposition of 0.82 μm MMAD uranium particles to a small scale, 'model' Norway spruce (*Picea abies*) canopy have been determined by means of wind tunnel experiments. These are presented for both the total canopy and for five horizontal layers within the canopy. The results show a complex pattern of deposition within the canopy. The highest deposition velocity V_g (0.19 cm s^{-1}) was recorded for the topmost layer within the canopy (i.e. the layer in direct contact with the boundary layer) whereas the lowest V_g (0.02 cm s^{-1}) occurred at the soil surface. Vertical penetration of depositing aerosol through the canopy was influenced by variations in biomass, wind velocity and turbulence within the canopy. A total canopy V_g of 0.5 cm s^{-1} was obtained and this is in line with field measurements of V_g reported in literature for both anthropogenic and radionuclide aerosols of similar size ranges. Extrapolation of wind tunnel data to 'real' forest canopies is discussed. The information presented here is of importance in predicting the likely contribution of dry deposition of aerosols to pollutant inputs to forest ecosystems, particularly in the context of radioactive aerosol releases from nuclear installations. The application of the present data may also be appropriate for other pollutant aerosols such as SO_4, NO_3 and NH_4, which are characterized by particle sizes in the range used in this study.

Szymanski, Wladyslaw Witold. "Aerosol Concentration Measurement with Multiple Light Scattering System and Laser Aerosol Spectrometer," *Atmospheric Research*, **62:3-4**, (June 2002) 255–265.

Aerosol Laboratory, Institute of Experimental Physics, University of Vienna, Boltzmanngasse 5, A-1090 Vienna, Austria.

Abstract: The performance of two different optical concentration-measuring techniques was investigated over a concentration range starting with about 10^2 cm^{-3} and extending over more than four decades. Both instruments are capable of real-time counting, however due to their particular design-single particle counter and ensemble particle-measuring system—they operate in overlapping, but different concentration ranges. The upper, coincidence-free counting limit for the single particle counter used in this study was established to be in the order of 10^4 cm^{-3}. The ensemble technique was

found to be functional and stable for concentrations of about 10^3 cm^{-3} and limited by the onset of multiple scattering at concentrations nearby 2×10^6 cm^{-3}. Within the determined boundaries, both techniques proved to provide reliable aerosol concentration data.

Wasson[1], Shirley J.; Guo[1], Zhishi; McBrian[2], Jenia A.; Beach[2], Laura O. "Lead in Candle Emissions," *The Science of the Total Environment*, **296:1–3**, (2002) 159–174.

[1]US Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Air Pollution Prevention and Control Division, Research Triangle Park, NC 27711, USA. [2]ARCADIS Geraghty and Miller, Inc., Durham, NC 27713, USA.

Abstract: The candle-using public should be made aware that the core of candle wicks may contain lead. Used as a stiffening agent to keep the wick out of the molten wax, lead can be emitted as particulates to the air and then deposited on indoor surfaces. To define the problem, 100 sets of candles (two or more identical candles) were purchased locally. The criterion for purchase was that the candles must appear to contain a metal-cored wick or be covered by a metallic pigment. Of the candles purchased, 8% contained lead wicks. The wicks were 39 to 74% lead (the remainder was fabric or paper) and the lead cores (approx. 100% lead) had linear densities of 13 to 27 mg/cm. Candles were burned to completion in a closed chamber to capture the air emissions, and the candle residue was extracted to assess the lead mass balance. It was found that individual candles emitted lead to the air at average rates that ranged from 100 to 1700 μg/h. Assuming realistic indoor conditions, these emission rates were modeled to project room air concentration, child exposure by inhalation, and indoor deposition. Results showed that burning single candles can easily raise the source room concentration above the ambient air lead concentration limit of 1.5 $\mu g/m^3$ set by EPA. Burning multiple candles can elevate it above OSHA permissible exposure limits of 50 $\mu g/m^3$. Although blood lead levels have dropped precipitously in the United States since lead was phased out of gasoline in 1986, nearly 900,000 children still had levels above 10 μg/dl during NHANES III. Considering that candle sales in the US are estimated at $1 to 2 billion per year, and that children may spend as much as 88% of their time indoors, it is reasonable to suspect that some blood lead elevation in children arises from indoor micro-environments where lead-wick candles are burned.

2001

Anisimova, Lyubov; Hopke, Philip K.; Terry, Jason. "Two Channel Vapor Nucleation in the Vicinity of the Triple Point," *J. Chem. Phys.* **114**, (June 2001) 9852; DOI:10.1063/1.1372759.

Abstract: Considering the topology of semiempirical nucleation rate surfaces originate from lines describing the appropriate phase equilibria, there will be two nucleation rate surfaces that exist for the different physical states of the critical embryo phases that are formed near the triple point. Each rate surface is independently related to a nucleation channel and is described by individual equations for nucleation rates. Because of the differences in the sticking probability of vapor molecules when they collide with a physical surface (in this case, with the surface of the nucleation embryos) in the different phases, the growth rates of the different phase clusters will be different. As a result of this difference, one expects to find different sized particles for two cluster phases in the vicinity of the triple point for first order phase transitions. In the present study, particle size distributions were measured near glycerin triple point. A clearly bimodal size distribution was observed. This result suggests that there are two independent nucleation channels that exist near the triple point. This experimental system has the ability to discern particles produced through the two separate nucleation channels so that the nucleation rates can be measured for each channel. ©*2001 American Institute of Physics.*

Burtscher, H.; Baltensperger, U.; Bukowiecki, N.; Cohn, P.; Huglin, C.; Mohr, M.; Matter, U.; Nyeki, S.; Schmatloch, V.; Streit, N. "Separation of Volatile and Non-volatile Aerosol Fractions by Thermodesorption: Instrumental Development and Applications," *Journal of Aerosol Science*, **32:4**, (2001) 427–442.

Abstract: An instrument to remove volatile material from aerosol particles by thermal desorption is presented. The thermodesorber consists of a heated tube, where volatile material is desorbed from the particles, and a water- or air-cooled tube, consisting of activated charcoal. This last tube removes desorbed material and thus prevents it from re-adsorbing onto particles. Although designed for measuring particulate emissions from combustion processes it can also be applied to atmospheric aerosols. After theoretical and experimental determination of thermodesorber operating characteristics (temperature profile, losses, removal of desorbed material), examples of applications in several fields are given. Examples of atmospheric measurements at several remote and urban sites are presented. In combustion technology, the thermodesorber is applied to remove all volatile materials, allowing separation of volatile species and the non-volatile core (mainly elemental carbon) of combustion particles. Finally, the thermodesorber is used to study adsorption and desorption processes of polycyclic aromatic hydrocarbons on particles.

Lawless, P.A.[1]; Rodes, C.E.[1]; Evans, G.[2]; Sheldon, L.[2]; Creason, J.[3]. "Aerosol Concentrations During the 1999 FRESNO EXPOSURE STUDIES as Functions of Size, Season, and Meterology," *Aerosol Science and Technology*, **34:1**, (2001) 66–74.

[1]Research Triangle Institute, Research Triangle Park, North Carolina, ETATS-UNIS. [2]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, North Carolina, ETATS-UNIS. [3]U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Research Triangle Park, North Carolina, ETATS-UNIS.

Two 1999 Fresno exposure studies took place in February (winter season) and April/May (spring season) for periods of four weeks each. During that time, nearly continuous measurements of outdoor aerosol concentrations were made with a TSI Scanning Mobility Particle Sizer (SMPS) and a PMS optical particle counter (LASX). These instruments provide particle size distribution information from about 0.01 to 3 μm. Although the primary concentration measurements were performed with integrated samplers, the SMPS/LASX combination provided useful information on the real-time variations of concentration and particle size distributions. This paper describes the agreement between the real-time instrumentation and the integrated measurements and examines some of the information available from the SMPS/LASX combination. In particular, two different types of aerosols contributing to $PM_{2.5}$ were deduced from the instrumental data.

Mainelis, G.; Willeke, K.; Baron, P.; Reponen, T.; Grinshpun, S.A.; Gorny, R.L.; Trakumas, S. "Electrical Charges on Airborne Microorganisms," *Journal of Aerosol Science*, **32:9**, (2001) 1087–1110.

Abstract: We have investigated the parameters affecting the magnitude and polarity of the electric charges carried by biological particles in the airborne state. A recently developed experimental setup through which we analyzed the electric charges imposed on airborne particles by a means of induction charging [Mainelis et al. (Aerosol Sci. Technol. 2001, submitted for publication)] was utilized for this research. In this study, the microorganisms were aerosolized under controlled conditions and an electric mobility analyzer extracted particles of specific electric mobility. The extracted microorganisms were then analyzed by an optical particle size spectrometer. The amount of electric charge carried by airborne microorganisms was found to depend on the dispersion method and can be more than 10,000 elementary electric charges. This finding contrasts with the low electric charge levels carried by non-biological particles. Our data show that repeated pneumatic dispersion of sensitive bacteria affects their structural integrity, which, in turn, changes the magnitude of electric charges carried by these bacteria. We have concluded that the amount of electric charge carried by aerosolized bacteria may be used as an indicator of mechanical stress. It was also found that the electrical conductivity and the pH level of a bacterial suspension increase during aerosolization from a Collison nebulizer. Thus, these two parameters may be used as indicators of the mechanical stress, injury and loss in viability, endured by bacteria during aerosolization, i.e., measuring the electrical conductivity and pH level of bacterial suspensions may be a simple and convenient method for monitoring the "wear and tear" of the bacteria suspended in deionized water.

Millerand, S.L.; Nazaroff, W.W. "Environmental Tobacco Smoke Particles in Multizone Indoor Environments," *Atmospheric Environment*, **35:12**, (April 2001) 2053–2067.

Abstract: Environmental tobacco smoke (ETS) is a major source of human exposure to airborne particles. To better understand the factors that affect exposure, and to investigate the potential effectiveness of technical control measures, a series of experiments was conducted in a two-room test facility. Particle concentrations, size distributions, and airflow rates were measured during and after combustion of a cigarette. Experiments were varied to obtain information about the effects on exposure of smoker segregation, ventilation modification, and air filtration. The experimental data were used to test the performance of an analytical model of the two-zone environment and a numerical multizone aerosol dynamics model. A respiratory tract particle deposition model was also applied to the results to estimate the mass of ETS particles that would be deposited in the lungs of a nonsmoker exposed in either the smoking or nonsmoking room. Comparisons between the experimental data and model predictions showed good agreement. For time-averaged particle mass concentration, the average bias between model and experiments was less than 10%. The average absolute error was typically 35%, probably because of variability in particle emission rates from cigarettes. For the conditions tested, the use of a portable air filtration unit yielded 65 to 90% reductions in predicted lung deposition relative to the baseline scenario. The use of exhaust ventilation in the smoking room reduced predicted lung deposition in the nonsmoking room by more than 80%, as did segregating the smoker from nonsmokers with a closed door.

Pitz[1,2], M.; Kreyling[3], W.G.; Hölscher[2], B.; Cyrys[1,2], J.; Wichmann[1,2], H.E.; Heinrich[2], J. "Change of the Ambient Particle Size Distribution in East Germany Between 1993 and 1999," *Atmospheric Environment*, **35:25**, (Sept. 2001) 4357–4366.

[1]Ludwig-Maximilians-University, Institute of Medical Data Management, Biometrics and Epidemiology, Munich, Germany. [2]GSF National Research Center for Environment and Health, Institute of Epidemiology, Postfach 1129, D 85758 Neuherberg/Munich, Germany. [3]GSF National Research Center for Environment and Health, Institute for Inhalation Biology, Neuherberg/Munich, Germany.

Abstract: Size distribution of particle number concentrations in the geometric equivalent diameter range 0.01 to 2.5 μm were determined in three communities, Zerbst, Bitterfeld and Hettstedt of the state of Sachsen-Anhalt in Eastern Germany, in the first half of 1993 and 1999. A Mobile Aerosol Spectrometer (MAS) consisting of a differential mobility particle spectrometer (DMPS) and a laser aerosol spectrometer (LAS-X) were used for size-selective particle number concentration measurements from which mass concentrations were derived based on an apparent mean density of the ambient aerosol of the closely situated city of Erfurt.

The total number concentration was governed by ultra-fine particles (<0.1 μm) (81% in 1993 and 90% in 1999) and 0.1 to 0.5 μm size fraction dominates total mass concentration (approximately 80%). While the mass concentration of fine particles ($PM_{2.5}$) decreased from 39 to 19 μg m^{-3}, the geometric means of total number concentration showed constant concentration (13.3×10^3 cm^{-3} in 1993 and 13.3×10^3 cm^{-3} in 1999, p=0.975) and the geometric means of number concentration of ultra-fine particles (UP) between 10 and 30 nm increased from 5.9×10^3 to 8.2×10^3 cm^{-3} from 1993 to 1999 (p=0.016). The temporal changes of number and mass concentrations in the three communities are similar. The clear shift to smaller particle sizes within this six years period was caused by changes of the most prominent sources, traffic and domestic heating, since formerly dominating industries in Bitterfeld and Hettstedt had vanished grossly.

Wichmann[1,2], H.-Erich; Peters[1], Annette. “Epidemiological Evidence of the Effects of Ultrafine Particle Exposure,” *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, **358**, (Oct. 2000) 2751–2769. doi:10.1098/rsta.2000.0682.

[1]LMU - University of Munich, Ingolstadter Landstraße, 1, D ‐ 85764 Neuherberg, Germany. [2]GSF - Institute of Epidemiology.

Abstract: In epidemiological studies associations have been observed consistently and coherently between ambient concentrations of particulate matter and morbidity and mortality. With improvement of measurement techniques, the effects became clearer when smaller particle sizes were considered. Therefore, it seems worthwhile to look at the smallest size fraction available today, namely ultrafine particles (UPs, diameter below 0.1 μm) and to compare their health effects with those of fine particles (FPs, diameter below 2.5 μm). However, there are only few studies available which allow such a comparison.

Four panel studies with asthma patients have been performed in Germany and Finland. A decrease of peak expiratory flow and an increase of daily symptoms and medication use was found for elevated daily particle concentrations, and in three of these studies it was strongest for UPs. One large study on daily mortality is available from Germany. It showed comparable effects of fine and ultrafine particles in all size classes considered. However, FPs showed more immediate effects while UPs showed more delayed effects with a lag of four days between particulate concentrations and mortality. Furthermore, immediate effects were clearer in respiratory cases, whereas delayed effects were clearer in cardiovascular cases.

In total, the limited body of studies suggests that there are health effects, due to both UPs and FPs, which might be independent from each other. If this is confirmed in further investigations, it might have important implications for monitoring and regulation, which until now does not exist for UPs. Data from Germany show that FPs cannot be used as indicator for UPs: the time trends for FPs decreased, while UPs was stable and the smallest size fraction of UPs has continually increased since 1991/92.

2000

Hand[1], J. L.; Ames[1], R. B.; Kreidenweis s[1], M.; Day[2], D. E.; Malm[2], W.C. “Estimates of Particle Hygroscopicity During the Southeastern Aerosol and Visibility Study,” *Journal of the Air & Waste Management Association*, **50:5**, (2000) 677–685 (16 ref.).

[1]Atmospheric Science Department, Colorado State University, Fort Collins, Colorado, ETATS-UNIS. [2]Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado, ETATS-UNIS.

Abstract: Aerosol water content was determined from relative humidity controlled optical particle counter (ASASP-X) size distribution measurements made during the Southeastern Aerosol and Visibility Study (SEAVS) in the Great Smoky Mountains National Park during summer 1995. Since the scattering response function of the ASASP-X is sensitive to particle refractive index, a technique for calibrating the ASASP-X for any real refractive index was developed. A new iterative process was employed to calculate water mass concentration and wet refractive index as functions of relative humidity. Experimental water mass concentrations were compared to theoretically predicted values assuming only ammonium sulfate compounds were hygroscopic. These comparisons agreed within experimental uncertainty. Estimates of particle hygroscopicity using a rural aerosol model of refractive index as a function of relative humidity demonstrated no significant differences from those made with daily varying refractive index estimates. Although aerosol size parameters were affected by the assumed chemical composition, forming ratios of these parameters nearly canceled these effects.

Lawless[1], P.A.; Rodes, C.E.[1]; Evans, G.[2]; Highsmith, R.[2]; Sheldon, L.[2]; Creason, J.[3] "Aerosol Mass Concentrations from SMPS and LASX Measurements," *Journal of Aerosol Science,* **31**, (2000) S196–S197.

[1]Research Triangle Institute, Research Triangle Park, NC 27709, ETATS-UNIS. [2]U. S. Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC 27711, ETATS-UNIS. [3]U. S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Research Triangle Park, NC 27711, ETATS-UNIS.

Lin, J.-C.; Zhang, L.; Bahreini, R.; Gentry, J.W. "Improved Size Selection for Inhalable Aerosols," *Journal of Aerosol Science*, **31:S1**, (2000) 787–788.

Liu, Y.; Daum, P.H. (2000). "The Effect Of Refractive Index on Size Distributions and Light Scattering Coefficients Derived from Optical Particle Counters," *Journal of Aerosol Science,* **31:8**, 945–957.

Abstract: The effect of refractive index on particle size distributions measured by optical particle counters is examined. Similar to previous investigations, it is found that optical counters undersize ambient particles because the refractive index of these particles is generally lower than that of the latex particles commonly used for the calibration of optical counters. The maximum undersizing is found to occur when particle sizes are comparable to the wavelength of light used in the measurement. A new approach for modeling the effect of refractive index on the sizing of optical counters is presented. Previously derived optical response functions are compared and a generalized formulation is proposed which includes the existing response functions as special cases. Algorithms are presented for correcting size distributions measured by optical counters for the difference between the refractive index of ambient and calibration particles. Data collected by a Passive Cavity Aerosol Spectrometer (PCASP) and by an integrating nephelometer are compared. Light scattering coefficients calculated from the optical probe data uncorrected for the effect of refractive index differ from those measured by the integrating nephelometer by a factor of 2. An iterative procedure that adjusts the PCASP-measured size distribution for the effect of refractive index is used to derive the best agreement between calculated and observed light scattering coefficients. The refractive indices of aerosols at wavelength of 0.45 μm that best fit the data vary between 1.3 and 1.5, with an average of 1.41. The relative importance of the underestimation of light scattering coefficients calculated from the PCASP-measured size distributions due to the refractive index and the size truncation effect are evaluated. The former is found to be more important than the latter. Implications of this study for addressing aerosol shortwave radiative forcing and potential uncertainties relevant to this study are discussed.

Mavliev, R.; Wang, H.-C. "Design and Performance Characteristics of a Turbulent Mixing Condensation Nuclei Counter," *Journal of Aerosol Science*, **31:8**, (2000) 933–944.

Abstract: The design and optimization of operation parameters of a Turbulent Mixing Condensation Nuclei Counter (TMCNC) are discussed as well as its performance using dibutylphthalate (DBP) as the working fluid. A detection limit of 3 nm has been achieved at a flow rate of 2.8 lmin−1 (0.1 cfm). In addition, the effect of saturation temperature on particle growth in the TMCNC was investigated to identify the temperature range where particles could grow to a detectable size regardless of their initial sizes and materials. Size distributions of particles after condensation growth were measured as a function of saturation temperature for three types of nuclei: atmospheric aerosol particles, monodisperse NaCl particles, and liquid DBP particles generated by homogeneous nucleation. The size distribution after condensation growth can be described by a log-normal distribution with σg=1.2–1.3. The modal diameter of the size distribution can be predicted by the classical equations for particle growth in supersaturated media. The final particle size distribution is a function of the initial particle diameter unless the saturator temperature is above 125°C.

Pinnick, Ronald G.; Pendleton, J. D.; Videen Gorden. "Response Characteristics of the Particle Measuring Systems Active Scattering Aerosol Spectrometer Probes," *Aerosol Science and Technology*, **1521-7388, 33:4**, (2000) 334–352.

Abstract: Predictions of the size response of various light-scattering aerosol counters manufactured by Particle Measuring Systems are reported. Models that exploit the high intensity of light available within the cavity of a He-Ne gas laser (generically referred to by the manufacturer as "active scattering aerosol spectrometer probes") are considered. The new response function properly averages over particle trajectories through nodes, antinodes, and intermediate regions of the intracavity laser beam. Our studies address probes having two basic scattering geometries: those that collect light scattered over a relatively narrow solid angle (subtending angles between 4° and 22° from the laser beam axis, as in the model ASASP-300 and ASASP-300X probes) and those that collect light over a rather large solid angle (between 35° and 120°, as in the ASASP-X, ASASP-100X, LAS-250X, LAS-X, and HS-LAS probes). The theoretical response predictions for both narrow-angle and wide-angle probes are compared to previous measurements of monodisperse test aerosols of polystyrene latex, dyoctylphthalate, nigrosin dye, and carbon black. The new response function predicts smoother dependence on particle size than the previous response function of Pinnick and Auvermann (1979) and is in better agreement with measurement. Response calculations for common atmospheric aerosol (water, sulfuric acid, ammonium sulfate, and black carbon) reveal the considerable sensitivity of the response to particle dielectric properties. Response functions for internal mixtures (black carbon inclusions in water droplets, quartz in sulfuric acid, carbon in ammonium sulfate, and metal in sulfuric acid) are somewhat different than those for homogeneous particles. Comparison of response calculations with the manufacturer's calibration reveal conditions for which the manufacturer's calibration is most appropriate and the potential for errors (as much as a factor of two in sizing) when it is blindly applied. Finally, response functions for multiline laser operation, as the manufacturer suggests might be appropriate for the HS-LAS and LAS-X probes, are nearly the same as for single-line lasing. These results should help the user of these instruments to more realistically interpret size distribution measurements.

Ten Brink[1], Harry M.; Khlystov[1], Andrey; Kos[1], Gerard P.A.; Tuch[2], Thomas; Roth[3], Christa; Kreyling[3], Wolfgang. “A High-Flow Humidograph for Testing the Water Uptake by Ambient Aerosol,” *Atmospheric Environment*, **34:25**, (July 2000) 4291–4300.

[1]Netherlands Energy Research, Foundation (ECN) Westerduinweg 3, 1755 ZG Petten, Netherlands. [2]Ludwig-Maximilian-University, Institute of Medical Data Management, Biometrics and Epidemiology, Neuherberg/Munich, Germany. [3]GSF National Research Center for Environment and Health, Institute for Inhalation Biology, Neuherberg/Munich, Germany.

Abstract: A “humidograph” with an air flow rate of 0.4 m^3 s^{-1} was built to investigate the uptake of water and its effect on sizing, collection and light scattering of ambient aerosol. In the humidograph the relative humidity (RH) can be scanned over a large RH trajectory. Its performance was assessed with laboratory particles of ammonium nitrate, ammonium sulfate and sodium chloride that are the major hygroscopic components of ambient aerosol. The increase in size at the deliquescence points, which ideally is a stepwise function of RH, occurs over a range of 3% RH units. This is shown to be an optimum value in a system of such large dimensions. Because the vapor pressure of ammonium nitrate increases significantly with temperature, its evaporative loss was investigated as a function of heating/drying temperature. The loss of pure test aerosol, with a mass distribution similar to that in the ambient atmosphere, was found to be acceptable for drying temperatures of up to 40°C. The sizing of deliquesced aerosol by LAS-X monitors was tested and found to be a complex function of RH. In Berner low-pressure impactors growth of hygroscopic aerosol was not observed, not even at an RH approaching saturation.

Ten, Brink H.M.; Dougle, P.; Even, A. “Internal Mixing of Ammonium Nitrate and Ammonium Sulfate,” *Journal of Aerosol Science*, **31:S1**, (2000) 899–900.

Tuch[1], Th.; Mirme[3], A.; Tamm[2], E.; Heinrich[4], J.; Heyder[5], J.; Brand[5], P.; Roth[5], Ch.; Wichmann[1], H.E.; Pekkanen[3], J.; Kreyling[5], W.G. "Comparison of Two Particle-Size Spectrometers for Ambient Aerosol Measurements," *Atmospheric Environment*, **34:1**, (Jan. 2000) 139–149.

[1]Ludwig-Maximilians-University, Institute of Medical Data Management, Biometrics and Epidemiology, Munich, Germany. [2]University of Tartu, Tartu, Estonia. [3]National Public Health Institute, Unit of Environmental Epidemiology, Kuopio, Finland. [4]GSF National Research Center for Environment and Health, Institute of Epidemiology, Neuherberg/Munich, Germany. [5]GSF National Research Center for Environment and Health, Institute for Inhalation Biology, Neuherberg/Munich, Germany.

Abstract: There is an ongoing debate on the question which size fraction of particles in ambient air may be responsible for human health effects observed in epidemiological studies. Since there is no single instrument available for the measurement of the particle-size distribution over the full range of the fine fraction (diameter <2.5 μm) of the atmospheric aerosol, two instruments, the mobile aerosol spectrometer (MAS) and the electrical aerosol spectrometer (EAS), have been tested in a side-by-side comparison measuring ambient aerosol for a time period of six weeks in spring 1996 in the city of Erfurt, Germany. Furthermore, total particle number concentration measured by a condensation particle counter (CPC) and mass concentrations PM_{10} and $PM_{2.5}$ were determined. Both spectrometers, MAS and EAS, are based on electrical mobility measurements for particles <0.1 μm and <0.5 μm, respectively, while MAS applies optical particle spectrometry and EAS applies again electrical mobility analysis for particles up to 2.5 and 10 μm, respectively. Both instruments proved to be reliable during this comparison providing data availability of >94%. To compare the spectral data, particle numbers were integrated within three size ranges: 0.01 to 0.1, 0.1 to 0.5, 0.5 to 2.5 μm. Hourly mean number concentrations of each size range observed during the six week comparison was: $2.6\times10^4\pm19500$ ($2.48\times10^4\pm1.79\times10^4$), $3.1\times10^3\pm1.5\times10^3$ ($4.1\times10^3\pm2.0\times10^3$), 50 ± 45 ($1.9\times10^2\pm1.2\times10^2$) cm^{-3} for MAS (EAS), respectively. Both aerosol spectrometers followed the variations of the ambient aerosol in a similar manner and yielded almost identical results for particle number concentrations of particles with diameters smaller than 0.5 μm. Furthermore, the total particle number concentration derived from MAS and EAS measurements (29000 ± 20000; 29000 ± 19000 cm^{-3}) is well comparable with the number concentration derived from an integral counting CPC (31100 ± 22000 cm^{-3}). The results of this side-by-side comparison suggest that MAS and EAS together with $PM_{2.5}$ measurements are suitable to reliably characterize size-distribution parameters of number and mass concentration of ambient aerosols.

1999

Kuo, Y.-M.; Wang, C.-S. "Effect of Rise Distance on the Characteristics of Droplets Generated from Bubble Bursting on the Surface of Chromic Acid Solutions," *Journal of Aerosol Science*, **30**, (1999) S713–S714.

Mavliev, R.; Hopke, P.K.; Wang, H.-C.; Lee, D.-W. "A Transition from Heterogeneous to Homogeneous Nucleation in the Turbulent Mixing CNC," *Journal of Aerosol Science*, **30**, (1999) S31–S32.

Zellweger[1,2], C.; Ammann[1], M.; Hofer[2], P.; Baltensperger[1], U. "NO_y Speciation with a Combined Wet Effluent Diffusion Denuder – Aerosol Collector Coupled to Ion Chromatography," *Atmospheric Environment*, **33:7**, (March 1999) 1131–1140.

[1]Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland. [2]EMPA, CH-8600 Dübendorf, Switzerland.

Abstract: A wet effluent denuder - aerosol collector (WEDD/AC) system coupled to ion chromatography for the measurement of atmospheric HONO, HNO_3 and particulate nitrite, nitrate and sulfate is described. Several experiments were performed to outline its performance. The main features are low detection limits and a fast response to concentration changes which enables measurements with high time resolution. In contrast to highly soluble gases, the collection efficiency of less soluble gases is shown to depend on the Henry's law constant rather than on the uptake

kinetics. To improve the collection efficiency for HONO under simultaneous presence of acidifying gases, $NaHCO_3$ was added to the effluent solution. The system was tested in a field campaign in the suburban area of Zürich, Switzerland. Elevated concentrations of nitrous acid up to 3.2 ppb were detected during the measurement campaign. The diurnal variation of the HONO to NO_2 ratio clearly points to a fast and persistent process producing HONO in the atmosphere. The correlation with NO_x and black carbon suggests a heterogeneous formation of HONO, and is consistent with a reaction on soot aerosol particle surfaces postulated from previous laboratory results.

1998

Baltensperger[1], U.; Schwikowski[1], M.; Jost[1], D.T.; Nyeki[1], S.; Gäggeler[1,2], H.W.; Poulida[3], O. "Scavenging of Atmospheric Constituents in Mixed Phase Clouds at the High-Alpine Site Jungfraujoch Part I: Basic Concept and Aerosol Scavenging by Clouds," *Atmospheric Environment*. **32:23**, (Dec. 1998) 3975–3983.

[1]Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland. [2]Department of Chemistry and Biochemistry, University of Bern, CH-3012 Bern, Switzerland. [3]Atmospheric Physics, ETH-Hönggerberg, CH-8093 Zürich, Switzerland.

Abstract: Extensive field experiments were performed in April/May 1992 and October/November 1993 in order to investigate the aerosol–cloud relationship at the high-alpine site Jungfraujoch, 3450 m asl. Aerosol and cloudwater samples were collected simultaneously and analyzed for the major water-soluble anions and cations. In addition, the cloud liquid water content (LWC) and the aerosol size distribution were measured. A nearly complete activation of particles with diameter $d \geqslant$ 0.2 μm was observed, independent of the number concentration. Since there was only a slight variability of the LWC, it was concluded that higher aerosol concentrations at high-alpine sites are associated with smaller droplet sizes. Long-term measurements of LWC and of the aerosol concentration suggested that this may be true throughout the year, giving additional evidence for a possible impact of anthropogenic aerosols on cloud albedo.

Bunz, H.; Mohler, O.; Schurath, U.; Tiede, R. "Behaviour of H_2SO_4/H_2O Droplets under Stratospheric Conditions Dependence on Relative Humidity and Temperature," *Journal of Aerosol Science*, **29**, (1998) S789–S790.

Chen, Ching-Jiang; Liu, Chi-Chang; Lin, Yu-Ming. "Measurement of Equilibrium Factor and Unattached Fraction of Radon Progeny in Kaohsiung, Taiwan," *Applied Radiation and Isotopes*, **49:12**, (Dec. 1998) 1613–1618.

Radiation Monitoring Center, AEC, 823, Cherng Ching Road, Kaohsiung 833, Taiwan, ROC.

Abstract: To reasonably estimate the population dose from radon, equilibrium factor, *Fp*, and unattached fraction, *fp*, of radon progeny are important parameters. A Lucas cell and a working level monitor was used for most *Fp* measurement. The unattached fraction was measured by SARAD EQF3020. A detached house was chosen to measure the *Fp* in different rooms. The *Fp* value depended mainly on the ventilation rate and surface to volume ratio of the rooms. *Fp* and *fp* were measured in bedrooms of 14 other dwellings. Two hospitals were also chosen for measurement of *Fp* in the working place using rooms located in the basement. The average *Fp* for dwellings was about 0.5 and the average unattached fraction was about 0.055. The radon levels in the hospitals were higher than those in the dwellings but the equilibrium factors in the hospital were very low (about 0.06). The low *Fp* was attributed to the use of a dehumidifier in the hospitals. Dehumidifiers are popular for reducing fungi problem induced by the high humidity in Taiwan.

Diehl[1], K.; Mitra[1], S.K. “A Laboratory Study of the Effects of a Kerosene-Burner Exhaust on Ice Nucleation and the Evaporation Rate of Ice Crystals,” *Atmospheric Environment*, **32:18**, (Sept. 1998) 3145–3151.

[1]Institut für Physik der Atmosphäre, Johannes Gutenberg-Universität Mainz, Mainz, Germany.

Abstract: Laboratory experiments are described during which the influence of gases and particles from the exhaust of a kerosene burner on microphysical processes were studied. In one experimental investigation the evaporation rates of ice crystals polluted with the kerosene-burner exhaust were compared with the evaporation rates of pure ice crystals. During another experimental investigation the ice nucleating ability of the exhaust particles was studied in terms of the efficiency of the exhaust particles to act as deposition and condensation freezing nuclei, as immersion freezing nuclei, and as contact nuclei. The results of our experiments showed that the evaporation rate of ice crystals polluted with the kerosene-burner exhaust was significantly reduced compared to the evaporation rate of pure ice crystals, implying an increased lifetime of aircraft contrails in comparison to a cloud of pure ice crystals. We also found that the kerosene-burner exhaust particles act as ice nuclei in all studied modes of ice formation at temperatures as high as −20°C, particularly freezing between 20 and 70% of the drops at temperatures warmer than −28°C in the immersion mode. Since the temperature at the level of the contrails is typically below −30°C our result allows the speculation that drop formation at the cruising altitude of air planes is immediately followed by ice crystal formation via heterogeneous nucleation.

Eldering, Annmarie; Glasgow, Ronna M. “Short-Term Particulate Matter Mass and Aerosol-Size Distribution Measurements: Transient Pollution Episodes and Bimodal Aerosol-Mass Distributions,” *Atmospheric Environment*, **32:11**, (June 1998) 2017–2024.

Abstract: Aerosol-size distribution of fine aerosols were measured in Pocatello, Idaho along with hourly average PM_{10} mass concentrations. Aerosol size distribution measurements are made with a laser optical particle counter while short-term mass concentrations are measured with a Tapered Element Oscillating Microbalance. The short-term mass concentration measurements show wide variations in mass concentration over 24 h periods. The accumulation mode of the aerosol-size distribution is bimodal in a few cases, primarily when elevated mass concentrations exist.

Forsyth, B.; Liu, B.Y.H.; Romay, F.J. “Particle Charge Distribution Measurement for Commonly Generated Laboratory Aerosols - Fundamentals, Measurements and...,” *Aerosol Science and Technology*, **28 (6)**, (June 1998) 489–501.

Abstract: An improved particle charge analyzer system has been developed to measure the absolute charge distribution of common generated laboratory aerosols. The charge analyzer system consists of an integral cylindrical mobility analyzer used in conjunction with an optical aerosol spectrometer, with computer assisted operation and data reduction. The charge analyzer collects aerosol particles over an absolute electrical mobility range from $4.2*10^{-4}$ to 400 cm^2/(stat Volt second) and flow rates that can vary from 0.3 to 30 liters per minute. The charge analyzer has been used to investigate the nature of spray and contact electrification during aerosol generation by measuring the residual charge distribution on the liquid and solid generated particles. In addition, the neutralization of charged particles by bipolar ions also was studied using conventional neutralizers that use ionizing radiation from alpha and beta sources. Charge distribution measurements were performed on alumina dust (Al), Arizona road dust (ARD), potassium chloride (KCl), sodium chloride (NaCl) and di-octyl sebacate (DOS) liquid particles. Aerosol generation devices include a Collison atomizer, a condensation aerosol generator and a fluidized bed dust generator. Our work provides experimental charge distribution data for comparison with simple models of electrification theory. Experimental results showed that charge levels of atomized KCl and NaCl particles were high and decreased as the dissolved ion concentration increased. DOS particles generated by evaporation-condensation were both neutral and moderately charged. These conclusions support the existence of a dipole layer at the liquid-gas interface that interacts with dissolved particles and changes their charge state. Alumina and ARD generated by the fluidized bed disperser are highly charged due to strong contact electrification

during dispersion. In most cases, the charge on generated aerosols could be reduced to Boltzmann charge equilibrium conditions by commonly used radioactive neutralizers.

Lin, J.-C.; Gentry, J.W. "Development of particle morphology of drying drops containing dissolved and suspended solids," *Journal of Aerosol Science*, **29**, (1998) S903–S904.

Marui, Y.; Chang, Y.C.; Lin, J.C.; Curto, E.; Nadarajan, A.; Ranade, M.B.; Gentry, J.W. "Characterization of a New Inertial Classifier," *Journal of Aerosol Science*, **29**, (1998) S337–S338.

Mavliev, R.; Wang, H.-C. "On the Particle Growth in a Turbulent Mixing CNC," *Journal of Aerosol Science*, **29**, (1998) S65–66.

Nyeki, S.F.; Li, E.; Weingartner, N.; Streit, I.; Colbeck, H. W.; Gäggeler, and Baltensperger, U. "The Background Aerosol Size Distribution in the Free Troposphere: An Analysis of the Annual Cycle at a High-Alpine Site," *J. Geophys. Res.*, **103:D24**, (1998) 31,749–31,761.

Abstract: Measurements during free tropospheric (FT) and planetary boundary layer (PBL) conditions were conducted over an annual cycle at the Jungfraujoch high-Alpine research station (3454 m), Switzerland, in order to establish diurnal and seasonal cycles of the background continental aerosol over central Europe. Using a condensation nucleus counter (TSI 3025) and an optical particle counter (PMS Las-X) from June 1996 to May 1997, the following were determined: (1) accumulation mode lognormal parameters and (2) number concentrations for the nucleation (diameter $d < 0.1$ μm), accumulation ($0.1 \leq d \leq 1.0$ μm), and part of the coarse ($1.0 < d \leq 7.5$ μm, designated coarse) modes. Lognormal parameters were found to be similar for FT and PBL conditions, and exhibited a weak seasonality in geometric median diameter $d_{GN} = 0.13$ and 0.10 μm, and standard deviation $\sigma_G = 1.73$ and 1.64 for summer and winter, respectively. Aerosol number concentrations in each mode exhibited a more pronounced seasonality, with FT concentrations being lower than those for PBL. Summer and winter FT median concentrations for the nucleation, accumulation, and coarse modes were 405 and 195 cm^{-3}, 114 and 26 cm^{-3}, and 0.052 and 0.014 cm^{-3}, respectively. These results provide tentative support of other long-term observations that the FT background aerosol mode appears to vary mainly in concentration rather than accumulation mode shape. Further analysis indicated that only the total concentration in each mode varied with weather type and a classification between that of a remote continental and polar aerosol model was found for the Jungfraujoch.

Poulida[1], O.; Schwikowski[2], M.; Baltensperger[2], U.; Staehelin[1], J.; Gaeggeler[2], H.W. "Scavenging of Atmospheric Constituents in Mixed Phase Clouds at the High-Alpine Site Jungfraujoch—Part II. Influence of Riming on the Scavenging of Particulate and Gaseous Chemical Species, *Atmospheric Environment*, **32:23**, (Dec. 1998) 3985–4000.

[1]Atmospheric Physics, ETH Hoenggerberg, CH-8093 Zurich, Switzerland. [2]Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland.

Abstract: The importance of riming as transfer mechanism of pollutants from the atmosphere into the snow in mixed phase clouds was investigated at the Jungfraujoch (3450 m a.s.l), during two intensive measurement campaigns in April 1992 and in October–November 1993. Cloud water and bulk snow crystal samples were concurrently collected during precipitation events, and were chromatographically analyzed for inorganic ions. The extent of riming was determined from the collection of individual snow crystals on Formvar replicas. Relatively low degrees of riming were observed during all the events. The rimed mass fraction (RMF) was being used as a tool to determine the role of riming with respect to other scavenging processes. No significant difference between the early-spring and the early-winter events was found.

The precipitation events were classified on the basis of the temporal changes of the number concentration of aerosol particles and the equivalent potential temperature during an event. When the site could be considered as a "closed system", meaning that there was no air mass change, and that all the physical processes were occurring in the air mass being sampled at the site, then a strong positive correlation between the RMF and the concentration ratios, *R*, of snow water to cloud water was

found. In contrast, a lack of statistical correlation between the RMF and the ratios *R* was observed when the sampling site was an "open system", meaning that it was affected by the entrainment of a new air mass. The application of a simple physical scheme revealed that a linear relationship between RMF and *R* is expected, provided that the cloud water samples are representative of the air mass in which the snow crystals are generated. Further modification of this scheme provided a relationship for the assessment of the importance of riming as transfer mechanism. The riming process was found to be responsible for 82 (±17) % of Cl^-, 49 (±31) % of NO_3^-, 77 (±20) % of SO_4^{2-}, 82 (±16) % of Na^+, 48 (±45) % of NH_4^+ and 76 (±19) % of Mg^{2+} transported from the cloud water in the ice phase. The cloud microphysics and the extent of the precipitation layer above the sampling site are considered to be the limiting factors for the contribution of riming to the incorporation of the inorganic atmospheric impurities into snow. The impact of the latter factors is also highlighted from the comparison of the observations at Jungfraujoch with those from lower altitude sampling sites.

Ten, Brink H.M.; Khlystov, A.; Kos, G.P.A.; Kreyling, W.; Rood, C.; Tuch, T. "The "Wetness" of Ambient Aerosol and its Influence on Sizing and Collection," *Journal of Aerosol Science*, **29**, (1998) S963–S964.

Walsh, D.C.; Stenhouse, J.I.T. "Parameters Affecting the Loading Behavior and Degradation of Electrically Active Filter Materials," *Aerosol Science and Technology*, **29 (5)**, (Nov. 1998) 419–432.

Abstract: Electrically active fibrous filters, that is fibrous filters whose fibers carry a permanent electric charge, are a popular alternative to conventional fibrous filters in applications where low pressure drop and high collection efficiencies are critical. The advantage of these materials is the additional collection efficiency, due to electrostatic mechanisms, that can be achieved without pressure drop increase. Although the efficiency of these materials is always superior to that of a conventional material of similar structure, the efficiency of these materials can fall as they are loaded with particles, so it is necessary that a proper account be taken of this process during use. Significant advances have been made in understanding the mechanisms responsible for this reduction in efficiency in a recent experimental study of the loading behavior of a mixed fiber type electrically active material. This study has identified a number of parameters that cause the filtration efficiency to be reduced, and in so doing also has allowed an empirical equation to estimate the maximum penetration through the material over the course of its life to be elucidated. Furthermore, a series of experiments designed to investigate the effects of particle size and particle charge on filter degradation has been performed that prove conclusively that the reduction in filtration efficiency of this material during loading is not a charge neutralization process.

Willeke, PhD Klaus; Qian, PhDYinge. "Tuberculosis Control Through Respirator Wear: Performance of National Institute for Occupational Safety and Health-Regulated Respirators (supported in part by the National Institute for Occupational Safety and Health through grant number R01-OH-03244. Yinge Qian, PhD, also was partially supported for 1 year by a graduate scholarship from the University of Cincinnati.)," *American Journal of Infection Control*, **26:2**, (April 1998) 139–142.

Department of Environmental Health, University of Cincinnati, Ohio USA.

Abstract:
Background: In 1995 the National Institute for Occupational Safety and Health issued new rules for personal respirators. All nine new respirator categories are authorized in health care facilities for the prevention of the transmission of tuberculosis (TB) The new N95 respirator category is the most frequently used for this purpose. Data are presented on their efficiency for collecting TB-size bacteria and their potential for re-aerosolizing collected bacteria.

Methods: All measurements of bacterial penetration were performed with dynamic aerosol size spectrometers at flow conditions corresponding to normal wear and respirator certification conditions. The re-aerosolization tests were performed at conditions ranging from normal breathing to violent coughing or sneezing.

Results: The tested N95 respirators collected 0.1 to 0.3 μm particles with efficiencies of 95% or higher, as specified by the regulations. TB-size bacteria of 0.8 μm and larger, however, were collected

with 99.5% or higher efficiencies; that is, the penetration of these bacteria through the filter material was 0.5% or less, much less than the required maximum penetration of 5% for the smaller particle sizes. No bacteria were re-aerosolized during normal exhalation. Some re-aerosolization (0.1% or less) was observed only at low humidity and extremely high air flow through the respirator, corresponding to violent coughing or sneezing.

Conclusions: The filter materials of N95 respirators provide good protection against TB bacteria. Thus, a significant number of bacteria can enter the respirator-wearer's breathing space only through spaces where the respirator inadequately seals to the wearer's face. Re-entrainment and re-aerosolization of mycobacteria is not a problem when normal work practices are observed in health care facilities.

1997

Chang, Y.-C.; Lin, J.-C.; Gentry, J.W, "Charge Distribution Estimation for Non-spherical Particles," *Journal of Aerosol Science*, **28:1001**, (1997) S653–S654.

Cheng, S.-H.; Ranade, M.B.; Gentry, J.W. "Experimental Design of High Volume Electrostatic Charger," *Aerosol Science and Technology*, **26 (5)**, (May 1997) 433–446.

Abstract: A corona charger was developed for charging aerosols having flow rates of 0.6 to 6.0 m^3/s. To prevent wall loss transpiration flow from 0.6 to 4.8 m^3/s was introduced at 90° from the principal direction of flow. The redesigned charging section could produce ion currents as high as 10^{-4} A for applied corona voltages below 10 kV. Calibration experiments with glass aerosols showed that particle penetration through the charging section could be substantially increased by the use of transpiration air, that the transpiration air did not alter the shape of the particle size distribution, and that for particles less than 0.5 μm, diffusion charging was the dominant mechanism.

Grinshpun, S.A.; Willeke, K.; Ulevicius, V.; Juozaitis, A.; Terzieva, S.; Donnelly, J.; Stelma, G.N.; Brenner, K.P. "Effect of Impaction, Bounce and Re-aerosolization on the Collection Efficiency of Impingers," *Aerosol Science and Technology*, **26 (4)**, (April 1997) 326–342.

The collection efficiency of liquid impingers was studied experimentally as a function of the sampling flow rate with test particles in the bacterial size range. Three impingers were tested: two All-Glass Impingers (AGI-4 and AGI-30), widely used for bioaerosol sampling, and a newly developed slot impinger. The aerosol particles were generated by a Collison nebulizer, and an Aerosizer® particle size analyzer was used to measure the particle concentrations and size distributions upstream and downstream of each impinger. The effect of the air pressure drop across the impinger on the Aerosizer® analyzer performance was investigated, and the particle measurement system was modified and calibrated accordingly. While inertial impaction is the dominant particle removal mechanism in impingers, particle bounce and re-aerosolization were also found to have significant effects on the impinger collection characteristics. At relatively high flow rates and low levels of collection fluid (corresponding to the collection fluid level after evaporation of most of the liquid during prolonged impingement), the liquid under the impinger jet was observed to be removed by the air pressure and pushed against the container's walls. Particles, such as bacterial or fungal spores, may thus bounce from the bottom of the collection vessel and escape with the effluent air flow or may impact sideways into the liquid that was previously pushed against the walls. It was found that such particle bounce may significantly reduce the collection efficiency of impingers containing a small amount of liquid. When the impingers were operated at a high level of collection fluid and sufficiently high sampling flow rates, it was observed that the bubbles, rising through the liquid, entrained previously collected particles and created new aerosols by bursting at the liquid-air surface. Such particle re-aerosolization was also found to reduce the impinger collection efficiency.

Haware, S.K.; Ghosh, A.K.; Raj, V.V.; Sharma, V.K. "Assessment of the Computer Code NAUA Mod 5 Against a Small-Scale Containment Aerosol Test," **28:4**, (1997) 663–675.

Abstract: The Committee on the Safety of Nuclear Installations (CSNI) of the Organization for Economic Cooperation and Development (OECD) organized in 1992–1994, an International Standard

Problem Exercise Number 34 (ISP-34), on aerosol behavior in the primary circuit and the containment of a nuclear reactor. The exercise involved carrying out specific experiments in the Falcon Test facility at Winfrith Technology Centre, U.K., analysis of these experiments using different computer codes. Containment analysis of these tests was carried out by the Indian participants BARC using the computer code NAUA Mod 5. The present paper compares the code predictions with experimental measurements. The containment floor deposits are predicted closely, whereas the wall deposits are considerably under-predicted. The air-borne concentrations predicted by the code are well within the uncertainties of measurement. The possible reasons for the differences are brought out.

Hering[1], Susanne; Eldering[2], AnnMarie; Seinfeld[2,3], John H. "Bimodal Character of Accumulation Mode Aerosol Mass Distributions in Southern California," *Atmospheric Environment*, **31**:**1**, (Jan. 1997) 1–11.

[1]Aerosol Dynamics Inc., 2329 Fourth Street, Berkeley, CA 94710, U.S.A. [2]Department of Civil and Environmental Engineering, University of Iowa, Iowa City, IA 52242-1527, U.S.A. [3]Division of Engineering and Applied Science, California Institute of Technology, 104-44, Pasadena, CA 91125, U.S.A.

Abstract: Size-resolved measurements of fine particle chemical composition and physical measurements of fine particle size distributions obtained during the Southern California Air Quality Study (SCAQS) are compared. Number distributions of the ambient aerosols were measured using optical particle counters and electrical aerosol analyzers. Optical counter data are reduced using an ambient-based calibration. Mass size distributions are inferred from the sum of size-resolved chemical composition as measured by impactors. Optical counter data reduced with an ambient-based calibration compare well to impactor measurements. Both sets of data show that the accumulation mode of the total mass size distribution may be bimodal. Condensation and droplet modes previously identified in chemical species size distributions are frequently apparent in the total mass size distribution.

Hinds, W.C.; Kadrichu, N.P. "The Effect of Dust Loading on Penetration and Resistance of Glass Fiber Filters," *Aerosol Science and Technology*, **27 (2)**, (Aug. 1997) 162–173.

Abstract: As glass fiber filters become loaded with solid particles, their resistance to airflow increases and penetration at a given flow rate decreases. In the present study, we measured the effect of loading on resistance and penetration for three types of loading dust with Mass Median Aerodynamic Diameter (MMAD) from 0.8 to 7.5 μm, and mass loading up to 2.2 mg/cm^2. Penetration as a function of particle size and resistance measurements were made for five loading conditions, seven face velocities (0.04 to 3.38 cm/s), and 12 particle sizes (0.137 to 3.65 μm). As expected, loading modified filter performance to give greater resistance and lower penetration. Unit mass loading by the finer loading dust caused a greater increase in resistance and a greater decrease in penetration than did the coarser dusts. A computer model to predict the effect of loading on resistance and penetration was prepared. The model uses modified single-fiber filtration theory to estimate resistance and penetration. It assumes that solid particles deposited on a fiber act like additional short "fibers" having a diameter equal to the diameter of average mass of the loading dust. Loading directly affects only the average fiber diameter and the filter solidity, but these two parameters affect all single-fiber collection mechanisms. For the conditions of these experiments, resistance increased linearly with loading, particle size of maximum penetration changed little with loading, and penetration decreased more rapidly for initial loading than subsequent loading. The change in measured resistance and the change in model predicted resistance were correlated with a correlation coefficient (r) of 0.87. The model correctly predicted the trend in penetration with loading for each of the three loading particle sizes.

Li, F.; Nyeki, S.; Baltensperger, U.; Weingartner, E.; Lugauer, M.; Colbeck, I.; Gaggeler, H.W. "Aerosol Size Distribution Retrieval from Multiwavelength Nephelometer Data," *Journal of Aerosol Science*, **28:1001**, (1997) S249–S250.

Nyeki, S.; Li, F.; Rosser, D.; Colbeck, I.; Baltensperger, U. "The Background Aerosol Size Distribution at a High-Alpine Site: an Analysis of the Seasonal Cycle," *Journal of Aerosol Science*, **28:1001**, (1997) S211–S212.

Schwikowski, M.; Weingartner, E.; Baltensperger, U.; Gaggeler H.W. "The Effects of Clouds on Particle Size Distributions at the High-Alpine Site Jungfraujochi," *Journal of Aerosol Science*, **28:1001**, (1997) S573–S574.

Ten Brink[1], H.M.; Kruisz[2], C.; Kos[1], G.P.A.; Berner[2], A. "Composition/Size of the Light-Scattering Aerosol in the Netherlands," *Atmospheric Environment*, **31:23**, (Dec. 1997) 3955–3962.

[1]Netherlands Energy Research Foundation (ECN), Unit Fossil Fuels, Westerduinweg 1, 1755 ZG, Petten, The Netherlands. [2]Institute for Experimental Physics, University of Vienna, Austria.

Abstract: In 1992, 1993 and 1994 the size/composition of the aerosol in The Netherlands was measured in several measuring campaigns. The central aim of the study was the characterization of those anthropogenic particles which most effectively scatter short-wave solar radiation. Since the largest effect of aerosol on radiation was expected at the times with the highest radiative flux, the measurements were made in the summer half-year around midday and under sunny conditions. Aerosol in arctic marine air served as the reference background. It contained as little as 0.l gm m^{-3} nitrate and non-sea-salt sulphate. In continental air some 75% of the aerosol mass was submicron. Ammonium nitrate and ammonium sulphate were the dominant (anthropogenic) aerosol species in the size range with maximum light-scattering (0.4 to 1.0 gm) and, with values up to 25 gmm^{-3}, almost completely of a manmade origin. The ammonium nitrate concentrations were as high as or higher than those of ammonium sulphate, while the concentration of ammonium nitrate may have been underestimated because of evaporative losses during collection, of which examples are given. The sulphate size distribution was very similar to that in the period 1982 to 1984, which is indicative of stability of the distribution over time. Almost half of the submicron aerosol in the relevant size range could not be identified. Elemental-carbon contributed only an estimated 10% to this mass and the submicron dust content was even smaller. It was thus concluded by inference that most of the unidentified material was organic carbon. In marine air adverted over the U.K. the submicron aerosol was manmade. In the particles which most effectively scatter solar radiation natural sea-salt-chloride is substituted by manmade sulphate. This substitution greatly changes the aerosol (radiative) properties: laboratory investigations, performed as part of this study, showed that sodium sulphate is a water-free crystal, while the original sea-salt aerosols are metastable saline droplets.

Thatcher, T.L.; Nazaroff, W.W. "Effect of Small-Scale Obstructions and Surface Textures on Particle Deposition from Natural Convection Flow," *Aerosol Science and Technology*, **27 (6)**, (Dec. 1997) 709–725.

Abstract: To increase knowledge of particle dynamics in indoor environments, we have conducted experiments on the effects of small surface discontinuities and roughness on deposition from natural convection flow. Measurements were made in a half-height (1.22 m) aluminum test chamber and in a full-scale experimental room. In the test chamber, air flow was induced by uniformly heating the floor and one wall while cooling the ceiling and opposite wall to a constant temperature difference of 3 K. In the full-scale room, one wall was heated and the opposite wall was cooled to a constant wall-to-wall temperature difference of 3 or 7 K. Other surfaces in both experiments were approximately adiabatic. Near-monodispersed fluorescent particles (diameters 0.1, 0.5, or 1.3 μm in the half-height experiments and 0.2 or 1.0 μm in the full-scale experiments) were injected into the chamber. Following an exposure period, the mass of fluorescent particles deposited on sections of the walls and/or plates mounted on the walls were extracted and measured by fluorometry. The effect of surface discontinuities was explored by comparing deposition onto the walls or onto flush-mounted plates with deposition onto thin, smooth, surface-mounted plates. The effect of surface roughness was investigated by measuring deposition onto textured plates (finely scratched, a rectangular array of 2.4 mm balls, or skip-coat drywall texture). Deposition of the smallest particles (0.1 and 0.2 μm) was relatively insensitive to surface obstructions and texture, but the effect of roughness increased with

particle size. For 1.3 μm particles, deposition to the roughest surface was as much as five times greater than deposition to a smooth wall. The effect of surface roughness was greater for vertical surfaces than horizontal and for warm surfaces than cool. Deposition velocities measured with a 3 K temperature difference are fairly consistent between the full-scale room and the half-height chamber. Overall, surface roughness of the type commonly found indoors can significantly impact deposition rates, and, therefore, many real surfaces cannot be assumed to be smooth when analyzing particle deposition in indoor environments.

Tiede, R.; Schulz, M. "Gas-to-Particle Conversion in the Urban Plume of Hamburg," *Journal of Aerosol Science*, **28:1001**, (1997) S557–S558.

Wessel[1], S.; Aoki[2], S.; Weller[3], R.; Herber[1], A.; Gernandt[1], H.; Schrems[3], O. "Aerosol and Ozone Observations in the Polar Troposphere at Spitsbergen in Spring 1994," *Atmospheric Research*, **44**:**1–2**, (May 1997) 175–189.

[1]Alfred Wegener Institute Research Department Potsdam, Potsdam, Germany. [2]Center of Atmospheric and Oceanic Studies, Sendai, Japan. [3]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany.

Abstract: The dynamics of the tropospheric ozone distribution during the transition from polar night to polar day has been investigated in Ny Ålesund, Spitsbergen (79°N, 12°E) in the period from March to June 1994. Surface ozone, the vertical ozone stratification as well as aerosols were measured. Surface 0_3 mixing ratios were found to be highest in March during prevailing advection from East Europe, while the lowest surface ozone amounts were observed in late June. The transition from winter to spring was characterized by striking surface ozone variations. In this period we observed five distinct 0_3 minima. Such events were typically associated with advection of marine polar air masses. The low burden of aerosols within the accumulation mode coinciding with low ozone mixing ratios suggests that 0_3 destruction occurred during long transport times in the remote marine Arctic, largely in absence of anthropogenic pollutants. It was found that the 0_3 depletion was restricted to the boundary layer only. Typically a capping inversion defined the upper limit of its vertical extension.

Xiang, X. D.*; Colbeck, I. "Charged Water Drops and Smoke Dissipation," *Fire Safety Journal*, **28:3**, (Apr 1997) 227–232.

*Institute for Environmental Research, Department of Biological and Chemical Sciences, University of Essex, Colchester C04 3SQ, UK

Abstract: Highly charged water droplets have been used as an ion source to increase the removal rate of smoke. The change in number concentration for smoke subjected to uncharged and charged droplets was determined. For charged sprays the number concentration fell by approximately 60% after five minutes compared with a 10% decrease for an uncharged spray.

Zellweger, C.; Baltensperger, U.; Ammann, M.; Kalberer, M.; Hofer, P. "Continuous Automated Measurement of the Soluble Fraction of Atmospheric Aerosols," *Journal of Aerosol Science*, 28:1001, (1997) S155–S156.

1996

Ciach, T.; Sosnowski, T.R. "Removal of Soot Particles from Diesel Exhaust," *Journal of Aerosol Science*, **27**, (1996) S705–S706.

Chu, Tieh-Chi; Liu, Ho-Ling*. "Simulated Equilibrium Factor Studies in Radon Chamber," *Applied Radiation and Isotopes*, **47**:**5–6**, (May-June 1996) 543–550.

*Department of Nuclear Science, National Tsing Hua University, Hsinchu, Taiwan 300, R.O.C.

Abstract: A series of experiments have been conducted to study the influences of environmental parameters on the equilibrium factor. Most of them were carried out in a walk-in type chamber. The deposition velocity was calculated using the Jacobi model. The ranges of the environmental

parameters studied in the experiments are humidity 30 to 90% r.h. and radon concentration 2 to 40 kBqm^{-3}. The aerosol sources included electric fumigator, mosquito coil, incense, and cigarette with the particle concentration 2000 to 6500 cm^{-3} and the attachment rate 10 to 350 h^{-1}. The results of the experiment show that the equilibrium factor tends to decrease as the radon concentration increases. On the other hand, the equilibrium factor tends to increase as the humidity increases, and so is the increasing attachment rate. Of all the parameters mentioned above, the influence that aerosols have on the equilibrium factor is the predominant factor. The calculated deposition velocity for the unattached fraction of radon daughters tends to increase as the radon concentration increases. However, it tends to decrease as the humidity increases.

Clarke[1], A.D.; Porter[1], J.N.; Valero, F.P.J.; Pilewski, P. *Journal of Geophysical Research*, **101:D2**, (1996) 4443–4453.

[1]Univ. Hawaii, school ocean earth sci. technology, Honolulu HI 96822, ETATS-UNIS.

Abstract: During the Atlantic Stratocumulus Transition Experiment (ASTEX) in June 1992, two descents in cloud-free regions allowed comparison of the change in aerosol optical depth as determined by an onboard total-direct-diffuse radiometer (TDDR) to the change calculated from measured size-resolved aerosol microphysics and chemistry. Both profiles included a pollution haze layer from Europe, but the second also included the effect of a Saharan dust layer above the haze. The separate contributions of supermicrometer (coarse) and submicrometer (fine) aerosol were determined, and thermal analysis of the pollution haze indicated that the fine aerosol was composed primarily of a sulfate/water mixture with a refractory soot-like core. The soot core increased the calculated extinction by about 10% in the most polluted drier layer relative to a pure sulfate aerosol but had significantly less effect at higher humidities. A 3-km descent through a boundary layer air mass dominated by pollutant aerosol with relative humidities (RH) 10 to 77% yielded a close agreement between the measured and calculated aerosol optical depths (550 nm) of 0.160 (±0.07) and 0.157 (±0.034), respectively. During descent the aerosol mass scattering coefficient per unit sulfate mass (inferred) varied from about 5 to 16 m^2 g^{-1} and was primarily dependent upon ambient RH. However, the total scattering coefficient per total fine mass was far less variable at about 4 ± 0.7 m^2 g^{-1}. A subsequent descent through a Saharan dust layer located above the pollution aerosol layer revealed that both layers contributed similarly to aerosol optical depth. The scattering per unit mass of the coarse aged dust was estimated at 1.1 ± 0.2 m^2 g^{-1}. The large difference (50%) in measured and calculated optical depth for the dust layer exceeded estimated measurement uncertainty (12%). This is attributed to inadequate data on the spatial variability of the aerosol field within the descent region, a critical factor in any validation of this type. Both cases demonstrate that surface measurements may be a poor indicator of the characteristics and concentration of the aerosol column.

Dick, W.D.; Sachweh, B.A.; McMurry, P.H. "Distinction of Coal Dust Particles from Liquid Droplets by Variations in Azimuthal Light Scattering," *Applied Occupational and Environmental Hygiene*, **11 (7)**, (July 1996) 637–645.

Dougle, P.G.; Brink, H.M.T. "Evaporative Losses of Ammonium Nitrate in Nephelometry and Impactor Measurements," *Journal of Aerosol Science*, **27**, (1996) S511–S512.

Khlystov, A.; Kos, G.P.A.; Ten Brink, H.M.; Kruisz, C.; Berner, A. "Activation Properties of Ambient Aerosol in the Netherlands," *Atmospheric Environment*, **30**:**19**, (Oct. 1996) 3281–3290.

Netherlands Energy Research Foundation (ECN), P.O. Box 1, 1755 ZG, Petten, The Netherlands Institut fur Experimentalphysik der Universit at Wien, Vienna, Austria.

Abstract: A cloud chamber has been used to study the cloud activation of ambient aerosol in The Netherlands. The large dimensions and throughput of the chamber allowed unperturbed collection of aerosol and droplets with cascade impactors and on-line measurements with cloud monitors (FSSP) inside the facility. The study provided maxima for the number of man-made aerosol acting as cloud nuclei in marine clouds in The Netherlands. Emphasis was given to the investigation of cloud formation in marine air, since sensitivity studies had shown that such clouds are most effectively

influenced by the (extra) anthropogenic aerosol particles. For this reason the supersaturations in the study were low (on average 0.12%), similar to those in actual marine stratus.

The effect of the anthropogenic aerosols on cloud formation was determined by comparing the number of droplets formed in "clean" arctic marine air to the number of droplets formed in "polluted" marine air (air which had traveled over the U.K.). Air masses with the total aerosol number concentration of the order of 100 cm^{-3} were considered as "clean" marine air. Air masses with higher aerosol concentrations were divided into "moderately" and "heavily" polluted with total aerosol concentrations of the order of 1000 and 10,000 cm^{-3}, respectively.

In the clean marine air all potential cloud nuclei (particles larger than the threshold size of the smallest reference particles that were activated at a given supersaturation) were activated and the number of cloud droplets formed was on average 45 cm^{-3}. In the moderately polluted air 72% of potential cloud nuclei were activated and the average droplet number was 190 cm^{-3}. The difference in the actual cloud droplet number and the number of potential cloud nuclei could be explained by the presence of water-insoluble particles which do not activate. In the heavily polluted air the average droplet concentration was around 320 cm^{-3}. which is, on average, 24% of the number of potential cloud nuclei.

Lin[1], Shih Y.; Ferg[1], Jeffrey; Biswas[1], Pratim; Enzweiler[2], Ray; Boolchand[3], Punit. "Characterization of Maghemite Ferric Oxide Crystals Processed by an Aerosol Technique," *Journal of Magnetism and Magnetic Materials*, **159**:**1–2**, (June 1996) 147–158.

[1]Aerosol and Air Quality Research Laboratory, Department of Civil and Environmental Engineering, University of Cincinnati, Cincinnati, OH 45221-0071, USA. [2]Department of Physics, Northern Kentucky University, Highland Heights, KY 41099, USA. [3]Department of Electrical Engineering, University of Cincinnati, Cincinnati, OH 45221-0071, USA.

Abstract: An aerosol technique is used to produce submicrometer-sized γ-Fe_2O_3 particles in two steps using ferrous oxalate dihydrate as the starting precursor. In the first step, a submicrometer-sized powder was produced by decomposing the precursor solution in an aerosol reactor. In the second step the powder was heat treated in a reducing ambient to produce maghemite (γ-Fe_2O_3). The kinetics of the maghemite formation are elucidated using a microscopic probe.

Seong-Ho, Y.; Seung-Ki, C.; Liu, B.Y.H. "Influence of Particle Refractive Index on the Lower Detection Limit of Light Scattering Aerosol Counters," *Aerosol Science and Technology*, **25 (1)**, (July 1996) 1–10.

Abstract: Light scattering particle counters are widely used for aerosol research. They are also important tools for monitoring airborne particles in the semiconductor and pharmaceutical industries. For the latter application, it is important to know the influence of particle material properties on the counter response, particularly the effect of particle refractive index on the lower detection limit of the counter. In this paper, the effect of particle refractive index on the lower detection limit of aerosol particle counters has been studied using the Mie theory. Counting efficiencies have also been measured to verify the theoretical results. The measurements were made with PSL (polystyrene latex), silicon, silicon nitride, and silicon dioxide particles. Two commercially available aerosol counters and a condensation nucleus counter were used in the study. The theoretical study show that both the real and the imaginary parts of the particle refractive index affect the lower detection limit of a light scattering particle counter. For transparent particles, an increase in the particle refractive index causes a decrease in the lower detection limit. And the absorptive component in the refractive index of the particle causes a further drop in the lower detection limit for the specific counters studied. Experimental measurements show good agreement with the theoretical results. Among the test particles used, silicon had the largest refractive index, followed by silicon nitride, PSL, and silicon dioxide. The lower detection limit of the counters studied also shows a corresponding decreasing trend with silicon dioxide giving the highest lower detection limit, followed by PSL, silicon nitride, and silicon as the refractive index of the particle is increased and the lower detection limit of the counter is decreased. The difference between the theoretical and experimental lower detection limits was found to be less than 10% in most cases.

1995

Chang, Y.-C.; Ranade, M.B.; Gentry, J.W. "Thermophoretic Deposition in Flow Along an Annular Cross-Section: Experiment and Simulation," *Journal of Aerosol Science*, **26:3**, (1995) 407–428.

Abstract: Thermophoretic deposition was investigated theoretically and experimentally using polydisperse submicron solid glass aerosols in an annular flow with fixed thermal gradients between two cylinders. The governing equations include the momentum and energy equations for the gas phase and the general dynamic equation (GDE) for the particle phase. Aerosol mechanisms included in the GDE are convection, Brownian diffusion and thermophoresis. The solutions were derived based on an implicit finite difference approach. Simulation results suggest that thermophoretic deposition increases with increasing thermal gradient and deposition distance, but decreases with increasing particle size and flow rate.

Experimental quantification of thermophoretic deposition was carried out in a prototype thermal cell consisting of two concentric cylinders with the capability of imposing a fixed thermal gradient between the cylinders. The measurements were with polydisperse solid glass aerosol using two optical counters. The effect of thermal gradients, flow rates, and cell orientation on thermophoretic deposition was examined. Thermal gradients covered in this study ranged from 60 to 150 K cm^{-1}. It was shown that thermophoretic deposition increases with increasing thermal gradient but decreases with increasing flow rate. Measurements with a vertical cell were stable for large particles but unstable for small particles.

Comparison between experiments and simulations showed qualitative agreement with the theoretical model. The deposition in the vertical mode was substantially higher than that predicted by the model particularly at large thermal gradients. This may indicate the onset of instability. The measurements do not settle the dispute between the theories proposed by Derjaguin *et al.* (1976, *J. Colloid Interface Sci.* **57**, 451–461) and Talbot *et al.* (1980, *J. Fluid Mech.* **101**, 737–758). However the difference between theoretically predicted deposition efficiency is too small in comparison with the magnitude of fluctuation in the aerosol source itself.

Ciach, T.; Sosnowski, T.R.; Podgorski, A. "Efficient filtration methods for diesel aerosols," *Journal of Aerosol Science*, **26**, (1995) S723–S724.

Foltescu, V.L.; Zahn, A. "Aerosols Used as Tracers for Stratosphere-Troposphere Exchange in the Arctic," *Atmospheric Environment*, **29**:**15**, (Aug. 1995) 1777–1784.

Department of Physics, Chalmers University of Technology, S-412 96, Göteborg, Sweden. Institut für Umweltphysik, University of Heidelberg, Im Neuenheimer Feld 366, 6900,

Abstract: Accumulation range particles as well as ozone and meteorological parameters were measured, *in situ* and on-line, during the 1991/1992 EASOE (European Arctic Stratospheric Ozone Experiment) aircraft measurement campaigns. Some interesting and significant findings relate to one flight in 31 January, 1992 from Kiruna (67°48′N, 20°18′E) to Spitsbergen (79°00′N 30°13′E) and back. At 390 mb the aircraft encountered stratospheric air, characterized by strong increases in concentrations of accumulation mode particles and ozone. The concentrations of particles with diameters between 0.31 and 0.79 μm were, moreover, highly correlated with ozone mixing ratios (R = 0.95). In the regions where stratospheric air was sampled the particle number size distribution showed a predominant mode centered at around 0.5 μm diameter. This mode was the signature of the stratospheric aerosol transported down into the upper troposphere where the measurements were conducted. There are indications that the measured stratospheric air originated from a folded tropopause. An approach to study the mixing between the intrusions of stratospheric air and the free tropospheric air has been used to quantify mixing coefficients (fractions of stratospheric air) along the flight route and absolute levels of particles and ozone in the lower stratosphere. This approach can be applied to study the dilution process during stratosphere-troposphere exchange. The requirement is that at least two conservative stratospheric tracers are measured simultaneously.

Foltescu, V.L.; Selin, E.; Below, M. “Corrections for Particle Losses and Sizing Errors During Aircraft Aerosol Sampling using a Rosemount Inlet and the PMS LAS-X,” *Atmospheric Environment*, **29**:**3**, (Feb. 1995) 449–453.

Department of Physics, University of Göteborg and Chalmers University of Technology, S-412 96, Göteborg, Sweden. Centre of Radiation Protection and Radio Ecology, University of Hannover, Herrenhäuser Str. 2, D-30419, Germany.

Abstract: *In situ* flight measurements of accumulation mode aerosol particles were performed in the upper troposphere during the 1991/1992 EASOE (European Arctic Stratospheric Ozone Experiment). On-line number size distributions were obtained by using an optical particle counter, the PMS LAS-X. Support data, like ozone mixing ratios, and meteorological as well as flight parameters were collected simultaneously. The present study analyses the particle sampling system used aboard the Transall aircraft. A correction algorithm for particle losses and sizing errors is developed based on calculations. A corrected number size distribution is compared with measurements reported in the literature.

Grinshpun, S.A.; Willeke, K.; Ulevicius, V.; Qian, Y.; Donnelly, J. “Aerodynamic Particle Sizing of Airborne Bacteria,” *Journal of Aerosol Science*, **26**, (1995) S879–S880.

Hautanen, J.; Watanabe, T.; Tsuchida, T.; Koizumi, Y.; Tochikubo, F.; Kauppinen, E.; Lehtinen, K.; Jokiniemi, J. “Brownian Agglomeration of Bipolarly Charged Aerosol Particles,” *Journal of Aerosol Science*, **26**, (1995) S21–S22.

Lehtimaki, M. “Development of Test Methods for Electret Filters,” *Journal of Aerosol Science*, **26**, (1995) S737–S738.

Lewis[1], S. “Solid Particle Penetration Into Enclosures,” *Journal of Hazardous Materials*, **43:3**, (Oct. 1995) 195–216.

[1]Israel Atomic Energy Commission, Soreq Nuclear Research Center, Yavne 81800, Israel

Abstract: Protection factors against toxic vapors for enclosures such as vehicles and shelters are commonly evaluated on the basis of the behavior of a simulant vapor. Mechanisms influencing protection against solid particles have yet to be integrated into integrity-testing procedures. The scarcity of empirical studies which could provide the basis for such procedures suggested a program whose objectives would be to provide means for measuring size-dependent solid particle protection factors for various exposure scenarios and for expressing the relevant mechanisms in model calculations. These could then aid in the design of such procedures.

A system providing a flexible infrastructure for experimenting with controlled challenge scenarios was assembled outdoors in an open-ended agricultural cloche. A sealed enclosure located at the end of the cloche far from the dissemination apparatus enabled testing of solid particle challenge penetration through well-defined apertures under controlled ventilation dynamics. A computer model was written to calculate protection factors for vapor and solid particles using both theoretical models and empirical data. The experimental system provided data for the calibration and verification of the model.

Pfalzmann, E. “A Non Invasive Method for Measuring Particle Mass Concentration of Wet Aerosols with Particles up to Accumulation Mode...,” *Journal of Aerosol Science*, **26**, (1995) S775–S776.

Pilacinski, W.; Sarnecka, E. “Laboratory Station for the Comprehensive Testing of Filtering Performance,” *Journal of Aerosol Science*, **26**, (1995) S727–S728.

Qian, Yinge; Willeke, Klaus; Ulevicius[1], Vidmantas; Grinshpun, Sergey A.; Donnelly, Jean. "Dynamic Size Spectrometry of Airborne Microorganisms: Laboratory Evaluation and Calibration," *Atmospheric Environment*, **29**:**10**, (May 1995) 1123–1129.

[1]Aerosol Research Laboratory, Department of Environmental Health, University of Cincinnati, Cincinnati, OH 45267-0056, U.S.A.

Abstract: Bioaerosol samplers need to be calibrated for the microorganisms of interest. The Aerosizer® particle size analyzer, a relatively new aerodynamic size spectrometer, is shown to be a suitable dynamic instrument for the evaluation and calibration of such samplers in the laboratory, prior to their use in the field. It provides the necessary reference count against which the microbiological response of the sampler can be compared. It measures the health-significant aerodynamic diameters of microorganisms down to 0.5 μm, thus including most of the bacteria, fungi and pollen found in outdoor and indoor air environments. Comparison tests with a laser size spectrometer indicate that the suspension of microorganisms needs to be washed several times before aerosolization to avoid coating of the airborne microorganisms with nutrients and microbial slime from the suspension, and to reduce the residue particles to sizes below the lowest size of the aerosolized microorganisms.

1994

Ankilov, A.; Baklanov, A.; Colhoun, M.; Enderle, K.-H.; Filipovicova, D.; Gras, J.; Julanov, Y.; Lindner, A.; Lushnikov, A.A.; Majerowicz, A.E. "Workshop on Intercomparison of Condensation Nuclei and Aerosol Particle Counters, Vienna, 1993: An Overview," *Journal of Aerosol Science*, **25:S1**, (1994) 533–534.

Grinshpun, S.A.; Willeke, K.; Donnelly, J.; Terzieva, S.; Chang, C.-W.; Juozaitis, A.; Ulevicius, V. "Inlet, Collection and Analysis Characteristics of Bioaerosol Samplers and Development of New Ones," *Journal of Aerosol Science*, **25:S1**, (1994) 7–8.

Lin, J.-C.; Chang, Y.-C.; Gentry, J.W.; Ranade, M.B. "Models for Discharge and Evaporation in Electrospray Pyrolysis," *Journal of Aerosol Science*, **25:S1**, (1994) 217–218.

Schiller-Scotland[1], Ch.F.; Hlawa[2], R.; Gebhart[3], J. "Experimental Data for Total Deposition in the Respiratory Tract of Children," *Toxicology Letters*, **72**:**1–3**, (June 1994) 137–144.

[1]Institut für Biophysik der J. W. Goethe-Universität, Paul-Ehrtich-Straβe 20, D-60596 Frankfurt, Germany. [2]Klinikum der J.W. Goethe-Universität, Paul-Ehrtich-Straβe 20, D-60596 Frankfurt, Germany. [3]GSF-Forschungszentrum für Umwelt und Gesundheit, GmbH, Paul-Ehrtich-Straβe 20, D-60596 Frankfurt, Germany.

Abstract: Up to now only few experimental data for total deposition of inhaled aerosol particles are available for children. In this study 29 healthy children aged between 3 and 14 years volunteered for the determination of 1 μm, 2 μm and 3 μm particles for spontaneous and controlled breathing. It turns out that total deposition values for children are higher than for adults. The effect is significant for all particle sizes (Kruskal-Wallis). For the applied breathing patterns deposition decreases as a function of body height. For inhalation risk assessments the number of particles deposited per unit time (deposition rate) rather than the deposition per breath has to be taken. During spontaneous breathing at rest the deposition rate is on average higher for children than for adults.

Thomas[1], A.; Gebhart[1], J. "Correlations Between Gravimetry and Light Scattering Photometry for Atmospheric Aerosols," *Atmospheric Environment*, Conference on Visibility and Fine Particles**, 28**:**5**, (March 1994) 935–938.

[1]GSF-Forschungszentrum fiir Umwelt and Gesundheit GmbH, Institut fiir Biophysikalische Strahlenforschung, Paul- Ehrlich-Str. 20, D-60596 Frankfurt am Main, Germany

Abstract: Light scattering photometers are useful for in situ measurements of mass concentrations of environmental aerosols if certain requirements are fulfilled. For the determination of relative

concentrations, the composition of the aerosol (particle size distribution, refractive index) has to be constant during the experiments. Absolute measurements of mass concentrations additionally require a calibration of the photometer in terms of gravimetric units. In the case of atmospheric aerosols special attention has to be paid to the relative humidity which has a strong effect on particle size. Preliminary measurements indicate that for atmospheric background aerosols with a dominating accumulation mode a fairly linear relationship between photometer response and mass (volume) concentration exists, a result, which is in agreement with theoretical predictions.

Light scattering photometer; mass concentration; atmospheric background aerosol; accumulation mode; median refractive index.

Thompson, M.W.; Donnelly, J.; Grinshpun, S.A.; Juozaitis, A.; Willeke, K. "Method and Test System for Evaluation of Bioaerosol Samplers," *Journal of Aerosol Science*, **25:8**, (1994) 1579–1593.

Abstract: A method and test system have been developed for the laboratory evaluation of the performance of bioaerosol samplers. The method differentiates between the overall physical sampling efficiency (which reflects the inlet and collection efficiencies) and the biological sampling efficiency (which reflects the survival of the test microorganisms during the sampling process). The number concentrations of laboratory-generated bioaerosol particles are measured with an aerosol size spectrometer up- and downstream of the bioaerosol sampler being tested. In a bioaerosol impactor, which was specially designed for testing microbiological aspects of bioaerosol sampling, the inlet and collection efficiencies are differentiated by measuring downstream of the collection surface location with and without the collection surface in place. The number of recovered particles is counted as microcolonies with a microscope after sampling the bioaerosol particles into agar and culturing them. The total recovery of these bioaerosol particles is determined as a ratio of the number of viable microorganisms recovered to the number of bioaerosol particles present in the air sampling volume upstream from the sampler. This total recovery is a measure of the ratio of culturable to non-culturable bacteria present in the air. By measuring physical and microbiological aspects simultaneously, information is gained on aspects of bioaerosol sampling that cannot be determined by either of these branches of science alone. This is exemplified by tests on the influence of relative humidity and desiccation time on colony count.

The newly-developed system can be used to test any bioaerosol sampler. A special single-stage impactor was designed, built and used to study how different sampling and analysis variables affect the total recovery of bioaerosol particles. The designed impactor was calibrated using PSL particles. Its inlet sampling efficiency was found to be within the range of 96 to 99.5%, depending on the sampling conditions and particle size, if the latter is less than 8 μm (this range represents single bacteria, bacterial agglomerates, and fungi). The collection efficiency was found to be about 100% when collecting PSL particles larger than 0.7 μm in diameter at 201 min^{-1} or higher air flows.

The total recovery of microorganisms measured under these conditions is characterized only by the "survivability" of microorganisms during their sampling. It was found that relative humidity had a pronounced effect on total *Pseudomonas fluorescens* recovery. Experimental data also showed that the sampling time may be limited due to bacterial desiccation and subsequent loss in viability of collected microorganisms.

1993

Peters, K.; Gerchau, J.; Bruckner, G. "The Filtering of Aerosol Particles by a Spruce Canopy-Measurements Versus Model Calculations," *Journal of Aerosol Science*, **24**, (1993) S313–S314.

1992

Schiller-Scotland, C.F.; Hlawa, R.; Gebhart, J.; Wonne, R.; Heyder, J. "Total Deposition of Aerosol Particles in the Respiratory Tract of Children during Spontaneous and Controlled Breathing," *Journal of Aerosol Science*, **23:S1**, (1992) 457–460.

Abstract: Medical doctors found out that in comparison to adults the number of children with airways decrease due to air pollution is much higher. However up to now experimentally data for total deposition of aerosol particles in the human respiratory tract are predominantly published for adults. In the present study 29 children with normal lung function data volunteered for the determination of total deposition using an inline inhalation technique. It turns out that total deposition data for children are higher than for adults, and thus confirm a general tendency already reported by BECQUEMIN et al. (1986). Using the inline technique the differences in deposition values between children and adults are more pronounced than found by those authors.

1990

Chang ,Y.C.; (Arun) Ranade, M.B.; Gentry, J.W. "Thermophoretic Deposition of Aerosol Particles on Transport Tubes," *Journal of Aerosol Science*, **21**, (1990) S81–S84.

Lehtimäki, Matti; Keskinen, Jorma; Janka, Kauko. "Sedimentation Method in Calibrating Optical Particle Counters," *Aerosol Science and Technology*, **1521-7388, 12:3**, (1990) 711–715.

Abstract: The use of a horizontal elutriator in calibrating optical particle counters according to aerodynamic particle size has been studied. As elutriator a ceramic component with 4800 parallel square channels with dimensions of 0.1 x 0.1 x 15.2 cm has been used. The advantage of the present method is that the particle penetration characteristic of the elutriator can be easily changed simply by varying the flow rate. The elutriator has been used in studying the properties of an optical particle size analyzer (PMS Las-X). The relationship between the equivalent aerodynamic particle size and the corresponding particle size indicated by the analyzer has been determined by using Arizona road dust particles and dioctylphthalate particles. The practical size range of the method is $D_p \geq 0.3$ μm.

1989

Biswas, P.; Tian, Y.; Pratsinis, S.E. "Receptor Modeling of Microcontamination in Clean Rooms," *Journal of Aerosol Science*, **20:8**, (1989) 1361–1364.

Karg, E.; Brand, P.; Hietel, B.; Kreyling, W.G.; Ruo, b K.; Tschiersch, J.; Tuch, T.; Heyder, J. "Intercomparison of Particle Size Spectrometers," *Journal of Aerosol Science*, **20:8**, (1989) 1481–1484.

Knollenberg, R.G. "The Measurement of Latex Particle Sizes using Scattering Ratios in the Rayleigh Scattering Size Range," *Journal of Aerosol Science*, **20:3**, (1989) 331–345.

Abstract: The diameters of polystyrene latex (PSL) particles in the size range of 0.065 to 0.460 μm were determined by scattering measurements using open cavity laser aerosol spectrometers operating at wavelengths of 633 and 1152 nm. A recently available NBS standard reference material (SRM) was adopted as a primary standard PSL size. By comparing the ratio of light scattered by various PSL sizes to the SRM, the sizes of large samples of PSL could be rapidly determined. Comparisons of various PSL samples confirmed that the measured diameters can differ from the nominal diameters a considerable degree. Differences as large as 20% were observed for sub-tenth micrometer sizes but typically less than 5% at sizes between 0.2 and 0.4 μm. The size of 0.1 μm particles was also determined from the direct measurement of the scattered power. The resulting size difference was less than the uncertainty of the NBS SRM.

Prodi, V.; Agostini, S.; Belosi, F. "Submicron Oil Droplet Filtration," *Journal of Aerosol Science*, **20:8**, (1989) 963–966.

Wang, H.C.; Wen, H.Y.; Kasper, G. "Mechanisms on Particle Generation by Mechanical Shocks," *Journal of Aerosol Science*, **20:8**, (1989) 915–918.

Wen, H.Y.; Kasper, G. "On the Kinetics of Particle Re-entrainment from Surfaces," *Journal of Aerosol Science*, **20:4**, (1989) 483–498.

Abstract: A kinetic model of particle re-entrainment is presented and compared with data from industrial high purity gas systems and with controlled experiments using Latex particles of 0.4 to 1 μm.

The model describes re-entrainment as a first order reaction, analogous to molecular desorption from an inhomogeneous surface, with a rate constant $a(F) = A\exp(-F)$(F = adhesion force/removal force). The rate equation is integrated over a model distribution of F, giving analytical solutions for the concentration of particles on the surface and in the gas stream as a function of time. For sufficiently broad initial adhesion force distributions, both surface concentration and gas concentration decay inversely proportionally to time, similar to Reeks *et al.* (*J. Phys. D: appl. Phys.***21**, 574, 1988).

The model agrees well with experimental data and also explains observed systematic deviations of the data from the $1/t$ law. **Based** on the model, rate constants A are inferred, and the widths of adhesion force distributions and the size of initial surface particle populations are estimated.

Wu, J.J.; Cooper, D.W.; Miller, R.J. "Evaluation of Aerosol Deconvolution Algorithms for Determining Submicron Particle Size Distributions with Diffusion...," *Journal of Aerosol Science*, **20:4**, (1989) 477–482.

Abstract: Determining the particle size distribution of airborne particles is important in many contexts, including understanding and thus reducing the deposition of particles on micro-electronic components during their manufacture. Sizing of particles smaller than 0.1 μm is usually done with a diffusion battery, which requires use of a deconvolution algorithm to obtain particle size distributions. The following algorithms were evaluated: CINVERSE (Crump and Seinfeld, *Aerosol Sci. Technol.***1**, 363, 1982). Twomey's iterative procedure (Twomey, *J. Comput. Phys.***18**, 188, 1975), expectation maximization (Maher and Laird, *J. Aerosol Sci.***16**, 557, 1985), constrained least-squares fit (Nelder and Mead, *Comput. J.***7**, 308, 1965; Cooper and Spielman, *Atoms. Envir.***10**, 1976). Expectation maximization and constrained least-squares fit are more suited to this use than are the other two. The non-monotonic response of the diffusion battery with respect to particle size cannot be corrected for by any such algorithm. One could modify the diffusion battery to prevent entrance of the larger particles or one could use an independent measurement of the larger particles to correct the diffusion battery data. Using the latter approach provided an improved estimate of the particle size distribution in a clean room.

1988

Wen, H.Y.; Kasper, G.; Montgomery, D. "Nucleation of Trace Amounts of Condensable Vapors in an Expanding Gas Jet," *Journal of Aerosol Science*, **19:1**, (1988) 153–156.

Abstract: Filtered Nitrogen gas was expanded from up to 150 bar to atmosphere through a specially cleaned orifice disc. The gas contained adjustable traces of impurities such as moisture and hydrocarbons. Above a critical pressure drop, formation of droplets mostly smaller then 0.1 μm was observed due to homogeneous nucleation of trace impurities in the gas. The experiments explain problems of particle formation observed in commercial pressure regulators for compressed gas cylinders.

1987

Bull, R.K.; Stevens, D.C.; Marshall, M. "Studies of Aerosol Distributions in a Small Laboratory and around a Humanoid Phantom," *Journal of Aerosol Science*, **18:3**, (1987) 321–335.

Abstract: The variations in aerosol concentration around a small room and around a phantom have been measured. Even in the steady state the average concentrations at different positions around the room can differ by an order of magnitude. The measured concentration can show dramatic time variations. Time-integrated concentrations resulting from nominally identical transient releases of aerosol can vary by factors of ~5. The correlation between integrated and instantaneous aerosol concentrations measured by two separate sampling tubes has been determined. Integrated concentrations measured at different samplers are usually within a factor of 2 to 3 of each other but

discrepancies increase as the distance between samplers is increased and the duration of the release decreases. Such behavior places limits on the accuracy with which the airborne radiation hazard can be determined over short time periods.

Kodas, T.T.; Sood, A.; Pratsinis, S.E. "Submicron Alumina Powder Production by a Turbulent Flow Aerosol Process," *Powder Technology*, **50**:**1**, (March 1987) 47–53.

Aluminum Company of America, Alcoa Laboratories, Alcoa Center, PA 15069 U.S.A. Department of Chemical and Nuclear Engineering, University of Cincinnati, Cincinnati, OH 45221-0171 U.S.A.

Abstract: Alumina powder production by condensation of aluminum—sec-butoxide vapor to form liquid droplets and subsequent chemical reaction of the droplets with water vapor was carried out in a turbulent flow system (Re = 5000). Particle size distributions were broader than those obtained in laminar flow systems. Turbulence led to increased redistribution of vapor among fluid elements relative to laminar flow systems and resulted in non-uniform particle growth. For unseeded operation, 90% of the vapor was deposited on the walls. Introducing seed particles before condensation reduced vapor wall deposition to as low as 10%. The product particles had a fairly narrow size distribution with a number average diameter of 0.5 μm, were of high purity (99.995%) and were spherical and porous. The experiments demonstrate the feasibility of manufacturing large quantities of powders by vapor condensation and chemical reaction in turbulent flow.

1986

Hautanen, J.; Janka, K.; Keskinen, J.; Lehtimaki, M.; Kivisto, T. "Optimization of Filtration Efficiency and Ozone Production of the Electrostatic Precipitator," *Journal of Aerosol Science*, **17:3**, (1986) 622–626.

Hinds, W.C.; Kraske, G. "Performance of PMS Model LAS-X Optical Particle Counter," *Journal of Aerosol Science*, **17:1**, (1986) 67–72.

Abstract: Performance characteristics of a Particle Measuring System (PMS) Model LAS-X (0.12 to 7.5 μm) optical particle counter were evaluated. The effect of particle refractive index was determined theoretically by calculating response curves for 32 refractive indexes. Nonabsorbing organic particles with unknown refractive index have measurement errors that range from −50 to +20%. Unknown particles (including absorbing particles) may have measurement errors from −60 to +250%. An aerodynamic calibration of range 3 (0.12 to 7.5 μm) with oleic acid particles found the indicated sizes to be within ±2 channel widths of the correct aerodynamic diameters. Measurements of the effect of coincidence on measured size found errors in CMD to be less than 10% for concentrations below 10,000 cm^{-3}. Experimental measurements of inlet losses showed a dependence on particle size and sample flow rate with about 50% loss of 12 μm particles at a sampling rate of 5 cm^3 s^{-1}.

Kodas, Toivo T.; Pratsinis, Sotiris E.; Friedlander, Sheldon K. "Aerosol Formation and Growth in a Laminar Core Reactor," *Journal of Colloid and Interface Science*, **111**:**1**, (May 1986) 102–111

Department of Chemical Engineering, University of California, Los Angeles, California, 90024,

Abstract: A novel aerosol flow reactor is described in which the core of a laminar flow of premixed reactants is irradiated to produce particles along the axis of the flow. The reactor was studied experimentally by irradiating an $NH_3/C_3H_6/NO_2$/air mixture to produce NH_4NO_3 aerosol. A theory developed for particle formation and growth in the core reactor, accounting for radial diffusion of the condensing species and the parabolic velocity profile, explained the behavior of the system. The theory was formulated in terms of moments of the particle size distribution. The formation of NH_4NO_3 particles from HNO_3 and NH_3 vapors followed classical nucleation theory with HNO_3 considered as the monomer. Values of the surface tension of the solid NH_4NO_3 and the rate of HNO_3 formation were determined by comparing theory and experiment.

Sexton[1], Ken; Webber[1], Lurance M.; Hayward[1], Steven B.; Sextro[2], Richard G. "Characterization of Particle Composition, Organic Vapor Constituents, and Mutagenicity of Indoor Air Pollutant Emissions," *Environment International*, Indoor Air Quality, **12**:**1–4**, (1986) 351–362.

[1]Indoor Air Quality Program, California Department of Health Services, 2151 Berkeley Way, Berkeley, California 94704, USA. [2]Building Ventilation and Indoor Air Quality Program, Lawrence Berkeley Laboratory, Berkeley, California 94720, USA.

Abstract: A joint chamber experiment was carried out by the California Indoor Air Quality Program and Lawrence Berkeley Laboratory to characterize particle and organic vapor emissions from several important indoor sources, including a gas range, tobacco smoking, hamburger frying, a kerosene heater, and selected aerosol spray products. Among the emissions data collected for each source were particle size distributions, particle-phase chemical compositions, volatile organic compounds, and mutagenicity of particles and vapor-phase constituents. Findings were used to assess qualitatively the nature of airborne emissions from each source and to compare emission constituents among source categories. This approach is a necessary first step in evaluating the feasibility of developing unique signatures for individual sources using a broad array of emission characteristics.

Wen, H.Y.; Kasper, G. "Counting Efficiencies of Six Commercial Particle Counters," *Journal of Aerosol Science*, **17:6**, (1986) 947–961.

Abstract: Counting efficiencies of a condensation nuclei counter (TSI 3020), a white-light optical particle counter (Climet CI-8060) and four laser instruments (PMS LAS-X, LAS-250X, LPC 525 and HP-LAS) were determined relative to the LAS-X.

Measurements were made in the geometric diameter range of 0.1 to 4 μm using latex spheres as well as monodisperse organic and inorganic particles produced by a vibrating orifice generator.

The high-pressure in-line counter (HP-LAS) shows a nonlinear response to gas velocity which can be taken into account by a calibration. The lower detection limits (50% points) of the conventional laser counters (LAS-X and LAS-250X) agree within 0.05 μm with their nominal specifications; for the white-light counter (CI-8060) the actual lower limit is at about 0.4 μm. For all counters, the degree of inlet losses for larger particles varies greatly with inlet design and flow velocity of each counter.

Yamada, Yuji; Miyamoto, Katsuhiro; Koizumi, Akira. "Size Measurements of Latex Particles by Laser Aerosol Spectrometer," *Aerosol Science and Technology*, **1521-7388**, **5:3**, (1986) 377–384.

Abstract: Size measurements of PSL (polystyrene latex) particles in a size range from 0.109 to 0.330 μm were made by laser aerosol spectrometer (PMS, LAS-X). The results were compared with those by electron microscopy. For example, the geometric standard deviation, σ_g, of nominally 0.176 μm PSL particles was measured as 1.05, assuming that their sizes distribute log-normally. The value of 1.05 was very close to 1.02 measured by electron microscopy. It was found that the spectrometer had very high size resolution, although the size resolution of the light scattering type spectrometer has been said to be poor. For some samples of PSL particles, however, there were large differences between particle sizes measured by LAS-X and those by electron microscopy. It was also found that LAS-X had a problem in calibration of size response curve.

1985

Shaw[1], Glenn E. “Aerosol Measurements in Central Alaska, 1982–1984,” *Atmospheric Environment (1967)*, **19**:**12**, (1985) 2025–2031.

[1]Geophysical Institute and Department of Space and Atmospheric Physics, University of Alaska, Fairbanks, Alaska 99701, U.S.A.

Abstract: Atmospheric aerosols in subarctic central Alaska were studied for two winter seasons. Both optical absorptivity and excess (non-marine) sulfate undergo seasonal variation similar to that reported in Arctic locations (maximum in late spring and minimum in summer), but the magnitudes are a factor of two smaller than in the Arctic. The meridional variation in aerosol blackness and sulfur content (cleaner air to the south) is contrary to the trend in the Scandinavian Arctic and is interpreted to indicate the existence of pollution sources generally north and west, outside of Alaska's borders.

Aerosol size varies with air temperature. Submicrometer aerosol mass and geometric mean diameter (GMD) increase as temperature decreases. Aerosols in all air masses studied were rich in volatile particles. The volatility suggests the presence of aqueous solutions of H_2SO_4. On the basis of (a) the relativity high aerosol volatility, and (b) the opposite trends between mean diameters and air temperature, it is conjectured that condensation of H_2SO_4 vapor may be an important mechanism for aerosol evolution in the winter (dark) polar troposphere.

1984

Janka, K.; Kulmala, V. “Pulse Processing and Coincidence-Error Correction in Optical Particle Counters,” *Journal of Aerosol Science*, **15:3**, (1984) 284–287.