Filtrate quality:

Even though premium quality filter material was used for the bag filter, the filtrate quality was fairly poor for two reasons:

(1) For reaching reasonable life times and change intervals (high dirt holding capacity), a rather large filter area per flow volume had to be installed. This required filter area led to sedimentation effects in the bag, resulting in a non-uniform cake formation in the filter bag.

(2) Furthermore, even the best monofilament material made of polymer filaments has a rather high variation in pore sizes, meaning that there are many pores being larger than 10 µm.

Both effects led to a poor performance of the downstream ultrafiltration unit, resulting in a low flow rate through the membrane, so that it became a bottleneck.

As the Lenzing OptiFil® is operating an automatic backwash system, it was designed for achieving the highest flow/time instead of focussing on the dirt holding capacity. This led to a much smaller filter area (only about 10% of the bag filter system) and hence a uniform cake formation as well as high quality filtrate very shortly after backwash. Additionally, a special stainless steel weave was used, also with 10 µm pores, but with a much more uniform pore size distribution. Therefore the actual filtration performance is close to 1 µm!

By using the Lenzing OptiFil®, the flow through the ultrafiltration system and the module life time could be increased significantly so it does no longer represent a bottleneck in the process.

Workplace, Health and Convenience:

The fermentation broth contains ammoniac, which leads to high odour nuisance along with each bag change.

The Lenzing OptiFil® is a completely closed system, using a double acting mechanical seal with a thermosyphone system to seal the rotating shaft to the outside, leading to zero emssions during operation.

Productivity:

Since the application of Lenzing OptiFil®, the company has been able to finish a batch in much less time, leading to a significant increase in production efficiency.

Aerosol technology is flying high
Report from the 27. Palas-Aerosol Technology Seminar

H. Lyko*

Karlsruhe-based Palas GmbH, specialist for aerosol technology and filter testing, celebrated 30 years of existence during the 27th Aerosol technology seminar in September 2013. The intensive exchange between all players in the field of aerosol technology, already cultivated since the 4th year of existence, has certainly also made a contribution to the large number of new technical developments that have been established in the market through the years. The enterprise success was particularly emphasised by the awarding of the SEED and GROW AWARD of IHK-Technologiefabrik to Palas GmbH, during the evening event of the seminar.

Resonance as a part of corporate culture

A jubilee always gives a cause for review. This initially happened here through the head of the Business Reframing Institute for Organisation and Humane management, Prof. Dr. Dr. Wolfgang Berger. He pointed out that the company foundation fell in the same period as the establishment of particle measurement technology as a business field of the VDI. He compared Palas to electromagnetic fields, in which resonance creates a positive working atmosphere as a measure of the direct vibration between fields transferred onto corporate culture. Because for complex systems, it is not momentary survival that is crucial but the constant adaptation to changing conditions, the success of the company Palas also lies in the fact that new strategies and decisions are communicated in a way that the people in the enterprise responsible for implementing them can identify with.

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Past and future of Palas

In a two-part presentation, Managing Director Leander Mölter and authorised signatory Dr. Maximilian Weiß described the history of the enterprise and its products from 1983 till today, as well as the planned developments for the future. The spectrum of the aerosol generators, dilution systems, aerosol spectrometers and filter test systems was extended more and more over the course of the years. Technological development is particularly evident through the changes that the aerosol spectrometer has undergone. The principle of the Particle Counter Sizer (PCS) was invented in the beginning of the 1970s by Dr. Umhauer in the Institute of Mechanical Process Engineering at the University of Karlsruhe. The first PCS that Palas installed in a filter test system came from Russia, and afterwards the enterprise got the rights for in-house production. The original PCS sensor weighed 28 kg and still had peripheral zone errors that had to be corrected. With the development and patenting of T-aperture technology, the peripheral zone error correction became superfluous, and also, the system allows the identification of coincidences. The welas® sensors designed with the T-aperture have become lighter and lighter and also less expensive since then. While the first welas® sensor nevertheless still weighed 11 kg, the smallest and lightest version, the Mini-sensor, now only weighs 200g. Dr. Maximilian Weiß, with the help of the so-called Ansoff matrix, illustrated in what direction the enterprise should grow in future. In the last five years alone, particularly the demand for high-quality devices with high flexibility and high measuring accuracy was satisfied with eight new device models. The future development aims on one hand at smaller lighter systems like mobile aerosol sensors triggered via wireless radio. On the other hand, one also wants to offer devices for the low price sector for applications where compromising on the measuring accuracy can be tolerated. Furthermore, through participation in different research projects with cooperation partners, one also wants

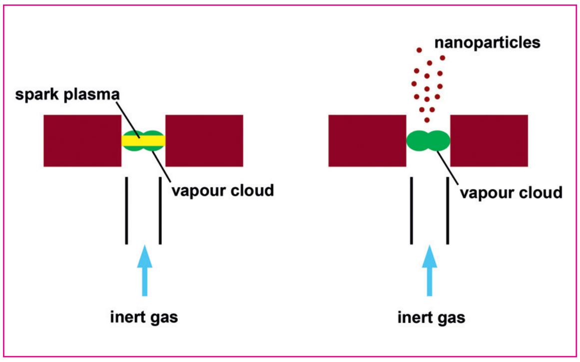

Fig. 1: Schematic diagram of nanoparticle production by spark discharge

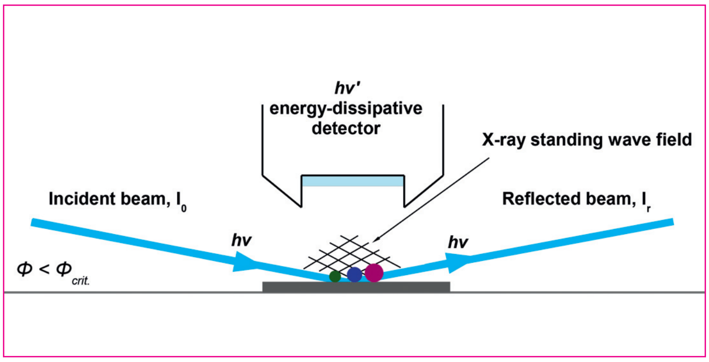

Fig. 2: Schematic diagram of TXRF- method with a standing wave field

to open new markets with new products. The Institut für Energie- und Umwelttechnik (IUTA) e.V. is a long-standing cooperation partner of Palas. The Director of the institute, Dr. Stefan Haep, reported on the fertile cooperation within the scope of the SME development BMWi IGF/ ZIM-KF. Since 1998, various different filter test benches have been developed and built jointly or implemented through the supply of components and with consultation by Palas. The more recent test systems, among them the test bench for large compressed air filters which has been reported on at this point several times already and still is being reported on (see below), originated within the scope of the ZF³ (Centre for filtration research and functional surfaces). Within the scope of IGF and other projects, numerous questions were worked on, like for example those concerning the behaviour of vehicle interior filters, the characterisation of filters for heating, ventilation and air-conditioning systems, for cooling lubricant deposition and for detection of fluorescent particles. The latter was implemented for the assessment of particle emission (and/or for the prevention of the same) through safety workbenches. A national and European Patent Application arose from this project (/1/).

Generation of nanoparticles

Nanoparticle aerosol generators for measuring tasks and testing tasks have already been available for some time in the market. Their output capacity lies in the order of magnitude of 5-7 mg/h. For the use of nanoparticles as a catalyst or chemical sensors, for the use in materials for hydrogen storage or electrodes for batteries or fuel cells, however, also for research into atomic clusters or the investigation of their toxicity, there is a need for larger production quantities. Prof. Andreas Schmitt-Ott of the University of Technology of Delft specialises in the spark generation of nanoparticles and explained more recent developments in the context of the EU project BUONAPART-E (Better Upscaling and Optimisation of Nanoparticle and Nanostructure Production by Electrical Discharges), in which he works together with Palas and the IUTA, inter alia. The function principle of electrical discharge is schematically shown in Fig. 1. The spark that originates between two electrodes, on account of the high temperature at this point, leads to the evaporation of electrode material and the vapour is driven from the gap through the accompanying gas stream and condenses to particles in the order of magnitude of a few nm, which, in the further flow course assemble into agglomerates. As materials, in principle all electrically conductive materials are acceptable. Through the use of mixtures of materials as the electrodes (alloyed or sintered, two different electrodes) mixed particles can also be produced. The size of the primary particles is adjusted via the spark energy, the gap width between the electrodes and the inert gas flow rate. If one wants to prevent agglomeration, one must dilute the particle cloud. However, one can also produce spherical particles to 100 nm diameter by aggregation and fusion of the primary particles in a heating track.

The objective of BUONAPART-E were systems for the production of particle volumes in the order of magnitude of 5 kg per day. One increases the production volume by an increase of the repetition frequency of the electric spark per electrode pair and by parallel connection of several electrode pairs. Moreover, the frequency increase has no influence on the resulting particles as long as it is ensured that successive particle clouds do not touch. The repetition frequency could be increased within the scope of the EU project by the factor of a 100. The decisive factor was the development of new electronic switches and appropriate switching circuits.

Analysis of nanoparticle aerosols

As already explained in reports of past ATS, nanoparticles are counted by increasing the particle size by condensation of a working fluid and afterwards supplying them to an optical sensor. Dr. Maximilian Weiß explained the special features of the Palas UF-CPC in comparison to condensation nucleus counters of other manufacturers that consist, in detail, in the feed of the working fluid, the special features of the optical sensor as well as in the volume flow control. The working fluid, Butanol or water, is actively being transported into the saturator via a spiralling U-channel, with other devices, the aerosol flows along a saturated fleece. In the first case, the exchange of the working fluid is simply possible because no residues can remain in the saturator. The optical sensor is operated with a LED as a light source, the measuring volume is limited thus that a single particle counting is possible also at high concentrations. This is not the case with sensors with which the entire aerosol volume passing through a laser light sheet is recorded. Via the variation of the volume flow, the Cut-Off (this is, the diameter with which the countable efficiency amounts to just about still 50%) can be shifted.

Depending on the surface properties of the particles, different particle numbers can be measured. While Butanol condenses on nearly every particle, this is valid with water only in a limited manner, however, this is the more ecologically friendly working means, particularly for application of the measurement technology in interior settings. Depending on particle material, working fluid, the temperatures in the saturator and capacitor and the volume flow, one expects different diameters of the condensed drops and an influence on countable efficiency course and Cut-Off diameter. The experimental determination of these contexts i.e. the thermodynamic characterisation of a condensation nucleus particle counter by Palas, was carried out in a work by Susanne Baltzer at the Institute for Mechanical Process Engineering and Mechanics at the Karlsruhe Institute of Technology. For this, an experimental plant was used, in which a neutralised aerosol generated by a spark generator or an atomizer is classified in a DEMC and is supplied in parallel, either as a mono-or - polydisperse aerosol,

Tab. 1: Examples of the replacement of pathogenic micro organisms by harmless species for test bioaerosols

Pathogene organism	Species/occurence	Model organism	Species/occurence
apergillus flavus, penicillum expansum	mildew/ foodstuff	penicillum roqueforti, penicillum camemberti	mildew/foodstuff (cheese)
cryptococcus neoformans	encapsulated yeast (candida)/forest floor, bird droppings	baker's yeast	yeast/ brewery, bakery
staphylococcus aureus	bacterium/human	staphylococcus xylosus	bacterium/sausages
mugwort pollen or birch pollen	pollen, high allergenic potential	rape pollen, stinging nettle pollen, spruce pollen	pollen, low allergenic potential

Tab. 2: National and European measurement campaigns for the detection of aerosols in ambient air

Acronym	Title	Duration	Details	Further information
UFIPOLNET	Ultrafine particel size distributions in air pollution monitoring networks	December 2004 – March 2008	4 measuring stations in Europe, development of measuring systems (UFP330/TSI3031), SMPS process	
UFIREG	Ultrafine Particles – an evidence based contribution to the development of regional and European environmental and health policy	July 2011 – December 2014	5 measuring stations in Europe, investigation of short term effects of particle size classes on rates of deseases and mortality	www.ufireg-central.eu
GUAN	German Ultrafine Aerosol Network	Since 2008	12 measuring stations, different measuring procedures, inter alia number distributions, soot concentrations and size resolved determination of chemical composition	see /2/ (inter alia)
AirMonTech	Air Pollution Monitoring Technologies for Urban Areas	Dez. 2010 – Mai 2013	EU-FP7-Project (Coordinator: IUTA e.V); brings together informations about currently used measuring systems for air quality monitoring, and formulates requirements for the examination and development of future automatic measuring procedures and monitoring strategies	www.airmontech.eu datanase: http://db-airmontech.jrc.ec.europa.eu

to the CPC and a Faraday cup electrometer. In the tests described by Mrs. Baltzer it was found that the drop diameter increased with increase of the difference in temperature between saturator and capacitor, reduction of the aerosol volume flow and with increase of the aerosol particle diameter in the Cut-Off area. At the same time, the increase of the difference in temperature and the reduction of the volume flow cause a reduction of the Cut-Off diameter i.e. the measuring range is shifted towards smaller particle diameters. An improved chemical compatibility of the material combination particles-working fluid works along the same lines. Overall, such studies allow a better adaptation of the measurement system to certain materials.

Angle-dependent X-ray fluorescence analytics (TXRF) is a measuring method with which one can also determine the chemical composition of substance samples, besides particle size and particle concentration. It was explained by Dr. Stefan Seeger, Federal Institute for Materials Research and Testing, who had further developed this method for automated insitu-characterisation of aerosols, together with the Physikalisch Technische Bundesanstalt and the measurement instrument

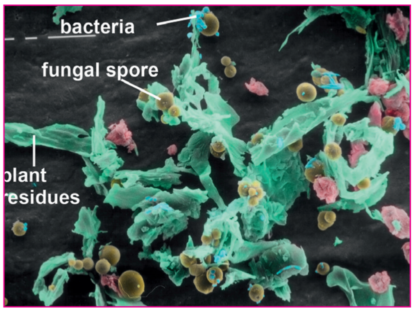

Fig. 3: Post-colorized electron microscope photograph of a native bio-aerosol sample (Image: von-Thünen-Institut, Braunschweig)

manufacturer Bruker. If one irradiates material samples with X-rays, the radiation is reflected with an energy typical for the respective chemical element. By varying the angle of incidence of such a ray gradually in the range below the critical angle of the total reflection, a standing wave field originates (see. Fig. 2). For a particle within this wave field, the course of the excitation intensity over the angle of incidence is dependent on the size i.e. how many antinodes and nodes of the wave "grid" made from strips of high and low radiation intensity are covered by this particle. With the angle scan, one can derive conclusions about the particle size from the steepness of the leading edge and from the position of the first intensity maximum and conclusions about the volume of the detected samples can be drawn from the surface underneath the curve. Since this process is not a method for analysing a particle collective flying past in sampling pipes insitu and in real time, a suitable system was developed with which the sampling on a substrate in which the TXRF method is carried out is automated. Moreover, models had to be developed for the interpretation of the signal courses and be verified on the basis of reference samples collected by impaction. This part of the development was undertaken by PTB and BAM on the measuring station BESSY II of PTB. Bruker was responsible for development of the hardware for a mobile TXRF device for which - beside the components for the actual measurement as previously described - a gas purge for the measurement and a sample changer for a maximum of 96 aerosol samples were provided. Important applications for this measurement technology are the analysis of complicated ambient aerosols and workspace aerosols as are emitted, for example, by laser printers or welding machines.

Supply and analysis of bioaerosols

Bioaerosols contain biological material such as endotoxins, viruses, bacteria, fungal spores, pollen and plant residues and are identified - beside with the parameters also decisive in inorganic aerosols - also by the biological activity of their components. Because biological activity is essential for different questions, bioaerosols often cannot be replaced by inorganic aerosols for research purposes and test purposes. Dr. Marcus Clauß from the Thünen-Institute in Braunschweig deals with the requirements for test bioaerosols, their production and dispersion as well as the applicable measurement technology. One example for a bioaerosol is shown in Fig. 3. Components of bioaerosols for test purposes should have no sensitising or toxic effect, however, they should have similar properties like their pathogenic relatives. Table 1 shows a selection of organisms which would be suitable for this. In addition, processed dust from henhouses is also used.

For the application of the bioaerosols, the tenacity (survival ability) of the organisms is vital. Because these also depend on the measures for cultivation, production of suspensions or piles and for their transportation in the airborne state, these steps must be documented and be carried out according to the standard protocols as far as possible. Brush dosers are in principle also suited for the dispersing, if this concerns dry particulate materials, or compressed air atomizers are suited for the dispersing of suspensions; in the process, however, stress is exercised on the organisms. A more recent development for the nebulization of suspensions is a modified "Bubbling Aerosol Generator", which is described in Simon et al. /2/ . For particle measurement, it is also possible to resort to established methods, wherein the optical particle counting, however, does not detect the individual species. The fastest detection, here, is in the collection on adhesive silicone surfaces and subsequent fluorescence microscopy with which the activity of the cells is detectable in addition.

The measurement of the concentrations of germs in living rooms and in workspaces for risk assessment and verification of the observance of any limit values, according to the statements of Anja Konlechner, University of Agricultural Sciences Vienna, is not as unambiguous as would be necessary. Since one receives, according to collector device and analysis method, different results, whereby the actual particle number cannot be determined because of the unknown device-specific losses, moreover, during the cultivation on a culture medium, only living germs are detected. To be able to compare collector devices with each other a calibrating chamber was designed together with Palas and then built, in which, ideally, a consistent, uniform particle concentration should be present. An aerosol is dosed into the accordingly purified supply

Fig. 4: Octocopter HORUS with a Fidas Ultra-Light Sensor (Image: Palas GmbH)

air, the concentration of which was measured on the inside with particle counters in 3 different heights in nine different positions. For this validation, an inorganic test dust was transferred into the air flow with a brush disperser. The particle concentration in the chamber was not equal in all positions but increased from top to bottom and with increasing distance from the aerosol dispenser, it decreased slightly, while the particle size distribution was the same in all positions. Taking into account these concentration profiles, one still deemed the chamber suitable for comparing germ collection systems. However, for the re-enactment of real bioaerosols, lower number concentrations would have to be generated than is possible with the generators used.

Particle analytics in the ambient air

Dr. Norbert Höfert, Commission on Air Pollution Prevention in the VDI, reported about current developments and open questions of particle measurement in the outside air as well as about current measuring campaigns. While the Directive series VDI 3867 about counting measuring methods was completed in 2013 with the publication of the Folio 6 about the electrical low pressure impactor, the works on the standardization of aerosol generators still continue in the Directive series VDI 3491 (cf. also /3/). However, the technological developments led to the fact that the first folios of the VDI 3867 (from 2008) have become outdated again. Currently, technical specifications for counting measuring methods are being promoted at European level , among the rest, on condensation nucleus counting. To this end, there is already a draft, publication is aimed at for 2014. Such technical specifications define minimum requirements for devices. They have a validity of a few years and can, if necessary, be converted into a European Standard. The development of standards happens in parallel with different national and international measuring campaigns in which the possibilities and the suitability of counting measuring methods are demonstrated for a longer period, and the effects of ultrafine particles are examined (see Table 2). Beside the particle counting, the composition of the particles will also be in the focus in the subsequent programmes.

Not recorded in the table are further local measuring campaigns dealing, for example, with the effect of environmental zones on air quality. New possibilities are also being opened up by unmanned aerial vehicles, which are equipped with measurement sensors. They serve the clarification of the aerosol emissions of certain sources and can elucidate their propagation paths . For this purpose, two aerial vehicles were also demonstrated directly at the conference venue. Firstly, an aerosol sensor was sent into the air, attached to a weather balloon , and the data collected by it could be traced on the screen in the conference room. On the other hand, the drone HORUS from Dresdner AirClip GmbH (see Fig. 4) was demonstrated, an ultralight, remotely controlled element made of carbon fibre composite material, which, according to load capacity, is built as quadrocopter, octocopter or dodecacopter.

As a complete system for particle counting with recording of all size fractions occurring in the outside air or even indoors from 8nm to 40 µm, Jürgen Spielvogel, Palas GmbH, presented the system U-Range. In this system, the two equipment units U-SMPS with DEMC-size grader and the condensation nucleus counter are combined with the fine dust measurement system Fidas. In each of the 3.5 decades, up to 64 size channels can be resolved, moreover, the classical PM fractions can be detected in addition.

Limit values for the fine dust pollution in the ambient air are still considered as mass concentrations and in spite of all

Fig. 5a) Test bench MMTC 200 for cleanable filter media, horizontal raw gas conduit (Image: Palas GmbH)

Fig. 5b) Test bench MMTC 3000 for cleanable filter media, vertical raw gas conduit (Image: Palas GmbH)

progress in the development of counting methods, the particle concentration in the many environmental monitoring stations is always also detected gravimetrically. For the practical execution in the state of Baden-Württemberg , this means that, in more than 50 measuring stations of the State measurement network, filters have to be collected daily and be equilibrated in the laboratory according to a routine required by the prEN12341 2012-02-10 (setting of rel. humidity and temperature) and they also must be weighed. Dr. Harald Creutznacher of the responsible State Environmental Agency pointed out the increase of the samples to be evaluated, to nearly 35,000 by 2011. To tackle them, an automatic weighing system was purchased and commissioned, with which 320 filters can be weighed successively on 20 plates and a total of 640 filters can be equilibrated at the same time. Every individual filter is automatically encoded so that it is assigned to a date and measuring station. By manual and automatic parallel weighings, it was shown that the failure rate of the machine with about 2%, by faulty coding / detection, is slight and that these errors can be avoided through plausibility checks by the laboratory staff.

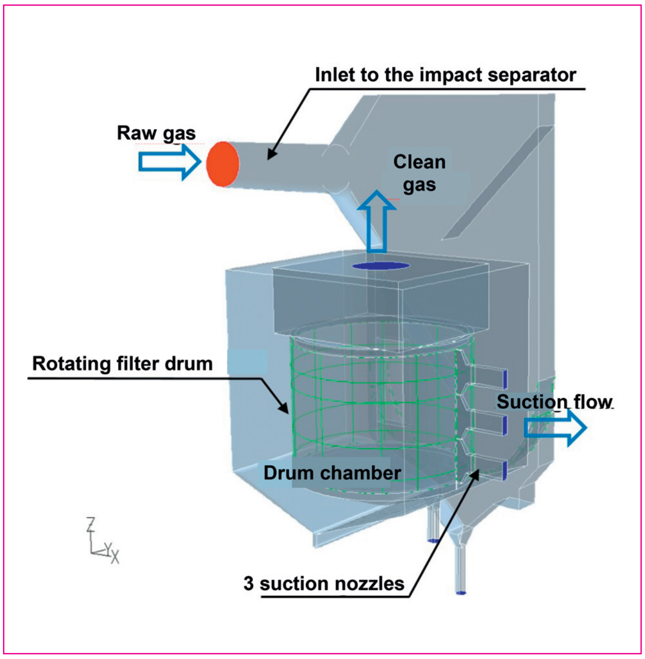

Fig. 6: Schematic diagram of drum filter (Image: Institute of Process Engineering, Environmental Technology and Technical Biosciences of the Vienna University of Technology)

Anja Baum of the Federal Highway Research Institute reported about a special application case of the pollutant detection and measurement in ambient air. The object of the investigation was the length-dependent aerosol composition in road tunnels. The measurements were carried out with the background that later on, interior walls or internal fittings provided with TiO_2- nanoparticles would be able to be implemented, through which, under the effect of a suitable light source, the catalytic degradation of the nitrogen oxides emitted by motor vehicles can be effected. As a preparation for this, the pollutant distribution was determined in the Rudower Höhe tunnel in Berlin, using an especially developed robot. This is a remotely steerable vehicle which is equipped with an aerosol collecting system and can take up different 19‘- measuring instruments. The first measurements showed that the nitric oxide concentration throughout the tunnel length increases by a factor of up

Fig. 7: Drum filter test bench at the Institute of Process Engineering, Environmental Technology and Technical Biosciences of the Vienna University of Technology

to 15, while the particle concentration increases by a factor of 11, however, for particles > 1µm more prominently than for smaller ones.

Systems and examples for filter testing

The testing of filter media and complete filters according to the standards applying for the respective product groups is implemented in different filter media test systems and filter test systems. Martin Schmidt, Palas, presented the individual versions and reported about new developments. As an example of the change of filter media testing with a changing standard, testing cleanable filter media may be mentioned. VDI Directive 3926 describes two test bench models, one each with horizontal and vertical raw gas conduit (cf. fig. 5a) and b)). The DIN ISO 11057, applying since 2011, describes the test bench with vertical raw gas conduit as a reference system, other measuring methods not explicitly excluded, however, they must fulfil equivalence criteria. In an especially designed test bench MMTC 3000 with two raw gas conduits, the differences are being examined together with Saxony Textile Research Institute (STFI) within the scope of a ZIM project.

Another new development is a small compressed air filter test bench, the only measuring station where particle sizes and numbers can be measured at a pressure of up to 7 bar. Besides finished compressed air filters, flat media, such as they as used in compressed air filters, can also be tested.

The small compressed air filter test system is constructed analogously to the large measurement path at the IUTA, on which Dr. Wolfgang Mölter-Siemens has been conducting research on large compressed air filters for some years. The object of the tests described here was the temperature influence on the filtration properties. The biggest part of the particles deposited are oil droplets collecting in the filter medium, which are discharged into a reservoir through a drainage layer. Because the viscosity of certain oils, with the temperature change by 30 – 40 K, changes by one order of magnitude and the surface tension also drops clearly, a significant temperature influence was expected. The temperature dependence of the filtration properties was determined with immersion -saturated or aerosol-saturated filters with in each case fluctuating or steady temperature. It was found that the pressure loss of the filters correlated with the saturation degree and accordingly is not dependent on temperature, however, that the aerosol concentration in the pure gas behind a saturated filter increases with temperature, something that one attributes to reentrainment (detachment and entrainment of already separated oil).

Dr. Frank Schmidt, University of Duisburg-Essen spoke on the influence of the relative humidity and the discrepancy between the filtration output of room air filters or vehicle-interior filters if they are tested at low (according to standard) or high relative humidity. The fact that high relative humidities significantly increase the pressure loss in the case of NaCl as a loading aerosol, the application of water droplets causes an extreme increase of the pressure loss and also the detachment of already deposited particles, has already been published in /5,6/. On account of these preliminary experiments, a new research project will start in 2014, which deals with the filtration behaviour of gas turbine filters for offshore operation.

Gas turbine filters must demonstrate high filtration and separation efficiencies, even in harsh surroundings. The proof of the filter quality is provided according to the Saudi Aramco Standard “32-SAMSS-008”. Dr. Dirk Renschen reported about construction and commissioning of such a filter test bench. The details are published here on pages 85 - 88.

Detecting the fading behaviour of an aerosol in an indoor space caused by a indoor air cleaner is to be regarded in principle as a filter test, too. Such indoor air cleaner are used, for example, in China for the reduction of exposure to both particles and gaseous air pollutants in indoor spaces. Hartmut Finger, IUTA, conducted the testing according to the Chinese standard GB/T 18801-2008, and used cigarette smoke as a test aerosol. The particle concentration in the test chamber decays exponentially and the fading coefficient, with air cleaner in operation, as expected, is higher than the natural the fading coefficient (natural decrease of particles or adhering to walls). For an indoor air filter equipped with a certain filter, the generateable clean air volume flow CADR (for: clean air delivery rate) is measured, into which the fading coefficient and the volume of the test room are integrated. These coefficients and hence also the CADR value can also be determined separately for certain particle size fractions . With respect to the electrical output of the device, its cleansing performance arises from this as a quality feature for comparing different devices.

Development of filter media and filters

For the application of filter media, not only pressure loss and separation efficiencies play a role but also the operational safety. Thorsten Stoffel, Gea Heat Exchangers, described the disastrous consequences of flying sparks, as arises, for example, when welding, for filter systems. Synthetic standard filter media are considered to be highly flammable construction materials and conventional flame retardant equipment is often toxic. With GEAFireTex, he presented a new filter medium that has been classified into class B1according to a fire shaft test pursuant to DIN 4102-1:1998-05 (Standard for the fire behaviour of building materials). This classifies the medium as flame retardant, that is the material does not burn completely after edge ignition and no burning ingredients will drip or fall off. According to the DIN 5510-2-2009-5 for preventive fire protection in railway vehicles, the material is characterized with the flammability class S4, the drop forming capacity class ST2 and the smoke development class SR2. In addition, the FireTex®- filter mats have been certified according to the latest standard EN 45545-2:2013-08 (fire protection of railway vehicles) in accordance with requirements set R5 category “HL3”and therefore suitable without restriction, according to the latest standard, for air conditioning systems of railway wagons. The requirements made there are even clearly undercut.

Johannes Wolfslehner, Vienna University of Technology, described his works on the modification of a drum filter for dust separation. The function principle of such a filter, which is used particularly in the textile industry and tobacco industry for high volume flows with low concentration of fibrous dusts, is evident from Fig. 6. In its original design with flat sheet filter media with high air permeability, the deposition of nanoparticles is not sufficient. Therefore, filtration experiments with pleated filter media -which have lower air permeability, however, higher separation efficiencies of nanoparticles - were carried out on the test bench shown in Fig. 7. As filter media , one medium with aluminium fibre web and one medium with ePTFE membrane were selected. Because of the clearly bigger filter area, the filter face velocity could be reduced so that the same pressure loss level could be kept as with a flat sheet medium. Here, the biggest challenge arose in the implementation of the cleaning through the externally mounted extraction nozzles. This was reflected in the substantial increase of the residual pressure loss causes by insufficient cleaning in the pleated depths. Here, measures are planned for the adaptation of the nozzle geometry and the cleansing strategy.

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Energy-efficient generation and treatment of compressed air

Report from COMVAC 2013

H. Lyko*

As an international, leading trade fair for compressed air and vacuum technology, ComVac has been an independent part of the Hanover Trade Fair since 2005. Both compressed air and vacuum technology are technologies in which energy and resource efficiency are an important trend, and one that is crucial in competition. This is partly because, for example, the use of compressed air is indispensable in almost any industrial plant.

The VDMA Blue Competence sustainability initiative is also considering the trend towards the increase of energy and resource efficiency of this technology. The VDMA Association Compressors, Compressed Air and Vacuum Technology, as conceptual sponsor of the trade fair, supports users in this area, among others, with tools such as the EcoLexikon and the Compressed air model computer. The EcoLexikon offers an informal introduction to the comprehensive operation of compressed air and vacuum technology to the users. With the interactive Compressed air model computer, the energy consumption and saving potentials of a compressed air system are determined. A large number of components illustrated, especially compressors, but also filters and other processing equipment units, should conform to the requirements of greater efficiency and sustainability. Improved Process Control and Instrumentation also make their contributions.

Compressed air qualities

Since 2010, the new version of ISO 8573-1 is valid, in which the quality classes are defined for compressed air, namely separately for contaminants particles, water (vapour) and oil (vapour). Accordingly, the quality classes are also specified as the combination of three digits (2.3.1 means: Class 2 for particulate pollution, Class 3 for humidity and Class 1 for oil). In comparison to the previously applicable version ISO 8573-1:2001 (see /1/), it is noticeable that the limit values for particles in Classes 1 - 5 have not fallen, but risen. This development is contrary to the experience often observed that newer standards also include stricter limit values according to the technological advancement of components and test instruments. In the new standard, on the other hand, more stringent requirements without general specification are categorized in Class 0. As the enterprise Parker Domnick Hunter advises in a brochure, the requirements for Class 0 must be defined in writing between the operator and device manufacturer. Moreover, they must be verifiable with the test methods or measurement methods described in Parts 2 to 9 of ISO 8573. This will provide users with high quality standards the possibility of getting compressed air quality tailor-made for their application.

The compressed air quality classes > 5 (apart from humidity) are rather uninteresting in view of the application of treatment techniques, and they are not to be found in more demanding applications. Table 2 gives an overview of which quality classes are possible for what kind of application, namely as is communicated by Omega Air GmbH in Moers.

To give consumers of compressed air a possible orientation about the qualities required for their applications, at the VDMA they are currently working on the creation of a new Standards Sheet /3/, in which, on the basis of the revised ISO 8573-1:2010, typical compressed air qualities for different uses are indicated, as well as measures to achieve these qualities, to monitor them and to uphold them by means of maintenance works. In addition, attention is paid to energy efficiency.

Efficiency of compressed air systems

On average, an efficiency increase of 33% and an effectiveness increase of 25% are considered feasible for industrial com-

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