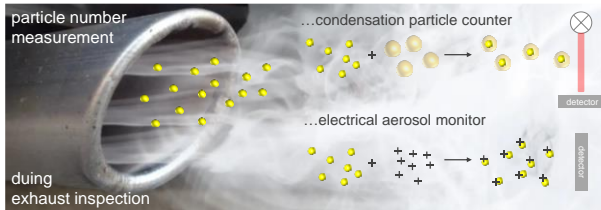


Calibration of particle counting devices

reference aerosol



New version of the "AU-Geräte Kalibrierrichtlinie" (German exhaust emission test equipment calibration guideline) defines requirements for the calibration and validation of particle measurement devices, which are used in the exhaust emission test of motor vehicles for:

- periodical technical inspection (PTI) as well as
- portable emission measurement system (PEMS).

However, one objective is to regularly check the number concentration measuring devices in the field using suitable reference aerosols and measuring devices.

Requirements for reference aerosols

- monomodal, polydisperse ($1,5 < GSD < 2,0$) size distribution with defined mean particle size
DE: (70 ± 20) nm; NL: (80 ± 4) nm
- adjustable particle number concentration between 0 - 1 000 000 #/cm³.

device implementation

The solutions of Topas GmbH for the generation of the reference aerosols vary in terms of:

- scope of application: stationary vs. mobile
- required resources
- handling
- acquisition costs

Major components for the aerosol delivery are: aerosol generator, dryer, particle-free air supply.

The aerosol substance used is a commercially available low-concentration (0.9% wt-%) sodium chloride solution (NaCl).

Aerosol generation

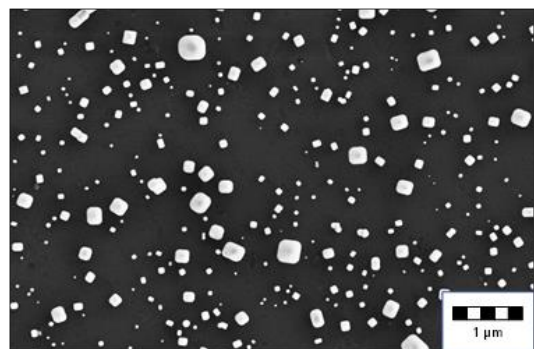
With regard to aerosol generation, the user can choose between an aerosol generator from the ATM series and a system solution that provides the already conditioned aerosol.

Unconditioned aerosols – primary aerosol

- pressurised air supply, uncontrolled:
[ATM 220](#), [ATM 221](#)
- pressurised air supply, controlled:
[ATM 222](#) (stable aerosol production rate)
- internal pressurised air supply:
[ATM 228/L](#) (mobile use)

Conditioned aerosols – reference aerosol

- internal pressurised air supply, uncontrolled; internal drying, transport air supply, sample splitting and sampling ports
[FCS 249](#) (completely dried particles, highly user-friendly)



Scanning electron microscope image of electrostatically precipitated test aerosol particles generated by FCS 249 with commercial isotonic saline solution (0.9 wt.-% NaCl). Particles are completely dried when a relative humidity $\leq 50\%$ is ensured.



Specifications

Aerosol drying

Non-conditioned aerosols must be dried in a next step. Instrument calibration using droplet aerosol is not permissible.

The technical implementation of low-loss drying with sufficient operating time is carried out by a diffusion dryer (DDU 570/L or DDU 570/H). Coloured silica gel is used as adsorbent due to its high water absorption capacity.

Particle-free support air (transport air)

However, the number of measuring devices to be tested in parallel determines the total sample volume flow required. In addition to the particle-carrying volume flow of the aerosol generator, an additional particle-free support air is required so that a sufficient volume flow for the sampling is ensured. Furthermore, the support air is used to adjust the particle concentration of the aerosol. The user is responsible for implementing a tailored solution.

Sample splitting and sampling

The sample splitting shall be done so that all measuring instruments are exposed equally to the generated reference aerosol. Aerosol specifications must not be influenced by this step. Additionally, atmospherically decoupled sampling is recommended. The user is responsible for finding a practical solution.

Generator vs. system solution

The benefits for the user of an ATM series generator are the low acquisition costs and the many degrees of freedom. Challenging are the high optimisation efforts regarding particle size adjustment and aerosol conditioning as well as the necessary validation of the entire system.

The system solution ([Field Calibration System FCS 249](#)) combines all individual process steps (aerosol generation and drying; generation of particle-free support air; sample splitting and sampling) in one mobile and compact device (11 kg). The effort required by the user for aerosol conditioning and particle size adjustment is minimised to the selection of the desired particle size and concentration via touch display.



Solution approaches: ATM series aerosol generators and FCS 249 system solution.

The following overview summarises the functions of the individual devices presented.

device	generation		conditioning					
	pressurized air (external)	pressurized air (internal)	control	mobile	drying	transport air	sample splitting	sampling
ATM 220	✓	✗	✗	✗	✗	✗	✗	✗
ATM 221	✓	✗	✓	✗	✗	✗	✗	✗
ATM 222	✓	✗	✓	✗	✗	✗	✗	✗
ATM 228/L	✗	✓	✓	✓	✗	✗	✗	✗
DDU 570	✗	✗	✗	✗	✓	✗	✗	✗
FCS 249	✗	✓	✓	✓	✓	✓	✓	✓

References

- Giechaskiel B. and Melas A. (2022) Comparison of Particle Sizers and Counters with Soot-like, Salt, and Silver Particles. *Atmosphere*. 13, 1675. doi:10.3390/atmos13101675
- Giechaskiel B. and Melas A. (2022) Impact of Material on Response and Calibration of Particle Number Systems. *Atmosphere*. 13, 1770. doi:10.3390/atmos13111770

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PARTICLE UNDER CONTROL