

Custom-made real combustion aerosols

A brand-new soot generator generates defined particle sizes over a large concentration range – individually adjustable depending upon measuring task

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Well proven: PALAS® aerosol generators

For already 20 years, the PALAS® GmbH has produced and sold aerosol generators for the generation of artificial soot particles, e.g. the GFG-1000 according to VDI 3491 sheet 15, which is used worldwide with success for inhalation tests and for the calibration of particle measuring devices.

However, it has not been possible so far to generate real combustion soot particles in small fractions and respectively in variably adjustable particle size ranges and concentrations.

That's why PALAS® now provides the new Variable Soot Generator family VSG in licence DLR Stuttgart. This generator family offers previously unrivalled new possibilities and advantages.

Applications for defined soot particles

For numerous measuring tasks diesel-soot-similar particles are needed – depending upon application in different concentrations and of different particle sizes, e.g. for

- Calibration of particle measuring devices
- Test of diesel soot filters
- Test of soot filter media
- Test of fire detectors
- Atmospheric research
- Inhalation tests

All soot aerosols used for these applications must be able to be generated accurately and reliably in the respectively necessary specific particle concentrations and size distributions. The new VSG family fulfils all these requirements and therefore offers the optimal solution for these applications.

Advantages of the new VSG family

The new Variable Soot Generator family VSG generates real soot particles in a combustion process according to a newly developed operation principle.

One can adjust exactly defined different particle size ranges and concentrations. With a high maximum mass flow of > 2,2 g/h, the VSG-3000 is optimally applicable e.g. for diesel soot filter tests. The VSG-3010-C, with a small mass flow, is optimally suitable for the reliable calibration of measuring instruments.

The generator is characterised by a high stability of the particle sizes and concentrations which are guaranteed by the defined fuel gas premixed with air.

The generation of the defined test aerosols cannot be impaired by external temperature alteration and air pressure alteration due to the fact that the VSG is not operated with a classical diffusion flame.

The simple and robust set-up of the generator guarantees a good reproducibility.

With the VSG family, particularly reliable and cost-effective tests and measurements are possible.

Adjustment of particle size and mass flow

The particle size and the particle quantity depend on the mixture ratio of the fuel gas and on the diameter of the burner. The higher the concentration of the ethene gas in the ethene-air-mixture, the more soot is generated during the combustion process and the larger are the generated particles.

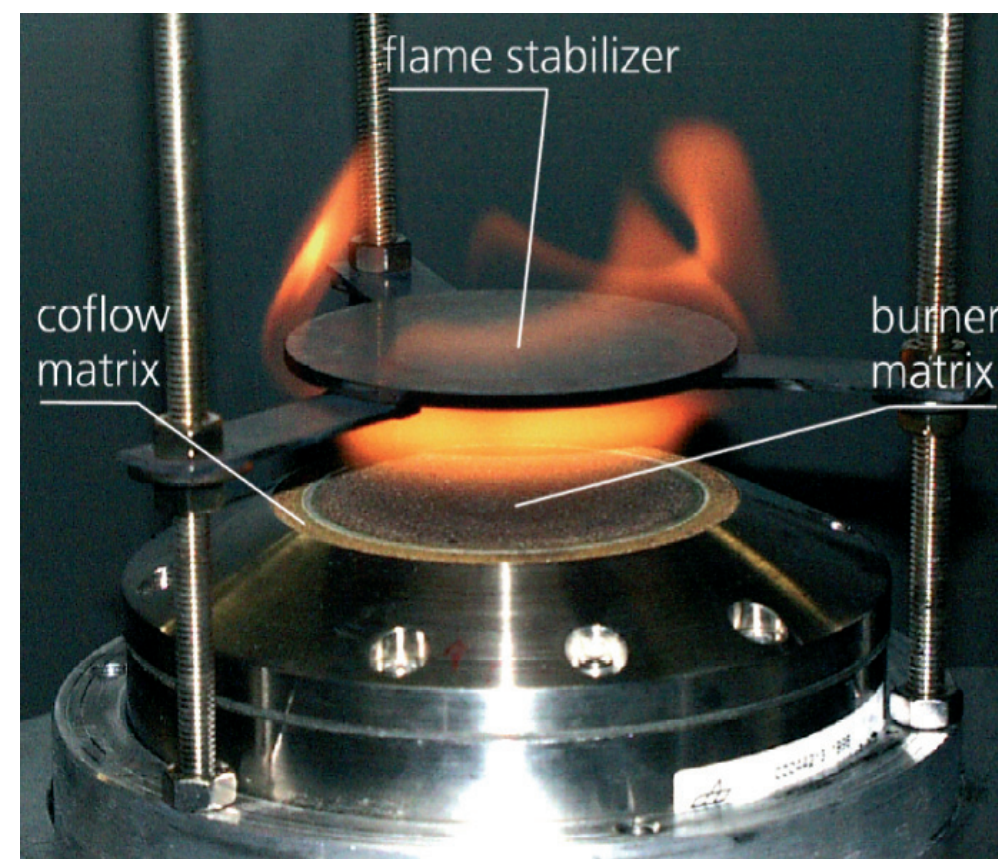
The VSG is available with three different burner sizes*:

- Version A: burner diameter 80 mm
- Version B: burner diameter 60 mm
- Version C: burner diameter 20 mm

* other sizes on request

NEW: Variable Soot Generator family VSG

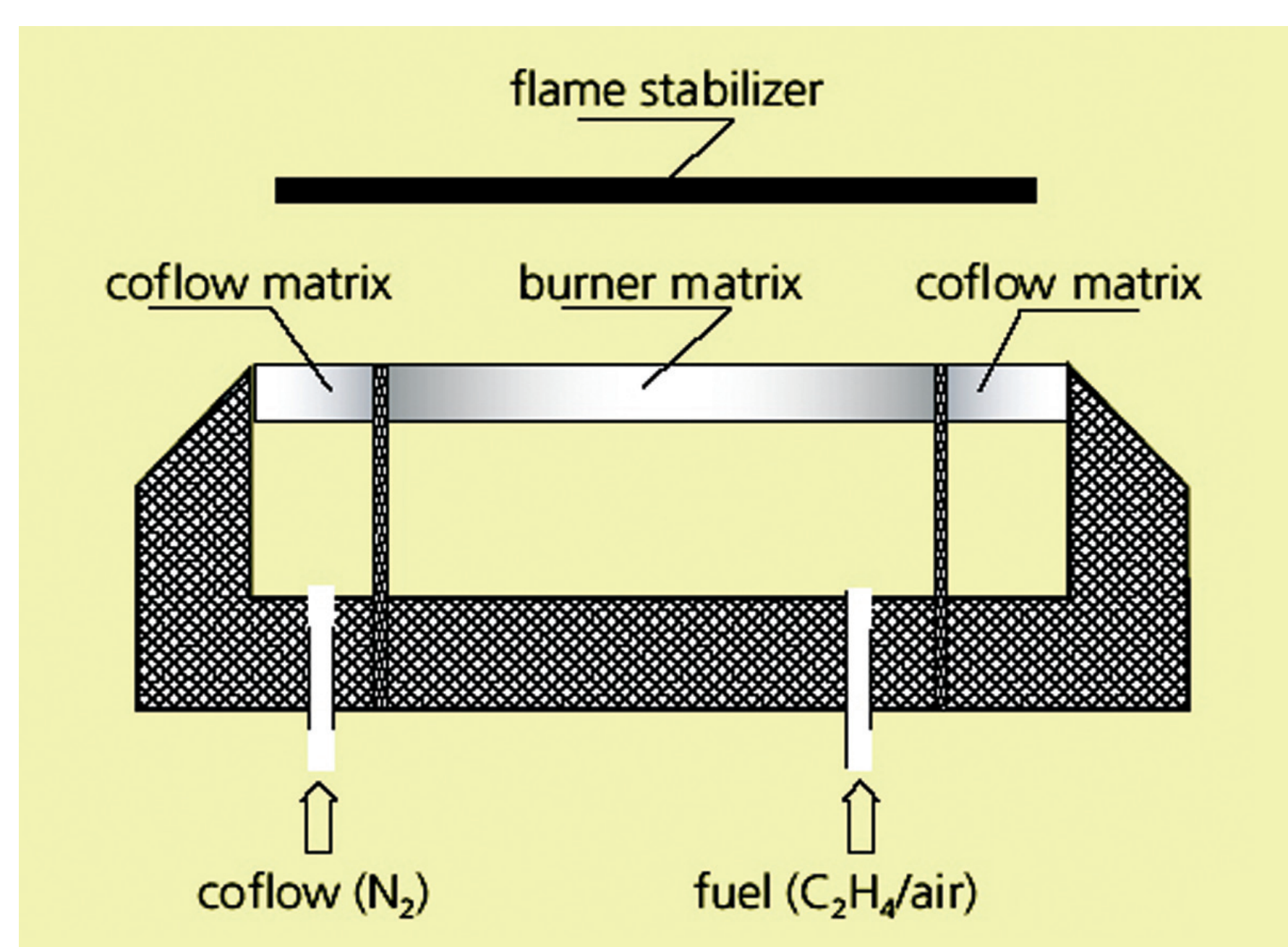
For the generation of defined combustion soot particles in the nanometer range



- in variably adjustable particle size ranges
- also in high mass flows
- ideal for filter tests and for the validation of measuring systems

Fig. 1

Function principle of the Variable Soot Generator family VSG



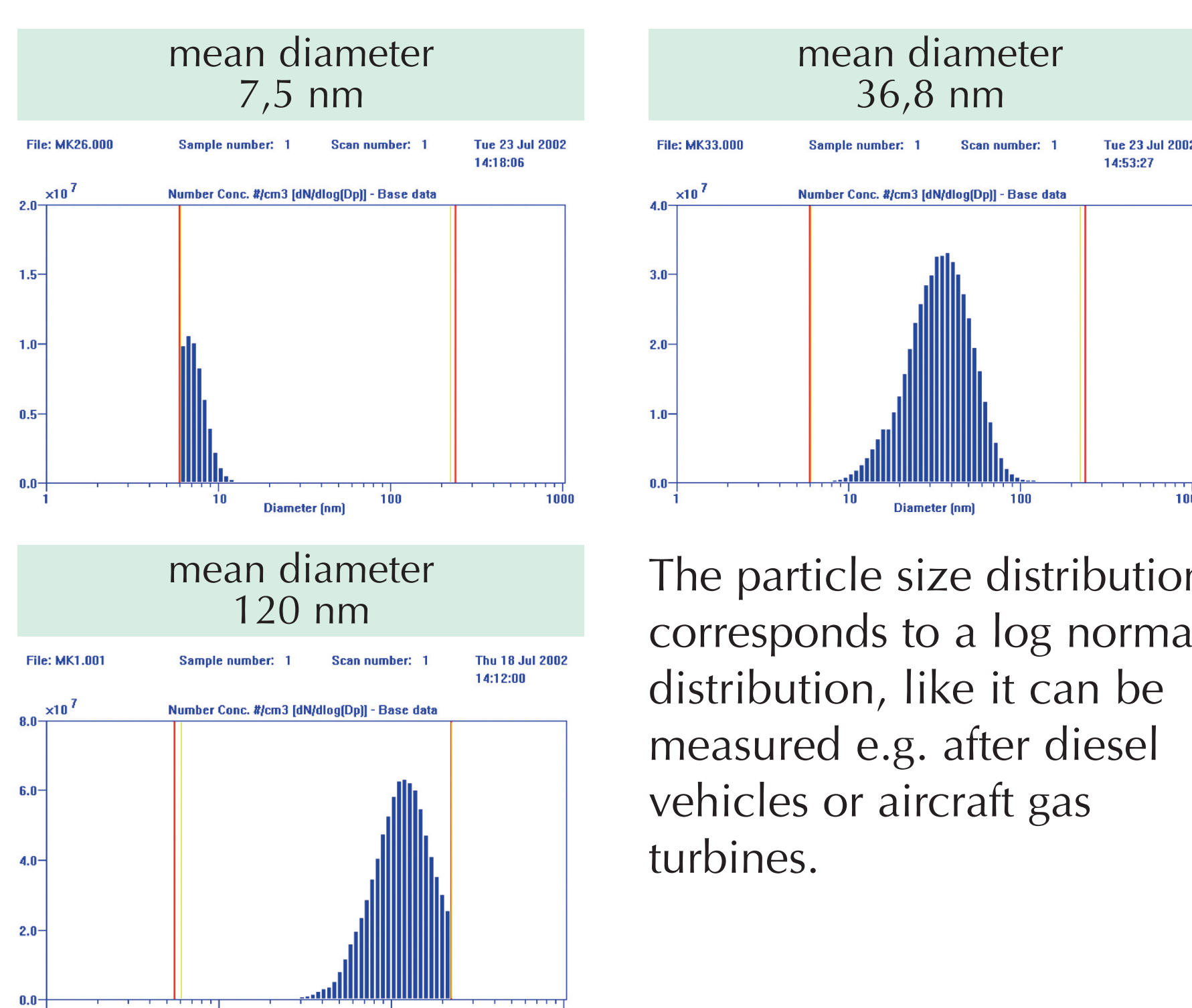
Changing the set-up of the generator around the burner as well as the diameter of the burner gives the possibility to cover the specifications from many different applications concerning particle size and concentration. Mass flows from a few nanograms up to more than 2.5 g/h can be achieved easily in the different versions.

Flame-soot is formed in fuel rich zones of a flame. In a diffusion flame, the "two dimensional" flame-front is very thin and the local air-fuel mixtures vary from full-lean to full-rich! But soot formation is strongly influenced by the air-fuel mixture!

Therefore, the new developed soot generator works with a premixed flame. Compared to a diffusion flame, the premixed flame has a well defined air-fuel mixture and a "three dimensional" flame-volume.

The great advantage is that the premixed flame is less influenced by ambient conditions, as e.g. temperature and ambient pressure, and allows an extremely stable soot generation concerning particle size and concentration. This leads to the possibility to adjust the mean particle size distribution, generated in the flame, just by changing the fuel-air mixture.

Typical particle size distributions at different mixture ratios of the fuel gas



The particle size distribution corresponds to a log normal distribution, like it can be measured e.g. after diesel vehicles or aircraft gas turbines.

Successfully used in practice: VSG-3000-S

- with dilution system
- $\dot{V}_{\max} = 60 \text{ Nm}^3/\text{h}$



Fig. 2

Already used in practice to the full satisfaction of the customer is the version VSG-3000-S. It is a fully automated test generator which enables a large variety of different settings:

- Particle sizes from 50 nm up to more than 200 nm
- Mass concentration from 100 mg/h up to 2.5 g/h
- Variable output temperature up to 300° C
- Adjustable volume flow up to 60 m³/h

VSG-3000-S: Technical Data

Soot mass and particle size depend on the respective ethene-air-mixture ratio in the fuel gas.

Burner diameter: 60 mm

The tabular values were measured at the outlet of the dilution tube (→ see Fig. 2) with a diameter of 30 mm, at a volume flow of 60 m³/h.

Correlation between soot mass and particle size

mass flow [mg/h]	mean geometric diameter [nm]*	geometric standard deviation*
94.7	49.47	1.86
107.4	75.76	1.72
292.4	99.20	1.75
462.3	120	1.76
889.6	152	1.71
1348.7	171	1.71
2206.4	184	1.66

* measured with SMPS

Soot particle diameter:	variably adjustable from approx. 5 nm up to > 200 nm
Burner:	Coflow Matrix burner
Fuel:	premixed ethene (C ₂ H ₄)/air
Admixture:	nitrogen
Pressure:	outside air pressure
Mass flow:	adjustable; maximum adjustable mass flow $\dot{m}_{\max}$ = approx. 2.5 g/h

Brand-new version: VSG-3010-C

A brand-new version of the VSG-series, small and comparably very economical, has been already developed. The version VSG-3010-C is especially made for calibration of measurement devices, as e.g.

- CPC-counters,
- SMPS-systems and
- Differential Mobility Analysers
- and for testing the fractional efficiency of small filters and filter media.



Both versions use the advantages of the burner principle, the well defined aerosol generation and high reproducibility to generate soot particles with mean diameters of e.g. 7.5 nm up to 150 nm. The particle size distribution is a log-normal distribution.

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