

AVL 



AVL Smoke Meter

Smoke measurement at its best

Smoke Measurement – Proved and Tested

Increasingly stringent emission regulations for combustion engines are the main drivers for high-performance emission measurement instruments. For some applications, such as durability tests, reliability and robustness are important factors.

In engines with exhaust aftertreatment systems, the high pressures and temperatures at the exhaust sampling point combined with high emission rates pose a real measuring challenge. Furthermore, engines emit hardly any soot after reducing the exhaust emissions with a diesel particulate filter system, which also requires a very low detection limit as well as a high accuracy for the soot measurement equipment.

The total cost of ownership also plays a crucial role. The Smoke Meter meets many essential factors to minimize operating costs, such as short service times, easy integration into the testbed automation system, short training periods thanks to its intuitive operation and remote maintenance options.

YOUR BENEFITS

- High measurement resolution (0.001 FSN or $10 \mu\text{g}/\text{m}^3$) and low detection limit (0.002 FSN or $20 \mu\text{g}/\text{m}^3$)
- Timely paper change due to remaining filter paper indicator
- Altitude measurements up to 5,000 m above sea level and altitude simulation up to 5,000 m
- High reproducibility, improved cleaning efficiency and increased robustness against wet exhaust gas thanks to compressed air purging of the gas path – option
- Extended application range up to 3 bar exhaust back pressure for engines with exhaust aftertreatment systems – option
- Remote-control service with intuitive user interface



FIELD OF APPLICATION

The AVL Smoke Meter uses the filter paper method and measures the soot concentration in the exhaust gas of diesel and GDI engines. The variable sampling volume and thermal conditioning of the exhaust gas ensures an extremely high reproducibility and a wide range of applications.

This innovative device can measure emissions in both large and heavy-duty engines as well as in smaller engines installed in passenger cars. The main application areas are combustion optimization on prototype engines and emission monitoring up to the start of series production and thereafter. In addition, soot concentration measurements in raw exhaust (e.g. upstream a DPF) as well as black carbon (BC) mass concentration measurements in line with ISO 8178-3 standards or measurements up to 5,000 m altitude can be performed by using device options.

MEASUREMENTS OF HIGH AND LOW SOOT CONCENTRATIONS

Particulate filters are commonly used in diesel engines. To determine their efficiency or detect any malfunctions, diesel exhaust is sampled and analyzed upstream and downstream of the DPF. Only one AVL Smoke Meter is needed to perform this measurement task. The use of two sample lines makes it possible to switch between two different sampling points.

This measurement can be carried out in two ways:

- The special sampling option is used for exhaust back pressures of up to +750 mbar and low pressures down to -200 mbar relative to ambient pressure. Exhaust gas is sampled upstream of the DPF and the cleaned sample is returned to the DPF free from particulates
- The high-pressure option reduces exhaust back pressures of up to 3,000 mbar relative to ambient pressure. The pressure is reduced via an orifice and the excess exhaust gas is blown off

MEASUREMENTS WITH HIGH REPRODUCIBILITY

Additional injections in exhaust aftertreatment systems, which are used to clean and burn out the particulate filter, often cause heavy contamination inside the exhaust measurement equipment. In order to prevent this, the AVL Smoke Meter can be equipped with a shop air purge option. It purges the entire gas path with compressed air from the inlet to the measurement

block and back to the sampling probe. The higher pressure compared to purging with the diaphragm pump has the key advantage of reducing particulate deposits in the device and in the sample lines. Therefore, purging with compressed air ensures a higher reproducibility of the measured values and reduces hang-up effects.

REMAINING PAPER INDICATOR FOR SEAMLESS OPERATION

By default, the AVL Smoke Meter is equipped with a remaining filter paper indicator on the front of the housing. The LED is clearly visible from the outside and indicates when the paper supply is low, making it easy to tell whether the paper roll should be replaced, for example before starting a durability test. The remaining paper quantity can also be queried numerically with AK commands on the testbed PC.



Inside view of the
AVL Smoke Meter
415SE

ALTITUDE SIMULATIONS AND ALTITUDE MEASUREMENTS

The AVL Smoke Meter also enables altitude simulations using low pressure in the exhaust gas system and measurements up to 5,000 m above sea level. For low-pressure simulations the simulated pressure in the exhaust gas system can be entered via software, while an integrated absolute pressure sensor takes over this task in real altitude measurements.

OPERATION AND AUTOMATION

By default, the AVL Smoke Meter is operated via the harmonized AVL Device Center™ software. The user interface is loaded with a browser via the Ethernet interface. Thus, the device can be accessed at any time via LAN, which enables remote diagnostics, for example for parameterization or servicing in case of a failure. The instrument can be integrated into an automation system via AK protocol.

REDUCED SERVICE TIME

The device is designed to allow fast and easy access to important components. For example, plug-in pressure sensors drastically reduce the service time once they need to be replaced.

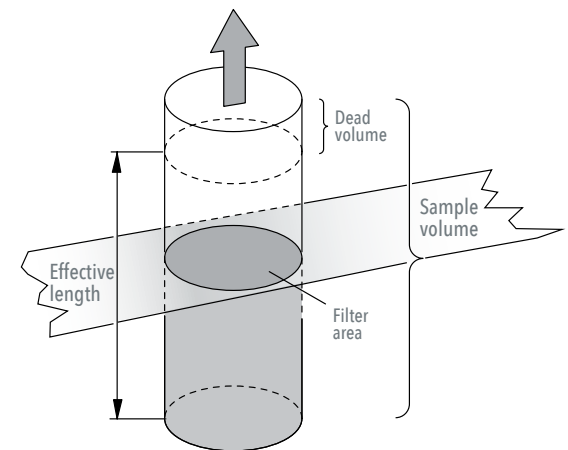
MEASURING PRINCIPLE

The AVL Smoke Meter uses the filter paper method to determine the Filter Smoke Number (FSN defined according to ISO 10054) and the soot concentration in mg/m³. A variable, but exactly defined sampling volume is sampled from the engine exhaust pipe and passed through clean filter paper inside the device. The filtered soot causes a blackening of the filter paper, which is measured by a photoelectric measuring head and evaluated in a microprocessor. The determined value is the Filter Smoke Number. AVL Smoke Meter measurements show excellent repeatability and reproducibility thanks to the possibility of adjusting the sample volume either manually or automatically. The proper pre-selection of the sample volume enables the measuring of low soot concentrations, e.g. on modern GDI engines, as well as of high soot concentrations with high exhaust back pressures and temperatures, e.g. upstream of a diesel particulate filter.



AVL Smoke Meter connections

Measuring Principle



$$\text{Effective length} = \frac{\text{Sample volume} - \text{Dead volume} - \text{Leak volume}}{\text{Filter area}}$$

OPTIONS AND ACCESSORIES

- Two-channel option for two-channel measurements, e.g. upstream and downstream of DPF
- Heater option for heating base unit and sampling line to avoid condensate formation and increase reproducibility
- Special sampling option for measurements at exhaust back pressures up to +750 mbar and low pressures down to -200 mbar relative to ambient pressure
- High-pressure option for exhaust back pressures up to 3 bars
- Shop air purge option for measurements of high soot concentrations and very wet exhaust gas
- Sample lines with different lengths (heated and unheated)
- Volume tester for volume calibration
- Reflectance standards for calibrating the optical measuring head
- Height-adjustable instrument carrier or wall-mounting frame

TECHNICAL DATA

Measurement principle	Measurement of filter paper blackening
Measured value output	FSN (filter smoke number), mg/m ³ (soot concentration)
Measurement range	0 to 10 FSN
Detection limit	0,002 FSN or ~ 0,02 mg/m ³
Exhaust pressure ranges	(-300*)-100 to +400 mbar (-500*)-200 to +750 mbar with the special sampling option 0 to +3,000 mbar with the high-pressure option
Maximum exhaust temperature	600 °C with standard 340 mm sample probe (800 °C with 780 mm long sample probe)
Interfaces	2 × RS232 with AK protocol TCP/IP with AK protocol Digital IN / OUT Analog IN / OUT
Power supply	100-115 VAC or 230 VAC, 50/60 Hz
Power consumption	700 VA (heated version)
Compressed air (option)	~ 150 l/min during purge
Compressed air quality required	Grades 1.1.1 to 1.4.1 according to ISO 8573.1:2001(E) Recommended connection pressure on the AVL Smoke Meter: 5 to 8 bars at the measurement device input
Weight	< 40 kg
Dimensions (w × h × d)	560 × 620 × 300 mm
Sample flow	~ 10 l/min
Ambient conditions	5 to 55 °C / max. 95 % relative humidity (non-condensing) Altitudes between -500 and +5,000 m above sea level
Repeatability	Standard deviation $1 \sigma \leq \pm (0,005 \text{ FSN} + 3\% \text{ of the measured value @ 10 sec intake time})$

*) with activated altitude simulation

