Dekati has over 25 years of experience in providing PM measurement solutions for stack emission measurements. Our measurement solutions are used in a wide range of applications from household small-scale combustion units to industrial power plants and beyond. Complete measurement solutions are available for the whole PM emission spectrum from high concentrations typically associated with combustion of solid fuels to low emissions typically associated with combustion of liquid or gaseous fuels. In addition to regular power and/or heat generation units, Dekati® Solutions are used in cement and steel industry stacks. TSP, PM10, PM2.5, PM1 and ultrafine fractions can be assessed as a gravimetric batch measurement or as a second-by-second real-time measurement.

Dekati® Emission Measurement Solutions

- PM10, PM2.5, PM1.0 and particle number concentration measurements
- Total concentration and detailed size distribution measurements
- Options for real-time monitoring and gravimetric measurements
- Measurements according to ISO23210 standard
- Laboratory-grade instrumentation designed for field work
- Complete setups available for a range of measurement needs and sources
- Measured PM result always independent of PM optical properties (unlike optical CEMs)
Particle mass concentration and size distributions from a modern coal fired power plant after flue gas treatment devices are shown in figures above. The peaks are caused by the cyclical flue gas cleaning system operations such as baghouse cleaning and ESP rapping. This data is measured directly from the stack with the Dekati® High Temperature Electrical Low Pressure Impactor+ (HT-ELPI®+) and heated isokinetic probe.

Real-time PM measurement and sophisticated data analysis tools allow:

- Characterization of PM emissions from different flue gas conditions
- Minimize emissions while controlling flue gas cleaning system maintenance and operation costs
- Quick and cost-effective process optimization - see the effect of process changes on the emissions in real-time
- Comprehensive data from short-timescale measurements - no need for long term measurement campaigns
Real-time measurement solution for medium to high concentration sources (>10mg/m³):
Real-time PM detection with versatile dilution system

ELPI®+ for real-time particle concentration and size distribution measurement

Real-time PM measurement is based on the proprietary Electrical Low Pressure Impactor+ (ELPI+) technology. The ELPI®+ is a unique, widely-used and well-characterized instrument for real-time particle size distribution and concentration measurements in the particle size range of 6 nm - 10 μm. Due to its wide operational particle size range, ELPI®+ can be used to measure particles in ultrafine -, fine - and coarse modes covering the complete size range with only one measurement technique. ELPI®+ measures particle concentration and size distribution in real-time at 10 Hz sampling rate enabling the detection of rapid changes in the sample concentration and size distribution. Since ELPI®+ uses an impactor for size classification, particles can also be analysed for chemical composition after the real-time measurement.

Dekati® eDiluter™ Pro for versatile flue gas dilution

Flue gas dilution system is the Dekati® eDiluter™ Pro, the latest Dekati development in the field of combustion sample conditioning. The Dekati® eDiluter™ Pro combines versatility with unmatched ease of use through an intuitive user interface and automated software features. Dilution is carried out in two stages, with the possibility to accurately control the first dilution stage temperature. The dilution stages are ejector diluters with an innovative sheath air flow designed to reduce particle losses in the diluter to a negligible level. Stack accessories include a heated probe, isokinetic nozzles and a heated in- or out-stack cyclone.

Dekati® eDiluter™ Pro and ELPI®+ for high concentration source measurements

- Complete measurement setup with versatile dilution system and real-time particle detection
- Real-time PM mass and number concentration with up to 10 Hz sampling rate
- Real-time number and mass size distributions from 0.006 µm to 10 µm
- Real-time simultaneous PM10, PM 2.5 and PM1 measurement
- Adjustable dilution factor between 1:25 and 1:225 for a wide range of PM concentrations
- Adjustable first stage dilution temperature (ambient to 400 °C) allows measurement of either primary or primary + secondary PM emissions
- Dekati® eDiluter™ Pro’s high diluted sample output (~100lpm) allows operation of multiple measurement instruments at the same time

Accessories

- Heated sampling line (1.5 or 3 m versions available) can be used between the source and the dilution system to transport the sample. The temperature is controlled with the eDiluter™ additional, integrated temperature controller.
- Heated probe to take the sample from the source, max 600 °C
- Isokinetic sampling nozzles
- Dekati® Cyclone to remove >10 μm from the sample, to be connected in front of the sampling line. Heaters available for heating the cyclone
- Etc.

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Real-time PM measurement solution for low concentration sources:
HT-ELPI®+ for real-time PM measurement directly at sample temperature without dilution

Modern power plants with high efficiency flue gas treatment systems and plants that use oil or natural gas as fuel generally emit very low levels of PM. Depending on the flue gas treatment system the gas may also be saturated with water at the sampling point.

In these conditions, it is preferable to avoid dilution and to measure the PM directly at or slightly above the flue gas temperature. For this purpose, Dekati has developed the High Temperature Electrical Low Pressure Impactor+ (HT-ELPI®+), which allows direct PM measurement from high temperature sources. The HT-ELPI®+ works on the same proprietary operation principle as the ELPI®+ instrument. The main difference between the ELPI®+ and the HT-ELPI®+ systems is that the entire measurement column of the HT-ELPI®+ can be heated up to 180 °C enabling direct measurement of high temperature particle samples. Otherwise the HT-ELPI®+ has all the benefits of the ELPI®+ system:

- Real-time particle size distribution and concentration measurement
- Particle size range of 6 nm - 10 μm in real-time
- 10 Hz sampling rate to enable detection of rapid changes in the sample concentration and size distribution.

The setup of the HT-ELPI®+ for stack emissions measurements is very simple; A heated probe extracts the sample from the flue gas stack and the sample is then led via a heated transfer line to the HT-ELPI®+ unit. Different size probes, isokinetic nozzles and cyclones are available from Dekati to suit any size stack.

HT-ELPI®+ for low concentration source measurements

- Real-time PM mass and number concentration with up to 10 Hz sampling rate
- Real-time number and mass size distributions from 0.006 μm to 10 μm
- Real-time simultaneous PM10, PM 2.5 and PM1 measurement
- Direct measurement at flue gas temperature up to 180 °C - sensitive to mass concentrations from 0.01 mg/m³
- Simple and easy to use setup for stack measurements, only electricity needed at measurement site

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Dekati® Impactors for gravimetric PM mass measurements

Impactor technology is a well known and well characterized method for the determination of mass concentration of airborne particulate matter. In impactors, size classified particles are collected on collection filters or substrates that are either weighed or analysed to determine particle mass and/or chemical composition in different particle size fractions. Dekati has over 25 years of designing impactors and the Dekati® PM10 Impactor and HT-DLPI+ impactors are especially well-suited for flue gas emissions measurement applications.

**Dekati® PM10 Impactor for ISO23210**

- Gravimetric particle size distribution measurement at up to 200 °C
- Simultaneous collection of PM10 and PM2.5 fractions according to ISO23210
- TSP and PM1.0 stages included for additional PM sizing information
- Available with 10 lpm and 30 lpm flow rates
- Concentrated mass collection on Ø25 mm collection substrates
- Complete measurement setups available for both in-stack and out-stack sampling

Dekati® PM10 impactor is an ideal tool to measure PM10, PM2.5 and PM1 mass concentrations from various sources. The Dekati® PM10 impactor is manufactured of stainless steel to ensure reliable operation in long term use and even in harsh environments. In emission measurements, the impactor can either be placed inside the flue gas or chimney, or it can be placed outside the stack and heated up to the sample temperature to avoid condensation and sample transformations. The measurement setup in emission measurements includes a pump with flow control, impactor heater with temperature control, isokinetic sampling line and needed connections. If large amount of material >10 µm exists in the sample, the Dekati® Cyclone can be applied in front of the impactor to collect these large particles which could otherwise interfere with the particle size classification inside the impactor unit.

**High Temperature Dekati® Low Pressure Impactor HT-DLPI+**

- Gravimetric particle size distribution measurement at up to 180 °C
- Particle mass size distribution in 14 stages from 0.016 µm to 10 µm
- 10 lpm sample flow rate
- Possibility for chemical and microscopic analysis of collected samples
- Integrated impactor heater and temperature controller
- Integrated low pressure measurement and control, no additional flow control device needed
- Concentrated mass collection on Ø25 mm collection substrates
- Complete measurement setups available for out-stack measurements

HT-DLPI+ is a widely used and well characterized cascade impactor for detailed particle size distribution analysis. HT-DLPI+’s stainless steel and robust design make it an ideal choice for stack emission measurements and other applications where the particle sample is in high temperature. The HT-DLPI+ can be heated up to 180 °C allowing direct measurement of up to 180 °C particle samples without the risk of condensation or sample transformations. The impactor support and heater controller are all integrated into one easy-to-use unit, which also allows control and adjustment of the impactor low pressure and flow rate. The measurement setup in emission measurements includes a pump (no additional flow control is required), isokinetic sampling line and needed connections. The Dekati® Cyclone can additionally be applied in front of the impactor to remove >10 µm particles from the sample.
Selected publications on different aspects of PM emission measurements with Dekati® Products

Huang et al., Investigation on the removal of SO3 in ammonia-based WFGD system, Chemical Engineering Journal, 289(537-543), 2016

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Mertens, J., Brachert, L., Desagher, D., Achallert, B., Khakharia, P., Goetheer, E., Predicting amine mist formation based on aerosol number concentration ans size measurement in flue gas, Energy Procedia, 63, 893-901, 2014


Ozgen et al., Analysis of the chemical composition of ultrafine particles from two domestic solid biomass fired room heaters under simulated real-world use, Atmospheric Environment, 150(87-97), 2017


Schmidt et al., Wood washing: Influence on gaseous and particulate emissions during wood combustion in a domestic pellet stove, Fuel Processing Technology, 174(104-117), 2018


Xu et al., Mass spectra features of biomass burning boiler and coal burning boiler emitted particles by single particle aerosol mass spectrometer, Science of The Total Environment, 598(341-352), 2017