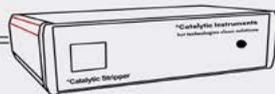
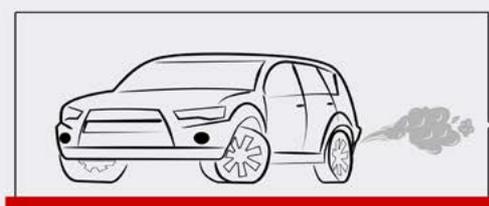


European Metrology Programme for Innovation and Research

Delivering Impact



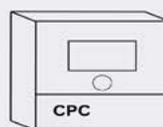
Elevate your Aerosol Measurement Precision with °Catalytic Instruments



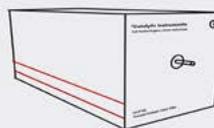
✓ Remove the volatiles



✓ Calibrate the CPC



✓ Remove the butanol



- ✓ Improve your research
- ✓ Compliance



Credit: Catalytic Instruments



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Providing the confidence in instrumentation for measuring vehicle emissions

Electric vehicles are becoming more popular, but for now, the dominant form of transportation is still powered with the internal combustion engine. These engines produce harmful tailpipe emissions contributing to hundreds of thousands of premature deaths in Europe each year. Vehicle manufacturers must now perform emission tests under real-world conditions, which requires new metrology and instruments to demonstrate compliance.

Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

Fine particulate matter with diameter ≤ 2.5 micrometres (PM_{2.5}), is estimated to contribute to 238,000 premature deaths in Europe annually. To align with World Health Organisation (WHO) recommendations, the EU must halve its PM_{2.5} concentration limits - a goal the Air Quality Standards Directive seeks to achieve by 2030.

Before 2017, emission monitoring was performed using Type Approval (TA) tests in the laboratory which did not always reflect real world conditions. To supplement these, the EU introduced the 'Real Driving Emissions' (RDE) test where "Portable Emission Monitors" (PEMS) directly measure emissions at a vehicle's tailpipe on the road, considering parameters such as acceleration, deceleration, ambient temperature, and payloads. To ensure measurement accuracy, particle counters for PEMS need to be calibrated with a stable particle generator and a reference counter.

However, commercial particle generators with a broad size range of 2-300 nm and a simple ease-of-use concept are not readily available and some, like "soot generators", struggle to produce stable and reproducible aerosols in a comparable size range. In addition, they require skilled operators, take several hours to calibrate PEMS and are not fully harmonised leading to variations in instrument response.

In 2025, the new vehicle regulation Euro 7 was implemented, further reducing allowed emission limits to meet WHO levels, creating a pressing need for a reliable and traceable way for size-certified nanoparticles with size down to 10 nm to calibrate PEMS.

Solution

During the [MetroPEMS](#) project, a new type of particle generator developed by Catalytic Instruments was characterised by METAS, the National Metrology Institute (NMI) of Switzerland.

Based on evaporation-condensation technology, solid silver is evaporated in a tube furnace. Carried by a nitrogen gas stream, the silver vapor cools and condenses leading to particle formation. By adjusting the temperature and flow parameters, the size of the particles generated can be fine-tuned.

The "Silver Particle Generator" (SPG) was characterised in terms of size and number of particles generated as well as the stability and repeatability of the instrument. Results indicated that the SPG could produce high concentrations of uniform particles and aggregates in the size range between 2 and 300 nm, with less than a 2% variation over 15 hours of continuous operation and around 10% inter-day variability.

Impact

Catalytic Instruments, based in Germany, have produced cutting-edge instruments for the automotive industry for over a decade. This includes their Catalytic Stripper and Catalytic Vapor Filter, designed to remove volatile and semi-volatile compounds to enable more reliable emission monitoring from engines and combustion processes.

The company's SPG is one of the first commercial, metrologically validated instruments in the world that can produce truly spherical particles in quantities sufficient for calibration purposes with a remarkable degree of long-term stability and reproducibility. This can be performed in line with ISO

27891:2015. The heat up time of the SPG is less than 15 minutes and can be operated by a service technician without any specific training.

Catalytic Instruments acknowledge the help from the project in allowing them to focus on the development of the SPG – especially by METAS, who's characterisation in the MetroPEMS project has helped enhance trust in the device. A number of leading NMIs in Europe are now using the SPG and the company is also adapting its technology used in the instrument to other areas, like generating gold particles to coat anodes to decrease charging times of electric vehicle batteries.

The SPG and work of MetroPEMS will allow automotive industries to meet current and new regulations for vehicle emissions and help reduce the health burden caused by poor air quality.

Providing the metrology to support emission legislation

The MetroPEMS project addressed an urgent need for new emission metrology.

The project:

- Developed SI traceable measurements for nitrogen dioxide and particle number (PN) including proving particle penetration and the assessment for flow
- Prepared static mixtures containing nitrogen dioxide at concentrations of 1 and 10 μmol per mole which were subjected to stability assessments over durations exceeding 12 months
- Performed an instrument intercomparison for linearity, particle counting efficiency and particle concentration dilution factor in three different laboratories.
- Provided an uncertainty budget in representative RDE-driving conditions and SI-traceable calibrations for two exhaust flow meters.
- Developed and deployed a "golden" PEMS device along with a transfer standard for particle number (PN) calibration.
- Successfully demonstrated solutions enabling in field linearity checks for PN PEMS analysers used in RDE tests.

By providing high quality reference standards and traceability to PEMS measurements, this project supported the improvement of air quality across the EU.



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www.euramet.org/19ENV09

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