

Handheld Emission Particle Counter for testing diesel particle filters of off-road engines

T. Rüggeberg¹, P. Specht¹, P. Steigmeier¹, M. Fierz², E. Weingartner¹, H. Burtscher¹

¹FHNW/ISE, ²Naneos

Introduction & Background

In Switzerland, construction machines and other off road diesel engines need to have a diesel particulate filter to minimize the exposure of on-site personnel to carcinogenic diesel soot particles. To test the correct function of these filters at construction sites and other locations, a mobile diesel soot sensor is needed, which is able to measure the particle number concentration of soot particles directly at the exhaust. This sensor has to fulfill the specifications of the Ordinance of the Federal Department of Justice and Police on Exhaust Gas Measuring Devices for Internal Combustion Engines (VAMV SR 941.242). The Aerosol Group of the Institute for Sensors and Electronics at the University of Applied Science and Arts, Northwestern Switzerland (FHNW) developed such a device, the Handheld Emission Particle Counter (HEPaC). The HEPaC is based on the Partector2 by naneos LLC. It has been certified by METAS.

Methodology and Results

The HEPaC is a diffusion charging sensor, consisting of a heavily modified Partector2. The result of the measurement is transferred to a tablet PC to generate protected PDF reports. To avoid problems with condensation or nucleation, the exhaust aerosol enters the sensor via a probe followed by an evaporation tube, which is heated to 195°C. The sensor itself is heated to 55°C.

This enables the fulfilment of the tetracontane test, i.e. evaporating at least 95% of 30nm tetracontane particles up to a particle number concentration of 10^5 pt/cm³. The heated evaporation tube is followed by the diffusion charger, which charges the soot particles constantly, followed by a pulsed electrostatic precipitator, switched between two voltage levels. The resulting periodically changing charge induces a pulsed current (fA) on arrival in a faraday cage, which is measured by an electrometer. To control the aerosol flow rate a differential pressure sensor and a nozzle are used in this sensor. When all operational parameters like diffusion current, pulsed precipitator voltage and flowrate are correct, the amplitude of the electrometer current is directly proportional to the particle number concentration of the aerosol. The battery operation time is approximately 3 hours.

Conclusions

The HEPaC is a METAS certified lightweight sensor, which allows mobile and simple measurements of particle number concentrations of construction machines directly at the construction site. The sensor implementation follows the protocol for Swiss regulation SR 941.242. It works up to a number concentration of 5'000'000 particles/cm³ with a CPC like counting efficiency curve. The efficiency versus particle size also fulfills the requirements of the Dutch PTI regulations and the suggestion by PTB for PTI.

Acknowledgement: This project was funded by the BAFU Umwelttechnologieförderung, contract Nr. UTF 601.13.19