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

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Introduction

• 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.

• 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 (VAMV SR 941.242; type certificate CH-K4-21002-00).
Methodology – Sensor design

The HEPaC is a heated diffusion charging sensor, based on a heavily modified Partector2 (naneos LLC)

- To avoid condensation and nucleation problems, the aerosol is heated to 195°C by an evaporation tube. The sensor itself is heated to 55°C.

- After the evaporation tube the aerosol is constantly charged by an unipolar diffusion charger, followed by a pulsed electrostatic precipitator.

- The resulting periodically changing charge induces a pulsed current (fA) on arrival in a faraday cage, which is measured by an electrometer

→ When all operational parameters like diffusion current, pulsed precipitator voltage and flowrate are correct, the amplitude of the electrometer is directly proportional to the particle number concentration of the aerosol
Result – Counting Efficiency measured by METAS

Figure 2: Counting efficiency of the HEPaC with polydisperse CAST soot (sigma = 1.5 … 1.6). Gray dots represent the minimum, yellow dots the maximum efficiency according to the VAMV requirement.

→ The counting efficiency (polydisperse soot) of the HEPaC is comparable to a CPC
Conclusion

• 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 diameter also fulfills the requirements of the Dutch PTI regulations and the suggestion by PTB for PTI.

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Questions?

**HEPaC specifications:**
- Particle number concentration: 1’000 … 5’000’000 pt/cm³
- Time resolution: 1 s
- Response Time: 5 s
- Inlet flow: 0.5 l/min
- Environmental Operating Temperature: 5 – 40°C
- Storage Temperature: -10 – 50°C
- Sensor temperature: 55°C
- Evaporation tube temperature: 195°C
- Heat up time: ~ 20min
- Relative Humidity: 10 % to 90%, non-condensing
- Environmental pressure range: 860 – 1060 hPa
- Battery: Rechargeable Li-Ion, 48Wh
- Battery lifetime: ~ 3h