Characterization of the ePNC number counter for annual PTI and testing applications

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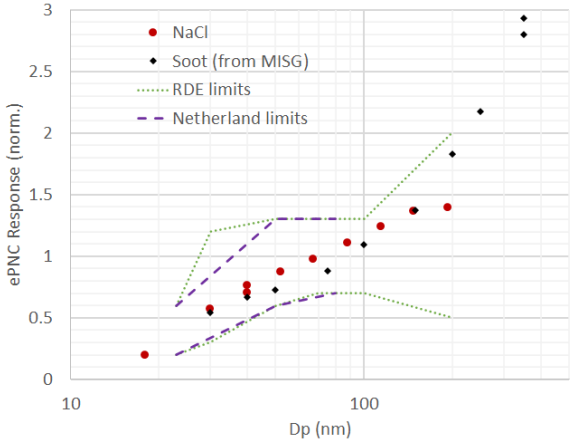
Diesel passenger cars sold in the Europe have been forced to use diesel particulate filters (DPF) to comply with particle number (PN) emission limits (Euro 5 standard). The DPF's are an effective way to control the PN and mass emissions, but from the car end-user perspective it is a rather expensive part to replace if it is not functioning properly. Thus, manipulation or removing the DPF is a problem in Europe, and a small number of cars equipped with non-working DPF's produce a majority of the overall emissions [1]. Therefore, European countries are incorporating a new PN measurement for the diesel cars in periodical technical inspection (PTI).

In this study, we introduce and characterize the operation of a new PN sensor for PTI applications called ePNC (Dekati Technologies Ltd) by modelling, and lab- and field-tests. The ePNC is based on the electrical detection of particles, and it operates in reduced pressure conditions (400 mbar). The main components of the sensor are a corona charger and a diffusion collector in a series configuration. The charge carried by particles to the diffusion battery is measured with an electrometer that is used to determine the PN of the sampled aerosol. The analytical and computational fluid dynamics modelling results of the sensor were compared with the measured sensor response as a function of particle size. To apply the sensor for the measurement of primary emissions (dried soot particles) of idling car in a PTI station, it is combined with a sample conditioning unit that removes moisture, subsequently evaporates hydrocarbons condensed onto particles, and reduces the sample pressure below ambient. The conditioning unit was characterized by determining the penetration of monodisperse NaCl and soot particles. The feasibility of the combination of the ePNC and the conditioning unit was investigated by comparing the results against a PMP-type reference measurement with several passenger cars running in idle.

The results show the charging phenomena is controlled by diffusion charging in the ePNC charger, and that the sensor number correlation is only weakly dependent on the particle size in the size range of 20 – 200 nm. Comparison of the sensor with the conditioning unit showed a good correlation with the reference measurement for several diesel and gasoline cars. Small deviations were mostly addressed to slightly deviating detection efficiency curves of the devices.



[1] H., Burtscher, Th., Lutz, A., Mayer, Emiss. Control Sci. Technol. **2019**, 5, 279–287.