Non-exhaust PMx emissions from road traffic

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Non-exhaust vehicle emissions are formed from wear particles of vehicle components such as brakes, clutches, chassis and tires. Although the non-exhaust particles are relatively minor contributors to the overall ambient air particulate load, reliable exposure estimates are few. (Panko et al. 2013). Suspended road dust will remain a problem because of an increasing number of vehicles in urban and rural areas. Only few real-world measurements of road dust resuspension have been performed to date. There is still a knowledge gap regarding the dominant mechanisms leading to road dust emissions, although resuspension of surface particle loading obviously plays an important role. (Pirjola et al. 2010). In practice, quantification of road dust emissions is complicated because of the many different factors that might need to be controlled —vehicle type and speed, tire type, pavement type and conditions, the use of road salt and sand (Hussein et al. 2008).

In current study the mobile measurement system was used to quantify the relative importance of road PMx emission and suspension of accumulated dust versus direct pavement wear, tire type (studded, non-studded and summer), pavement type, and vehicle speed. The mobile sampling cart was built, which enables simultaneously measure PMx concentrations directly behind the both rear tyres and the background air from the front of the vehicle. Simultaneously road and tire temperature were measured with infrared thermometer system. The tire pressure and ambient conditions were measured before and after each driving test. Measurements were performed during March-September on selected roads with different pavements and traffic conditions in Estonia. Particle number concentration and size distribution from 30 nm to 10 µm with 1-sec time resolution were measured by ELPI (Electrical low pressure impactor, Dekati Ltd.), behind the tires with the sampling rate of 2 x 29.25 l/min. The minimum detection level at 1 stage for the mass concentration is 0.01 µg/m^3 and for the number concentration 142 1/cm^3. The upper concentration limit at 13 stage for the mass concentration is 8269 mg/m^3 and for the number concentration 2.7E+04 1/cm^3. Simultaneous particle measurements were carried out using TSI optical particle counter OPC Model 3330 and DustTrak DRX. PM samples on impactor plates were also analysed by SEM (scanning electron microscopy, Zeiss EVO MA15 with Inca EDS) technique for chemical composition and morphology.

Results

The initial data show clear relationship between the vehicle speed and total PM emitted. Humidity of the road surface had strong implication on the PMx emission. Pavement composition has significant impact to the road wear and therefore PMx emission.

Studded tyres are generating more coarse PM emission compared to the non-studded winter and summer tyres.

There was a clear indication that the smallest particles with diameter less than 200 nm originate from the tires and not from the pavement. During the ride the tyre temperature is increasing, which leads to emissions of loosely bound reinforcing filler material and evaporation of semi-volatile softening oils. Particles larger than 300 nm consist mostly carbon reinforcement filler from the stone material in the pavement.

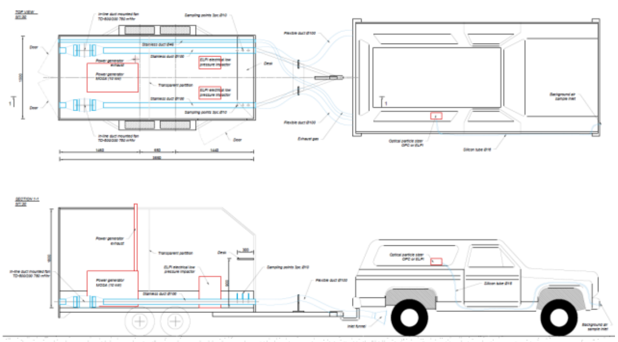

Figure 1. Scheme of the sampling device

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Hussein, T., Johansson, C., Karlsson, H., Hansson, H.C. 2008. Factors affecting non-tailpipe aerosol particle emissions from paved roads: On-road measurements in Stockholm, Sweden. Atmospheric Environment. 688–702.

Panko, J.M., Chu, J., Kreider, M.L., Unice, K.M., Measurement of airborne concentrations of tire and road wear particles in urban and rural areas of France, Japan, and the United States, Atmospheric Environment (2013), doi: 10.1016/j.atmosenv.2013.01.040.

Pirjola, L., Johansson, C., Kupiainen, K., Stojiljkovic, A., Karlsson, H., Hussein, T. 2010. Road Dust Emissions from Paved Roads Measured Using Different Mobile Systems. Journal of the Air & Waste Management Association. 1422-1433.