Characteristics of the particulate matter from road tunnel environment

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Presently, traffic represents one of the most significant sources of air pollution. Vehicle combustion itself emits fine and ultrafine particulate matter fractions (PM) (Morawska and Zhang, 2002). Besides, PM originates by abrasion of vehicle parts (tires, break-shoe lining, clutch lining etc.), corrosion of vehicle body or supporting equipment (crash barriers, traffic signs), and by resuspension of dust from road or maintenance materials (Colvile *et al.*, 2001). The road tunnel environment is a suitable site for characteristics of the traffic-related emissions (Sanchez-Ccoyllo *et al.*, 2009) and particle size distribution (Handler *et al.*, 2008).

PM sampling campaigns were performed in the Mrázovka city road tunnel that is the component of an internal city ring in Prague. This tunnel is 1,260 m long with driving directions placed in the separate tubes each with two lanes. In 2011, the traffic intensity in the studied tunnel part was 23,000 vehicles per 24 hours, 96 % of which were passenger cars. The PM_{10} and $PM_{2.5}$ fractions were sampled on nitrocellulose filters using Leckel MVS6 devices during 24 hours and the PM concentrations were determine by subsequent gravimetric analysis (Mettler-Toledo MX5/A). The Environcheck 107 device was used for a continual monitoring of particle size distribution. The monitoring was performed during one-week sampling campaigns. The variability in different seasons was studied especially in relation to winter road maintenance. The traffic intensity was calculated from a camera security system.

The results demonstrated the dominant share of coarse particles ($PM_{2.5\text{-}10}$) during all monitoring campaigns covering in average 72 % - 76 % of PM_{10}. These low differences indicate the same source of particles during all campaigns. Nevertheless, the fluctuation of coarse particles in time is evident from particle size distribution measurements. The highest portion of coarse particles in PM_{10} was determined in working days especially in morning and afternoon rush hours. However, very weaek correlation was found between the traffic intensity and the concentration of $PM_{2.5\text{-}10}$ particle fraction ($R^2 \sim 0.22 – 0.28$). The reason of the higher shares of coarse particle fraction during the rush hours could be a resuspension of the road dust from pavement and from surfaces next to the road and turbulent air flow due to moving vehicles.

The concentrations of fine particles ($PM_{2.5}$) that are produced mostly by a fuel combustion in vehicles engines indicate also some fluctuation in time with a local maximum during the morning rush hours. These fluctuations are very small compared to those of coarse particles. The stronger positive correlation was found between the $PM_{2.5}$ concentrations and the traffic intensity at spring sampling campaign (R^2 ranges between 0.25 and 0.5).

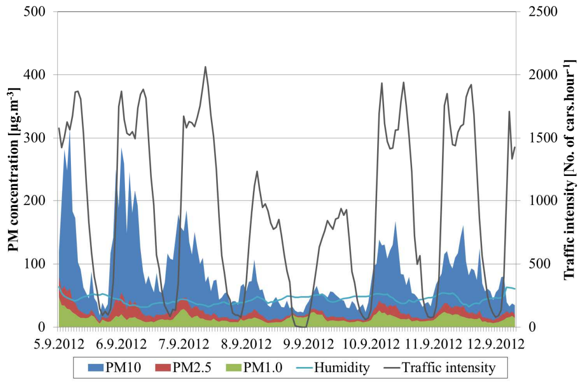

Figure 1. Particle size distribution and traffic intensity.

The PM_{10} and $PM_{2.5}$ samples were analyzed for 20 selected elements to characterise their chemical composition. Al and Ca were determined in the highest concentrations in both analysed fractions. Cu was found as the most common heavy metal in both fractions. In contrast, Pb and Ni concentrations were the lowest among the heavy metals. Trace element concentrations were very low (order of units of nanograms) including Pt concentrations near or below the detection limit of ICP-MS technique.

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