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On board ELPI measurements of PM size and numbers in vehicle aeration system - lung deposition dynamics

Electrical Low Pressure Impactors allow to perform short term response (1s) measurements of both PM numbers and size distribution. The relative low sensitivity of these systems to vibrations made it possible to perform on board measurements of PM in the aeration system of a car inserted in traffic flow, to assess the dynamics of PM size distributions and concentrations. A number of representative situations have been analysed: urban and rural backgrounds, tunnel profiles and measurements in the wake of trucks. The use of the respiratory tract PM size deposition models from IRCC 1996 coupled with the observed PM size distributions and numbers allowed us to predict the dynamics of human PM respiratory tract deposition. These calculations are made on the basis of mean human ventilation rates and epithelial surface area combined with exposure rates obtained with on board ELPI measurements. Maximal epithelial deposition rates of $5\text{pg}/\text{cm}^2/\text{min}$ and $100\text{pg}/\text{cm}^2/\text{min}$ in alveolar and tracheobronchial regions of the respiratory tract respectively can be expected from atmospheres in the wake of trucks which may peak at as much as ca. 1 to 4 mg/m^3 of $\text{PM}_{2.5}$. Data recorded in a tunnel (figure above) show that PM size distributions differ significantly when sampling in or out of the wake of a truck, thus suggesting important modifications during the aging of the exhaust aerosol in confined atmosphere. Either selective deposition of largest particles or the secondary formation of small size aerosol (30-50 nm) by exhaust gas condensation may occur during the atmosphere aging. In the view of PM/size lung deposition pattern, these nanoparticles may very efficiently deposit in the distal respiratory tract. Knowledge implementation concerning the nature of this secondary aerosol would be of major interest for health effect considerations.

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