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Deposition of Inhaled Particles from Diesel Fuelled Engines in Human Lungs: Comparison between Men and Women in Different Activity Levels

Particulates emitted by diesel engines range between 1 nm and 10 □m being over 90 % smaller than 1 □m. Particulates of this size have been found to be associated with several adverse health effects, such as pulmonary and cardiovascular diseases (Kittelson et al. 2002). Diesel particles contain soot, sulphate compounds and hydrocarbons such as polyaromatic hydrocarbons (PAH), which have been found to be carcinogenic (Cohen and Nikula 1999, Kittelson 1998). Hydrocarbons, as lipid soluble compounds, can cross the epithelial barrier of the lung cells and get to the circulation and influence the whole organ system, more easily than water soluble sulphates. In this study, lung deposition of diesel particulate emissions in males and females was studied *in silico*. Particulate emissions and their particle number size distributions were measured in a Euro 2 diesel bus with a partial diesel particulate filter (pDPF) on it in Technical Research Centre of Finland. This kind of catalyst gives particulate reduction about 40–70 %. Estimation of deposited particles was computed with a special lung deposition model using in house MATLAB scripts. Physiological parameters were standardized by a “virtual human”, adult male or female. The chosen activity levels were sleeping, sitting and light exercise. Exposures particle concentration was assumed to be equal to the outcome from the exhaust pipe. Particle transformation in air was ignored. Exposure time was chosen to be the same as in the European Braunschweig cycle. Respiratory tract was divided into five main deposition regions: anterior nasal region (ET1), main extrathoracic region (ET2, including posterior nasal region, mouth, pharynx and larynx), brochial region (BB, consisting of trachea and bronchi), bronchiolar region (bb, consisting of bronchioles), and alveolar interstitial region (AI, consisting of alveolar ducts and sacks) (ICRP 1994). Results were given as particle numbers deposited in different regions of lungs. Most of the measured number concentrations of diesel particles were smaller than 200 nm in their aerodynamic diameter. Results indicated that a majority of inhaled particles emitted from diesel engine penetrate deep into the unciliated regions and gas-exchange region of lungs. In addition, approximately half of the inhaled particles stay in the lungs. The inhaled dose of particulates was different in female and male lungs. The dose in male lungs was 19 % higher in sleeping, 48 % higher in sitting position and in light exercise 43 % higher than female had. These differences of inhaled dose results from differences of breathing parameters (ventilation rate 20-40 % higher in male than female) and deposition probabilities, and differences of anatomy and physiology of lungs in males and females. Percentages of particles deposited in the alveolar-interstitial region of male and female lungs in different activity levels were 55.2 % and 50.1 % in sleeping, 58.5 % and 51.5 % in sitting and 67.4 % and 65.7 % in light exercise of all deposited particles. Based on the results at similar exposure conditions, the lung dose of diesel particulates is different between males and females suffering also different health risk between genders *in vivo*.

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