Aerosol Deposition Measurement in the Model of Human Lungs using Positron Emission Tomography

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The ability to deliver the exact amount of aerosolized medication to the specific region of lungs is the cornerstone of effective inhalation therapy of both lung and systemic diseases. Targeted inhalation of medication is termed successful if at least 50% of inhaled aerosol deposit in the desired region (Zeman *et al* 2010). However, current inhalation devices reach only the level of 30% deposition in conducting airways that are the target region in the treatment of asthma, chronic obstructive pulmonary disease, or cystic fibrosis (Heyder, 2004, Zeman *et al* 2010). To achieve more effective targeted delivery of aerosolized medication further experiments are to be performed and analysed.

We employed Positron Emission Tomography (PET) for the measurement of aerosol deposition in a realistic model (Fig. 1) of human lungs (Lizal *et al* 2012a). PET is a commonly used method in the nuclear medicine. The method is based on a detection of a pair of simultaneously emitted annihilation photons moving in opposite directions as a result of positron – electron interaction after the positron emission decay of a suitable radioisotope. In our case the liquid aerosol particles from di(2-ethylhexyl) sebacate (DEHS) were generated by the condensation monodisperse aerosol generator (CMAG) and labeled with fluorine-18 as a radioactive tracer. (Lizal *et al* 2012b).

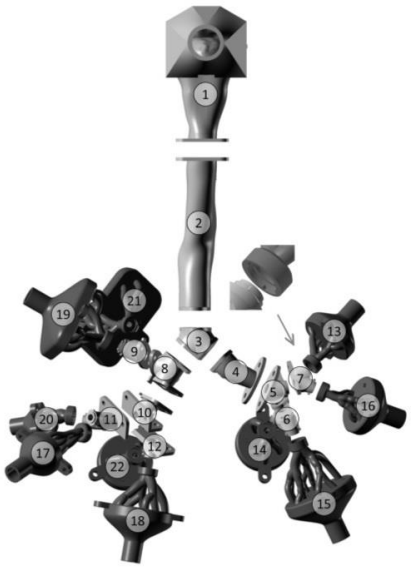

Figure 1. The realistic model of human lungs

Aerosol deposition was measured for two sizes of particles (2.5 μm and 4.3 μm) and for three different inhalation flowrates (15, 30 and 60 L/min). The radioactive aerosol particles were led to the model and non-depositing particles were collected by output filters following each of the model outputs.

Deposition characteristics were calculated from the radioactivity of the deposited aerosol measured by PET. *Deposition efficiency* (Fig. 2) is a ratio of the number of particles deposited in a given segment to the number of particles entering the segment.

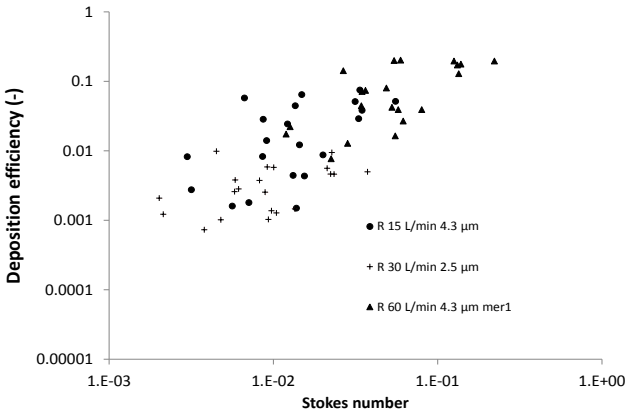

Figure 2. Deposition efficiency in the realistic model.

The results proved correlation of deposition efficiency with Stokes number, which means that the main deposition mechanism is inertial impaction. As a next task the methodology for tagging the solid aerosol particles with radioactive tracer will be developed and deposition of porous and fiber aerosols will be measured.

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