2I.4

Deposition of Fiber and Spherical Aerosols in the Human Tracheobronchial Airway. YUNG SUNG CHENG, Yue Zhou, Wei-chung Su, Lovelace Respiratory Research Institute.

Inhalation exposure of fiber aerosol may have serious health consequences including lung cancers. The deposition pattern in the respiratory tract as a function of fiber dimensions is the information critical to understanding respiratory dosimetry and etiology. Controlled studies of fiber deposition in human volunteers are not available because of ethical concerns. The purpose of this study is to investigate the effects of fiber dimension and breathing rate on the deposition pattern in an oral/tracheobronchial airway cast with a defined geometry. Two types of fibers including a carbon fiber and a glass fiber were used for the deposition study. The fiber was generated with a small-scale powder disperser (Model 3433, TSI Inc., St Paul, MN). Regional fiber deposition pattern was measured at a constant inspiratory flow rate of 7.5,15, 30 and 43.5 L min-1. As a comparison we also did deposition experiments in the same cast using polystyrene latex (PSL) test particles tagged with fluorescent. Fiber depositions in different sections of the airway cast and the backup filter were extracted and prepared for optical microscopy and image analysis. From the counting data, deposition efficiency as a function of fiber length /diameter was calculated. Our experimental data of fiber deposition in the tracheobronchial region show large variability but generally agree with the numerical simulation results published by Zhang et al. (1996). The deposition efficiency can be expressed as a function of Stokes diameter, Reynolds number and branching angle. We also show that deposition efficiencies of spherical particles are higher than those of fibers at the same impaction parameter. This can be explained by the orientation of fibers, which tend to align with the flow direction. This information is useful in predicting the deposited dose of inhaled fiber particles. (This research was supported by the NIOSH under the Grant 1R01 OH03900).

2I.5

Improved Conversion Scheme for Eulerian Deposition Probability Rates. Mohammad I. Rahman, CARLOS F. LANGE, University of Alberta.

Eulerian models of aerosol lung deposition typically employ deposition probability functions derived from Lagrangian analysis. The Lagrangian deposition functions are either empirical or derived under steady state conditions. In these models, the deposition rate is calculated by first estimating the particles deposition per unit time for a whole lung generation, simply dividing the total deposited amount over a certain period by this time period. Then the total deposition rate is distributed, dividing it by the length of the generation.

The main advantage of Eulerian deposition models is treatment of the unsteady deposition. To capture the true effect of the breathing pattern and to predict the transient local deposition, deposition functions based on instantaneous deposition rate are required. But, at present, no such deposition function is available. Development of such analytical expressions involves complex mathematics and requires sophisticated experimental facilities for the development of empirical correlations, both of which are time consuming.

An attractive alternative is to develop a numerical technique to convert the generational deposition probabilities into an Eulerian frame of reference valid for each control volume within the domain. In this study, two such conversion schemes, one based on Generation Residence Time (GRT) and the on other on Control Volume Residence Time (CVRT), were investigated, and then used to estimate total and regional lung deposition under several clinically important cases. Both schemes showed excellent agreement with experimental aerosol deposition data in the human respiratory tract, with CVRT giving slightly better results.