Deposition of industrial aerosols in the human respiratory tract

M. Moustafa[1], W. Hofmann[2], I. Balásházy[3], Á. Jókay[3], P. Füri[3], B. Czitrovszky[3] and Á. Farkas[3]

[1]Department of Physics, Faculty of Science, Minia University, El-Minia, 6151, Egypt
[2]Department of Chemistry and Physics of Materials, University of Salzburg, 5020 Salzburg, Austria
[3]Centre for Energy Research, Hungarian Academy of Sciences, H-1525 Budapest, Hungary

Keywords: industrial aerosols, mass size distributions, particle deposition model, human respiratory tract
Presenting author email: mona_moustafa9@yahoo.com

The most important port of entry of ambient aerosols into the human body is the respiratory system. Thus the lung is the primary target for the assessment of resulting health effects. For example, metals associated with respirable particles have shown to cause numerous diseases (Pandey *et al*, 2013). The assessment of health risks resulting from the inhalation of particulate matter has to be based on the calculation of particle deposition patterns in the human respiratory tract. Deposition of inhaled particles in the lung depends on particle diameter, which requires the measurement of mass size distributions, as well as on breathing parameters, which depend on work-related physical activities. Thus the main objective of the present study is to calculate the deposition fractions of industrial aerosols measured in an industrial site in El-Minia, Egypt for adult males under characteristic breathing modes.

Measurements of ambient industrial aerosols were carried out in the industrial area of Samalut in El-Minia, Egypt (Moustafa *et al*, 2015). A low pressure Berner impactor was used for the determination of mass size distributions. Samples collected on the impactor stages were then analysed using atomic absorption spectroscopy for seven elements including lead (Pb), manganese (Mn), iron (Fe), copper (Cu), potassium (K), calcium (Ca) and barium (Ba).

Based on the measured element-specific mass size distributions, deposition patterns of inhaled particles in the human respiratory tract were calculated by an advanced version of the stochastic lung deposition model IDEAL (Koblinger and Hofmann, 1990) for sitting, light exercise and heavy exercise breathing conditions.

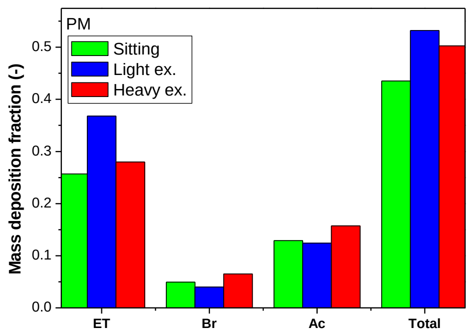

Figure 1. Regional deposited mass fractions of PM at three characteristic breathing patterns in the respiratory system of workers.

To illustrate the results of the deposition calculations, regional mass deposition fractions of particulate matter (PM) in the extrathoracic (ET), bronchial (Br), and acinar (Ac) regions as well as total deposition are plotted in Figure 1 for sitting, light and heavy exercise breathing conditions. For all breathing conditions, the highest mass deposition fractions were observed in the ET region.

Related mass deposition fractions of PM as a function of airway generation numbers in the human lung at the three characteristic breathing patterns are exhibited in Figure 2. Within the lungs, deposition fractions increased with rising airway generation number, reaching their maximum value in the distal acinar airways.

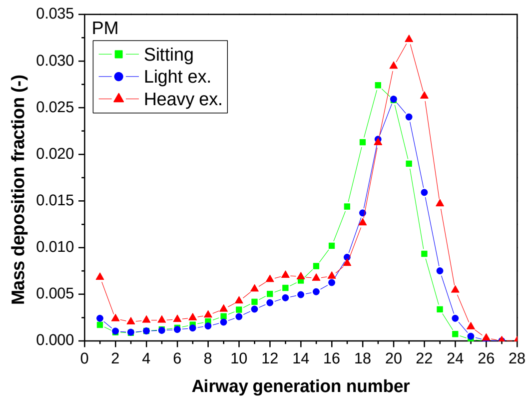

Figure 2. Deposited mass fractions of PM as a function of airway generations number three characteristic breathing patterns in the respiratory system of workers.

Corresponding calculations for Pb, Mn, Fe, Cu, K, Ca and Ba revealed very similar regional and generational distributions of deposited mass fractions.

The experimental part of the work was supported by the Faculty of Science, University of El-Minia (Egypt).

Koblinger, L. and Hofmann, W. (1990*) J. Aerosol Sci.* **21**, 661-674.

Moustafa, M., Mohamed, A., Abdel-Rahman, A. and Hyam, N. (2015) *J. Adv. Res.* **6**, 827-832.

Pandey, P., Patel, D.K., Khan, A.H., Barman, S.C., Murthy, R.C. and Kisku, G.C. (2013) *J. Environ. Sci. Health*, Part A **48,** 730-745.