A Model for Estimating Particle Concentration Indoors – Based on Information from Occupants' Questionnaires, Indoor Sources Emission Factors, Outdoor Concentration and Building Characteristics.

Wierzbicka, Aneta; Bekö, G.; Toftum, J.; Clausen, G.; Loft, S.; Karottki, G.; Massling, A; Hussein, T.

Published in:
Proceedings of 13th International Conference on Indoor Air and Climate 2014

2014

Topic A10: Public Health and exposure studies

A MODEL FOR ESTIMATING PARTICLE CONCENTRATION INDOORS – BASED ON INFORMATION FROM OCCUPANTS' QUESTIONNAIRES, INDOOR SOURCES EMISSION FACTORS, OUTDOOR CONCENTRATION AND BUILDING CHARACTERISTICS

Aneta WIERZBICKA[1,*], Gabriel BEKÖ[2], Jørn TOFTUM[2], Geo CLAUSEN[2], Steffen LOFT[3], Dorina Gabriela KAROTTKI[3], Andreas MASSLING[4] and Tareq HUSSEIN[5,6]

[1]Ergonomics and Aerosol Technology, Lund University, Sweden
[2] Department of Civil Engineering, Technical University of Denmark, Denmark
[3]Department of Public Health, University of Copenhagen, Denmark
[4]Department of Environmental Science**,** Aarhus University, Denmark
[5]Department of Physics, University of Jordan, Jordan
[6]Department of Physics, University of Helsinki, Finland

[*]*Corresponding email: aneta.wierzbicka@design.lth.se*

Keywords: Personal exposure, Modelling, Indoor activities

INTRODUCTION

Personal exposure to airborne particles in epidemiological studies is mainly assessed on the basis of outdoor concentrations, whereas recent studies indicate that on average ~60% of exposure to submicrometer particles in homes is attributable to indoor sources (Bekö et.al., 2013). There is a need to account for the contribution of indoor sources to submicrometer particle exposure (Morawska et al., 2013). Conducting measurements in a large number of residences remains a challenge. Thus an alternative approach is suggested. The aim of this study was to develop a model that allows estimation of indoor number concentrations and describes evolution of submicrometer particles indoors. The estimates obtained with this model can be used as input data for personal exposure estimation in epidemiological studies.

METHODOLOGIES

We developed a simplified version of the indoor aerosol model MC-SIAM (Hussein and Kumala, 2008) based on the mass balance equation and a simplified implementation of the dynamic behaviour of aerosol particles. Input data consisted of: frequency, time and duration of particle-generating activities (on the basis of activity logbooks/questionnaires); emission factors for indoor sources/activities (in particles/h) with geometric mean diameters of emitted particles; residence characteristics (volume, air exchange rate), penetration factor and outdoor number concentrations (obtained from urban monitoring station in Copenhagen). Forty eight-hour patterns of model simulated number concentrations were compared to measurements conducted in two residences in Copenhagen during winter season 2011/12.

RESULTS AND DISCUSSION

Model simulated indoor number concentrations showed 6 and 30% higher average concentrations over the total 48h measurement period in two residences. Comparison of average concentrations during occupied time periods, relevant for exposure assessment

indoors, showed 9 and 35% higher values in model simulations, whereas the estimated median values were 33 and 35% lower than the measured ones. The model simulated concentrations and the measured concentrations indoors and outdoors are given for one of the residences in Figure 1. Emission rates for frying and toasting were calculated from measured data (1.4×10^9 and 3×10^7 particles/h, respectively) and used in the model. Initial concentration indoors in model simulations was set to 4000 particles/cm^3. Unknown activities, not specified in the logbook, were not accounted for in the model.

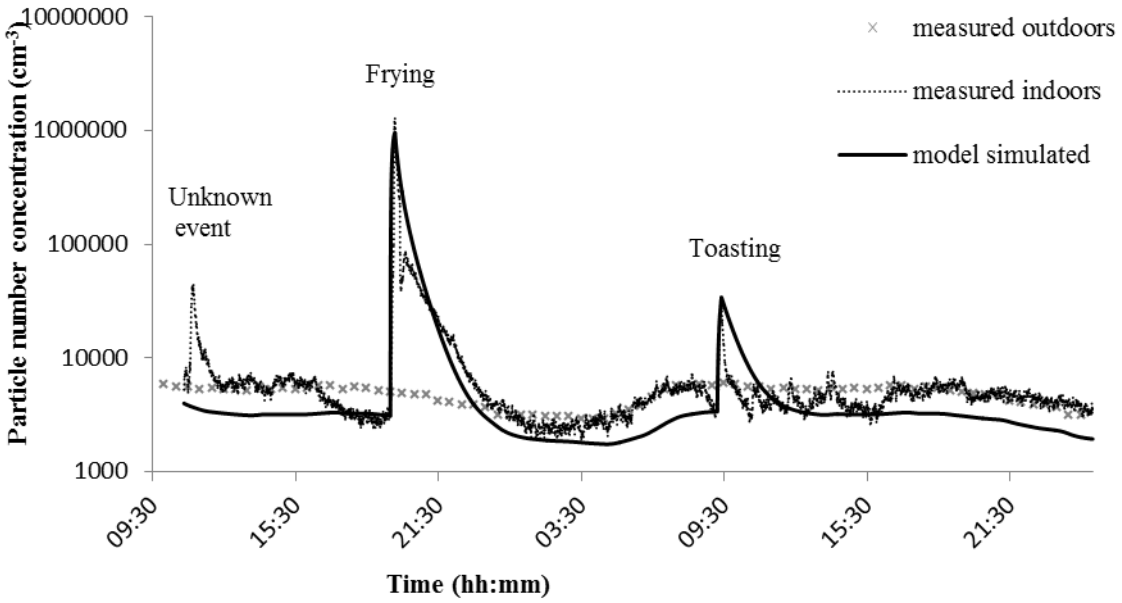

Figure 1. The model simulated number concentration of submicrometer particles in one residence in comparison to concentrations measured indoors and outdoors.

CONCLUSIONS

A simple indoor aerosol model based on information acquired through questionnaires and outdoor concentrations could be a promising alternative for deriving proxy exposure data on population-representative scale to account for indoor exposures to submicrometer particles in epidemiological studies.

ACKNOWLEDGEMENT

This work was financed by VINNOVA - Swedish Governmental Agency for Innovation Systems. The study was part of the Centre for Indoor Air and Health in Dwellings (CISBO) study, which was supported by the REALDANIA foundation.

REFERENCES

Bekö G, Weschler CJ, Wierzbicka A et al (2013) Ultrafine particles: Exposure and source apportionment in 56 Danish homes. *Environmental Science and Technology,* 47, 10240-10248.

Hussein T. and Kumala M. (2008). Indoor Aerosol Modeling: Basic Principles and Practical Applications, Water, Air, & Soil Pollution: Focus, 8: 23-34.

Morawska, L., Afshari, A., Bae, G.N. et al 2013. Indoor Aerosols: From Personal Exposure to Risk Assessment. Indoor Air, 23, 462-487