Effect of therapeutic salt aerosols on ambient particle concentrations and size distributions and related lung deposition

F. Kwasny, P. Madl and W. Hofmann

Department of Materials Engineering & Physics, University of Salzburg, 5020 Salzburg, Austria

Keywords: salt aerosol, inhalation, modeling, lung deposition

The investigated "Gradierwerk" (GW) is a covered open-air saltwater inhalation spa in Bad Reichenhall, Southern Germany, close to Salzburg. Almost 400 x 10^3 L of alpine brine per day trickle down the 13 m high wall made of stacks of hawthorn and blackthorn twigs. Drippling occurs at the luv-side of the GW, allowing the wind to press the nebulized brine through the twigs onto the lee-side of the GW, where patients are supposed to stand for therapeutic inhalation. The park is surrounded by a major road to the north-west, a residential area to the north-east and a pedestrian district on the remaining sides with the GW being located at the center.

The SMPS-sampling campaign investigated the suspended particle number in the range below 1 µm. A repetitive series of measurement was carried out at selected sites in the vicinity of the GW to obtain a realistic picture of the particle distribution around the GW and the adjacent spa garden. A comparison of the aerosol inventory was made when the GW was turned on and when it was turned off for maintenance reasons. During operation, a peak at around 100 nm occurred. Under almost identical meso-climatic conditions, a significantly higher amount of nano-particles was present below the 20 nm range when the GW was turned off (Figure 1).

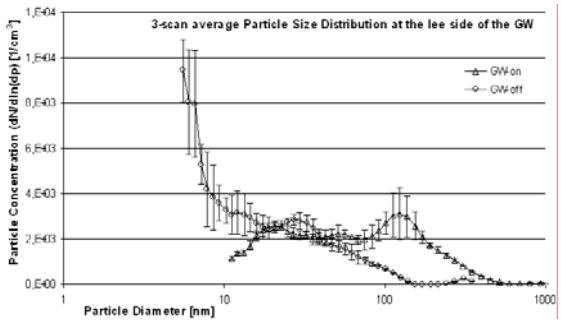

Figure 1. Difference in particle size distribution during on / off cycles at the lee sides of the GW.

To assign the observed agglomeration peak during on-site measurements to the brine aerosol, a lab-experiment was conducted which confirmed that nebulized brine did indeed level out over time towards the characteristic agglomeration peak at around 100 nm.

Investigating the fate of inhaled particles, the stochastic lung particle deposition model IDEAL-2 (Koblinger and Hofmann, 1990; Hofmann and Koblinger, 1990) was used. Applying the scanned particle spectrum of the GW under the two operational conditions, revealed a significantly higher total lung deposition when the GW was turned off (Figure 2). Calculations with the spectral data when the GW was in operation, total pulmonary deposition decreased somewhat. However, a further reduction was obtained when introducing an equilibrium hygroscopic growth factor (HGF) of 5 for the inhaled brine aerosol (Heyder et al., 2004) to reflect the almost super-saturated conditions within the human respiratory tract.

Besides the well-known therapeutic effects of nebulized brine aerosol, a significant reduction of nanometer-sized particles (probably traffic-related) in the ambient air could be observed.

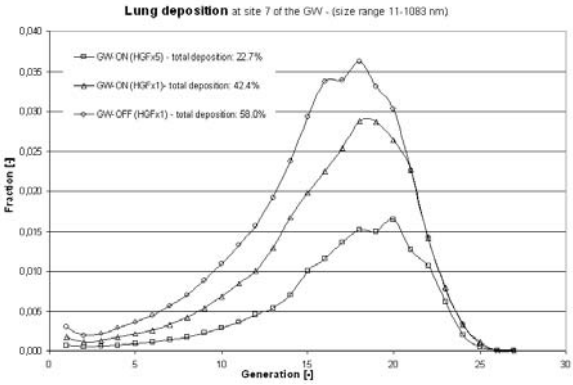

Figure 2. Computed particle deposition patterns of the nebulized brine aerosol in the various lung generations.

This research was made possible by the Kur GmbH Bad Reichenhall / Bayerisch Gmain. Climatic data were kindly provided by the Salzburg Airport and the Deutscher Wetterdienst.

Heyder, J., Gebhart, J. Roth, C., & Ferron, G. (2004). in Gradon L., Marijnissen, J.C. (eds.). *Optimization of Aerosol Drug Delivery*. Heidelberg, FRG: Springer Verlag, 139-147.

Hofmann, W., & Koblinger, L. (1990). *J. Aerosol Science*, 21, 675-688.

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