The measurement of nanoparticle deposition efficiency in the lungs of Wistar rats

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The nanoaerosol drug delivery to a patient is used now for the treatment of both respiratory and systemic diseases. Lung-deposited dose depends on the particle deposition efficiency, which in turn is function of the size. The aim of present work was experimental definition of dependence of nanoparticle deposition efficiency from the diameter in the rat's respiratory tract. The basic idea of the experiment was to determine the depletion of aerosol due to rats breathing.

The inhalation scheme (Fig.1) includes a flow aerosol generator, four glass boxes for rats, filter, diluter and aerosol spectrometer. The horizontal evaporation–condensation aerosol generator was made of a molybdenum glass tube with an outer heater. Air flow was supplied to the inlet of the generator. The original substances (nisoldipin or sodium chloride) were put to the hot zone inside the tube. The saturated vapor was formed inside the generator. The temperature dropped down at the outlet of the heated zone resulting in vapor supersaturation. Then there was the homogeneous nucleation. The final aerosol was admitted into the nose-only exposure glass chambers. Each chamber contained one rat during the experiment. The laboratory Wistar rats were used. The aerosol depletion due to rats breathing was determined by comparing the substance particle concentration at the outlet of loaded and unloaded consecutive chambers. The aerosol concentration and size distribution were measured with the aerosol spectrometer. This aerosol spectrometer consists of an automatic diffusion battery, condensation chamber, and photoelectric counter.

Nanoparticle deposition efficiency (Fig.2) was calculated via the following formula [1], [2]:

$$\varepsilon = \frac{F}{f * V_T} * [1 - (\frac{n}{n_0})^{\frac{1}{N}}]$$, where

ε - deposition efficiency, F - flow rate, f - average rat breathing frequency, V_T - tidal volume, n – number concentration of loaded chambers, n_0 - number concentration of unloaded chambers, N – number of chambers.

Using the NOE chambers, the rats lung deposition efficiency was evaluated as a function of the particle diameter changing from about unity at d = 5 nm to about 0.3 at d = 100 nm. Deposition efficiency was not depend on the type of material, but only on the size.

Financial support for this work was provided by the Siberian Branch of Russian Academy of Sciences (SBRAS): Interdisciplinary Integration Project No.3 and SBRAS-Taiwan Collaboration Project No.7; RFBR project No. 11-08-01204-a and the cooperation Agreement between CNR (Italian National Research Council) and RAS (Russian Academy of Science) years 2011-2013.

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2. Andrei A. Onischuk et al. // J. of Aerosol Med. And Pulmonary Drug Delivery. 2009. V.22. № 1.

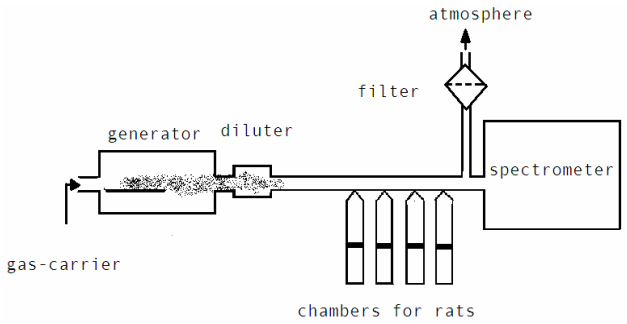

Fig. 1. Experimental setup.

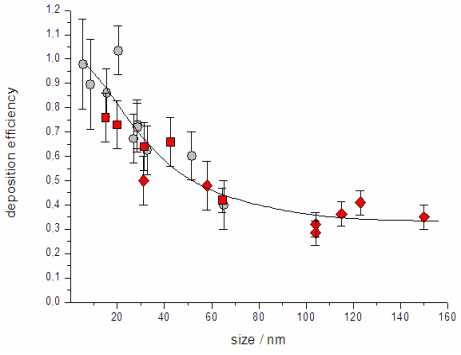

Fig. 3. Deposition efficiency from the size.