The assessment of efficiency of flow through type room air cleaners

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The creation of appropriate conditions in premises with high purity requirements is impossible without special preparation of air medium. For many productions, it is most critical to ensure aseptic conditions. Therefore, bioaerosol removal from indoor air is an urgent task. Currently, the market offers a wide variety of flow through type air cleaners and disinfectors, which are tested for filtration efficiency according to the available standards (see AHAM, 2002), based on the CADR (Clear Air Delivery Rate) value. However, the CADR value does not say anything about the inactivation of microorganisms that have passed through disinfectors, which results in the reduction of the concentration of viable microorganisms at the device outlet not only due to the retention of particles in the device.

A natural measure of the efficiency of aerosol disinfection by the test device, ***E*** is the ratio of the concentrations of viable microorganisms at the device output (C_{out}) and inlet (C_{in}):

$$\boldsymbol{E} = 100*(1 - C_{in} / C_{out}), \%.$$

While the proportion of the total number of aerosol particles that passed through the device only weakly depends on indoor temperature and relative humidity (except for their extreme values), for viable microorganisms such dependencies can be very sharp. In addition, even at fixed temperature and relative humidity, various microorganisms differently respond to inactivating factors inside the device such as ozone and air ions concentrations, UV-radiation, the gas phase composition, the composition of aerosol containing microorganisms, etc.

The available literature data (see e.g. Jensen, 1964; Harper, 1963; Akers, *et al*., 1966) and our own investigations illustrate the above. For example, influenza A viruses and vaccinia virus are almost completely inactivated by UV-radiation under the experimental conditions described in Jensen (1964), whereas adenovirus survives under the same conditions up to approximately 10 %. Generally, all microorganisms in an aerosol state are inactivated faster at higher temperatures under otherwise identical conditions. Some viruses are slowly inactivated at high or low relative humidity, while they are quickly inactivated at average relative humidity (Harper, 1963; Akers, *et al*., 1966).

The authors have investigated the inactivation of various microorganisms both in the passage through the "Tion B" disinfecting air cleaners and inside particles deposited on output filters of the electrostatic unit of the working device. It is shown that at similar temperature and relative humidity under the action of inactivating factors inside the "Tion B" disinfecting air cleaners, 99 % inactivation of microorganisms on the output filters of the electrostatic unit of the working device is achieved:

- for *Staphylococcus aureus* bacteria within 2 hours;
- for *Mycobacterium smegmatis* (GK strain) bacteria within 1 hour;
- for Ebola virus (Zaire strain) within approximately 1.5 hours;
- for influenza virus A/Aichi/2/68 (H3N2) – within less than 10 minutes.

When passing through the device inside aerosol particles (i.e. particles not deposited on the walls and the filters), a little more than 1 % of *Mycobacterium smegmatis* bacteria and influenza virus A/Aichi/2/68 (H3N2) but more than 20 % of *Staphylococcus aureus* bacteria remain viable under the test conditions of working device "Tion B".

Obviously, it is correct to compare the efficiencies of air disinfection by different devices only on condition of identical microorganisms aerosolized from the same material (liquid or dry) under identical microclimatic conditions. In all other cases, the comparison of the efficiencies of air disinfection by various devices will be incorrect.

Based on the foregoing, it has become necessary to develop a normative document (at the national or international level) regulating the assessment of efficiency of room air cleaners under standard temperature and relative humidity using only certain microorganisms such as bacteria, viruses and fungi.

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