# RESPIRATORY PROTECTION AGAINST OCCUPATIONAL BIOAEROSOLS

## SUITABILITY OF PARTICLE FILTERING HALF MASKS

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Particle filtering half masks are recommended as a personal protection measure against airborne biological agents with health risks for employees, with infection risk, e. g. at medical services, at post stations where terror attacks are possible, and for aircraft personnel or at building redevelopment.

Filtering masks used as respiration protection against dust and other particles are classified in Europe according to the standard EN 149 as FFP1, FFP2 and FFP3 representing penetration rates of max. 22%, 8% and 2%, respectively. These classifications are due to fit tests with test persons exposed to NaCl crystalline particles of a defined size spectrum. These masks are designed as one-way (single use) products and are in principle a good compromise between particle retention (safety!) and respiratory resistance (ergonomic comfort!).

According to EN 149 the penetration rate is determined by mass concentration measurements of NaCl outside and inside the masks. The mass concentration as the criterion used in EN 149 gives a useful information with respect to the assessment of the protection against chemical risks, e. g. of heavy metal dust, paint or solution aerosols. But with regard to biological agents penetrating into a filter mask, the number of particles more than the particle mass is responsible for possible health effects.

Therefore the numeric concentration of penetrating particles is a better basis when estimating the remaining respiratory risks using filter masks against hazardous bioaerosols. This is not considered by the EN 149 and by occupational safety experts in present recommendations for the use of simple filter masks.

In our studies we used samples of filtering mask material, and the whole filtering masks fixed on a standard test head (Sheffield Head) to determine numerical penetration rates of NaCl crystal particles (according to the EN 149 size range from 0,02 to 1 µm), spores of Bacillus subtilis (0,5 - 0,8 x 0,7 - 1,1 µm) and Aspergillus niger (diameter 3,3 - 5,0 µm) .

The following results are important for evaluating the risk reduction by the use of filtering half masks:

- The filter mask materials of the most important producers on the EU market accord to the EN 149, but within the three filter classes FFP1, FFP2, and FFP3 they still show different filtering characteristics depending on defined particle sizes within the whole range. This is due to the differing structure of the filter materials (influence of fibre density & diameter, thickness of the filter layer and in some cases electrical surface potential of the single fibres to optimize particle retention versus respiratory resistance of the material).
- The whole masks on the test head retain the mould and bacteria spores better compared with the EN 149 limits (with regard to the whole size range) due to the large size of the spores.
- The mask types of the different producers show a large variety of leakage rates between mask sealing and face, depending on the mask and sealing design.

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- Leakage between mask sealing and face surface is determined up to 70% of whole particle penetration into the masks depending on the mask type and producer, in some cases penetration rate is too high compared with the EN 149 limits.
- Oil coated NaCl particles equivalent to the aerodynamic particle size of the spores show a higher penetration than the biological particles. This may be a hint for particle properties other than the particle size to play a role in retention by the filter material. This contradicts somehow the common position of the experts about the particle size as the only parameter of retention.

These results lead to the following interpretation:

A classification of filter masks based on the determination of the mass concentration according to EN 149 is – with regard to the retention efficiency against biological particles with infection risk – not necessarily appropriate. In this respect measuring methods of the leakage rates, which are based on a numerical instead of a mass determination, are more suitable.

Regarding the assessment of the suitability of filter masks against infectious microorganisms a leakage analysis only with particles of the respective size and not with the whole size spectrum makes more sense as the filtering efficiency depends on the particle size.

The different results with bacteria spores and inorganic particles with an equivalent aerodynamic diameter indicate that possibly the surface characteristics of the particles (e. g. electric potential, physical-chemical characteristics) according to the properties of the different filter materials influence the retention capacity of the filter. So far the experts have assumed that the retention capacity of the filter material is not influenced by the surface characteristics of any particles.

For the determination of an optimal respiratory protection in combination with the lowest possible physical discomfort for the user (lowest possible respiratory resistance, wearing comfort) it seems to make sense – considering the stated results – to identify the type and size of the particles to be considered.

With regard to their suitability as protective measure against the exposition to airborne biological agents the filter masks should be classified based on the respective particle size classes and number-oriented measuring methods.

Concerning the further development of filter masks the improvement of the mask-face-sealing can be considered as the most important starting-point.