Tests of the personal respiratory protective equipment using radioactive aerosols

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Keywords: radioactive aerosol, respiratory protection, radon, filtration efficiency.
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Personal respiratory protective equipment (RPE) should satisfy at least the requirements of the European Standards. Non-radioactive aerosol particles are used in standard testing process for RPE. The presented paper describes alternative methods to test the protection level of RPE using radioactive aerosol particles.

Aerosol particles are sampled from Radon-Aerosol Chamber (RAC) which volume is 10 m^3. Nebulized salt crystals (size mode: 30 nm – 200 nm) and condensed carnauba wax (size mode 200 nm – 350 nm) are the main sources of aerosol particles. Aerosol particles are contaminated by radon daughter products. The standard concentration of radon for RPE testing is between 50 – 200 $kBq \cdot m^{-3}$.

Simplified diagram (Figure 1) presents the main principle of configuration for RPE material testing:

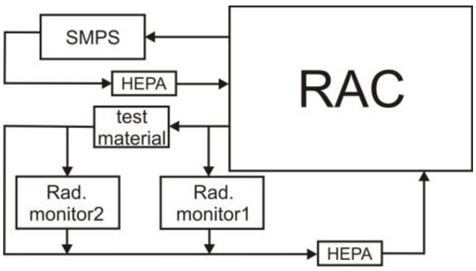

Figure 1. Simplified diagram of RPE material testing

In the upper part of Fig.1 it is possible to see aerosol measuring branch which controls parameters - concentration, geometric mean of diameter, GSD etc. by Scanning Mobility Particle Seizer 3936 (TSI).
In the lower part two equipment for radioactive aerosols measurement are demonstrated – one (1) characterized state before RPE, the left part (2) state behind „filtering“ by RPE. The ratio of results (2/1) represents an estimation of penetration at known velocity of air stream and known aerosol diameter. The volume of samples which are taken from RAC are negligible compared to the total volume of testing chamber. Radioactive contamination is determined by alpha spectrometer 7401 VR (Canberra).

Results and Discussion

This method was applied for testing RPE materials of personal protective equipment (filtering efficiency FFP3 and FFP2) and of medical masks. For each RPE there were five samples cut out, which were gradually tested. Each of the sample was tested at various flow rates.

The following figures 2 and 3 present the results of the best and the worst materials considering their penetration.

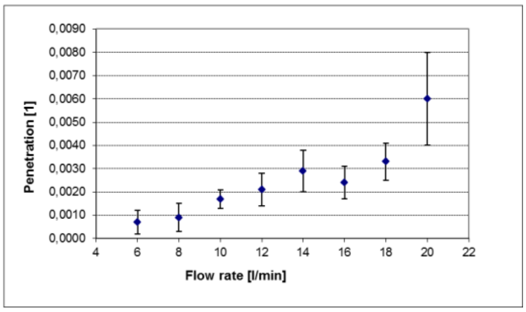

Figure 2 The dependence of penetration to flow rate for material class FFP3 (size mode 350 nm, GSD 1,4)

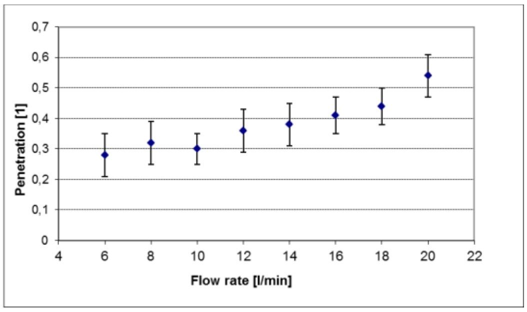

Figure 3. The dependence of penetration to flow rate for medical drape (size mode 320 nm, GSD 1,5)

Conclusion

Presented method allows the determination of penetration of aerosols particles for various types of materials forming RPE. Due to relative simplicity and large dynamical range of the measurements of radioactive contamination, this method seems to be more accurate mainly for materials with low degree of penetration.

This work was supported by project VF 20110201513 of Ministry of the Interior of the Czech Republic.

Burian I., Otahal P., Vosahlik J., Pilecka E. (2011): Czech primary radon measurement equipment, Radiation Protection Dosimetry, Vol 145, No. 2-3, pp. 333-336