Effectiveness of N95 Disposable Particulate Respirators and FPP3 Half Mask Respirators against target NMs for the pigment and inks industry

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Abstract:

In the particular case of the pigment, ink and paint industry, the use of engineered nanoparticles (ENPs), have a great potential for new applications, leading to products with new or enhanced properties, and opening new market opportunities. Consequently, many promising applications emerge nowadays, based on the use of ENPs such as Fe3O4, TiO2 or ZnO or quantum dots (QDs).

Along with the benefits, there is an on-going debate about their potential effects on human health or the environment, considering as a key issue the potential adverse effects of ENPs on workers upon inhalation. In this sense, it has been demonstrated that ENPs can become airborne during common industrial activities, some of them related with the production of nano-pigments and/or nano-inks. These airborne particles, including nanoparticles and ultrafine particles may enter into the human respiratory tract via inhalation.

Considering the growing production of nanoparticles to develop high-tech applications, there is an urgent need to define adequate risk management measures to mitigate and control the exposure. A first step to protect workers is to enhance the knowledge on the effectiveness of current risk management measures, including personal protective equipment (PPE) and engineering controls (OC).

A complete evaluation of the effectiveness of common RMMs against ENPs at the workplace has being carried out under the scope of the FP7 project NanoMICEX (NMP4-SL-2012-280713) and the LIFE+ Project NanoRISK (LIFE12/ENV/ES/178). We present here the results encountered during the evalaution of the protection factor (APF) and leakage efficacy effectivness of two different types of respirators, including a N95 Disposable Particulate Respirator and a FPP 3 reusable half mask respirator. The selected RMMs were evaluated in the testing chamber designed and developed by ITENE. A picture of the testing chamber and the Sheffield head employed during the test are depicted in figure 1.

The experimental protection factor was defined by the ratio between the number concentration of particles upside the protective device (Cupstream) and the concentration within that device (Cdownstream). The concentrations upstream were measured by means of a Philips Nanotracer, which detects particles below 300 nm and an Optical Particle Sizer (OPS-TSI), which detects particles up to 10 microns. Downstream the particles where detected by means of a CPS System (CPC model 9007 – TSI). To conduct the tests with our target ENPs, it was necessary to use a powder aerosolizer, in this case, the Naneum powder aerolizer PA100. Average penetration levels for the two different masks were between 26 and 2%., with a minimum penetration level for the Reusable Half Mask respirator. The results showed significative differences in the penetration factor for the models studied. It shall be noted also that the PF characterized are higher than the recommended 5%, which means that none of the mask tested are effective enough against ENPs

Figures

Fig. 1. Sheffield head (Courtesy of the INSHT) and the Aerosol Testing Chamber developed by ITENE