Comparison of the responses of a novel nanoparticle measurement device with commonly used aerosol instruments

Leskinen, J[1]., Ihalainen M[1]., Saukko, E[2]., Janka, K[2]., Jokiniemi J[1]., Miettinen, M[1].

[1]Dept. of Environmental and Biological Sciences, Univ. of Eastern Finland, P.O. Box 1627, FI-70211 Kuopio, Finland
[2]Pegasor Ltd, FI-33100 Tampere, Finland
Keywords: Occupational Hygiene, Instrument Development, Nanoparticle
Presenting author email: Jani.Leskinen@uef.fi

Nanoparticle concentrations need to be monitored and measured to ensure the safe working environment for the employees for example at nanotechnology workplaces. Numerous methods and instruments have been used for the monitoring. However, the markets are lacking an affordable and easy to use instrument, which would provide reliable and extensive information about the nanoparticles in the workplace air.

A novel aerosol instrument (Pegasor AQ^{TM} Indoor) for nanoparticle monitoring and measurements was compared with commonly used aerosol instruments including TEOM (ThermoScientific), NSAM (TSI), UCPC 3776 (TSI), CPC 3775 (TSI) and SMPS (TSI). The Pegasor AQ^{TM} Indoor utilizes diffusion charging and measurement of the charge carried by the particles with a sensitive electrometer. In addition, an adjustable threshold voltage is used to prevent gas ions entering to the electrometer. Moreover, the adjustable voltage is used in advance for characterizing the particles. The instrument provides a number, a mass and an active particle surface area concentration. The instrument is equipped with 2.5 µm precyclone, however the true maximum particle size is far below this limit due to the measurement technique.

Pulverized TiO_2 nanopowder (with Fluidized Bed Generator, TSI) and atomized ammonium sulphate ($(NH_4)_2SO_4$) solution (Constant Output Atomizer, TSI) were used as test aerosols. The aerosol was sampled from a chamber (Ihalainen et al., 2012) to provide a stable particle concentration. Moreover, the measurement instruments were used in actual workplaces including a welding workshop, a metal workshop, a bakery and a kitchen furniture factory.

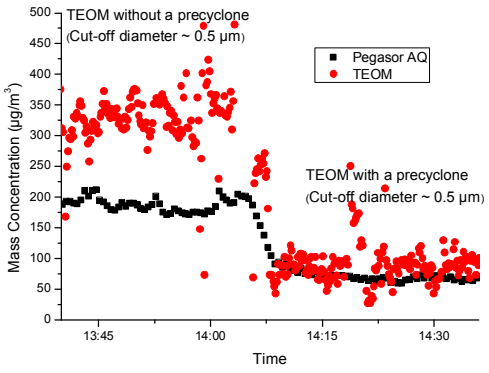
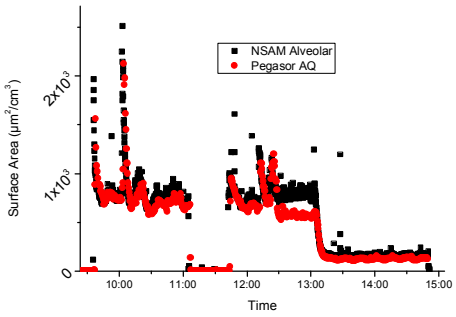


Figure 1. Mass concentration of TiO_2 particles measured with TEOM (with and without 0.5 µm precyclone) and Pegasor AQ^{TM} Indoor.

A)



B)

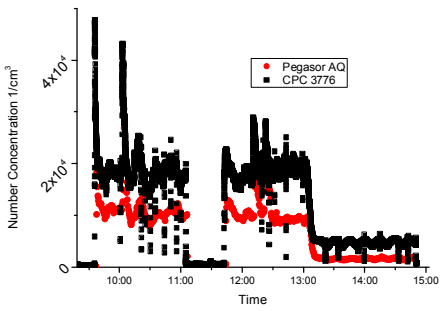


Figure 2. A) Surface area concentration of TiO_2 particles measured with NSAM (alveolar lung deposition) and Pegasor AQ^{TM} Indoor (active surface area), B) Number concentration of TiO_2 particles measured with CPC 3776 and Pegasor AQ^{TM} Indoor. Precyclone was not used with the CPC.

Pegasor AQ^{TM} Indoor instrument was found to measure surface area, number concentration and mass concentration with sufficient consistency compared to commonly used instruments (Fig 1 and 2). However, the values from Pegasor AQ^{TM} Indoor were generally lower. Nonetheless, the correlations are obvious. The differences between TEOM and Pegasor AQ^{TM} Indoor, for example, can be partly explained with the larger measurement range of TEOM.

Ihalainen, M.; Lind, T.; Torvela, T.; Lehtinen, K. E. J.; Jokiniemi, J. A method to study agglomerate breakup and bounce during impaction. Aerosol Sci. Technol. 2012, 46 (9), 990−1001.

The authors like to acknowledge The Finnish Work Environment Fund for the financial support.