Ventilation systems and respirators help protect workers from nanoparticles

Unprotected workers exposed to airborne nanoparticles face a potential health risk from carbon black and titanium dioxide nanoparticles, according to a recent study. Reducing airborne nanoparticle contamination to acceptable levels can be achieved by using a workplace filter ventilation system and personal respirators.

With the fast-growing use of nanoparticles (NPs) in a wide range of industrial processes, more research is needed to identify if they could cause any potential harm to human health and the environment. Properties of NPs are different to those of the same material in larger form, owing to their tiny size, large surface area, structure, surface chemistry and surface electrical properties.

This study assessed the health risks for nanotechnology workers exposed to airborne titanium dioxide NPs and carbon black NPs. Titanium dioxide NPs are commonly found in sunscreens and plastics and carbon black NPs are extensively used in vehicle tyres and plastics. It is believed that workers exposed to high concentrations of NPs in the workplace could potentially suffer health problems caused by NPs unless adequate measures are taken to prevent their inhalation.

The relationship between inflammation of the lungs and damage to lung cells caused by the cumulative amount of inhaled NPs was modelled to determine the potential health risks resulting from exposure to titanium dioxide NPs and carbon black NPs in manufacturing plants for the nanomaterials. NP concentrations and size distribution data were obtained from manufacturers in China. In addition, three management strategies to control exposure risks were evaluated.

Overall, the risks of lung inflammation and damage associated with exposure to NPs for carbon black NPs were twice as great than for titanium dioxide NPs. This is probably because significantly higher amounts of carbon black NPs are deposited in the lungs through inhalation compared with titanium dioxide NPs. In addition, it appears that carbon black NPs are more harmful to lungs than a comparable dose of titanium dioxide NPs. Unprotected workers in the nanotechnology industries would therefore be potentially at risk from inhaling carbon black NPs and titanium dioxide NPs.

The most effective management strategy to minimise the exposure of workers to NPs was found to be a combination of 1) removing NPs from the air via a ventilation filter system together with 2) the use of a personal N95 respirator. An N95 respirator is typically a disposable face mask capable of filtering fine particles.

This combination was more effective than using either a ventilation system or an N95 respiratory in isolation. However, the protection offered by the N95 respirator alone was significantly greater than that provided by the ventilation system (filter and updraft hood) alone.

Workers would be exposed to 161,015 particles per cubic centimetre (particles/cm$^3$) of carbon black NPs (in the lungs) in an uncontrolled environment. However, if both a ventilation system and an N95 respirators were implemented, this figure would drop to 112 particles/cm$^3$; 209 particles/cm$^3$ when controlled by an N95 respirator; and 86,008 particles/cm$^3$ when only a ventilation system was used.

The researchers suggest that these reductions in concentrations of carbon black NPs and titanium dioxide NPs are at an acceptable level that prevents the exposure risk of lung inflammation and damage.


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Additional information: In response to the study upon which this article is based, a series of letters to the editor of the journal Environmental Science and Pollution Research has since been published. The letters represent a debate between the study’s authors and other researchers concerning the methods used and the conclusions drawn by the study. To view all the letters, please see the following series of links (journal subscription may be required):