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Are respiratory protection standards protecting worker health against ultrafine diesel particulate matter emissions? An Australian perspective

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Are respiratory protection standards protecting worker health against ultrafine diesel particulate matter emissions? An Australian perspective

Abstract

Poster presentation made at the 20th ETH-Conference on Combustion Generated Nanoparticles, 13-16 June 2016, Zurich, Switzerland.

Aim: Ultrafine diesel engine emissions are known to cause adverse health impacts including lung cancer, cardiovascular and irritant effects (World Health Organisation 2012). Respiratory protective devices are commonly used to mitigate worker exposure to many hazardous contaminants, especially in heavy industry such as mining and refining. Current standards to evaluate penetration through respirator filter media may not consider ultrafine particles due to the diameter of the challenge aerosol and the detection limit of the instrument (Eninger et al. 2008). Nor do they test penetration at flow rates representative of moderate to heavy work rates. Research is currently being undertaken at the University of Wollongong, Australia, to develop a method to measure penetration through respirator filter media using diesel emissions, rather than the standard challenge aerosol of NaCl, at flow rates consistent with moderate to heavy work rates. **Methods:** Emissions from a Detroit D706 LTE diesel engine were fed into an experimental chamber which was purpose built for the study. Penetration through a range of commonly used respirator filters in Australian workplaces was determined by particle count at diameters ranging from 5.6 - 560nm, using an Engine Emissions Particle Sizer (EEPS). Penetration was also measured by mass of Elemental Carbon, using NIOSH 5040. Flow rates were as designated in AS/NZS 1716 (Standards Australia International Ltd & Standards New Zealand 2012) and ISO DIS 16975 - 1.2 Work Rates 2 and 3 (ISO 2015), consistent with moderate to heavy work rates. **Results and Conclusions:** A method has been developed and validated and a pilot study completed. Initial findings indicate penetration exceeded standards specified limits for filtering efficiency for a number of filters for the size range <50>nm, when measured as a function of particle count. Penetration through the filters was found to increase as flow rate increases. These results differed from the penetration by mass of elemental carbon through the respirator filters, using a paired samples t-test at a significance level of 0.05. This research is relevant as it has been postulated that ultrafine particles may contribute to adverse cardiovascular mortality and morbidity associated with diesel engine emissions (Martinelli, Olivieri & Girelli 2013) hence it is important to determine if these smaller size particles are penetrating through respirator filter media and may be inhaled by workers.

Keywords

respiratory, standards, protecting, worker, health, protection, matter, emissions, against, ultrafine, diesel, perspective, australian, particulate

Disciplines

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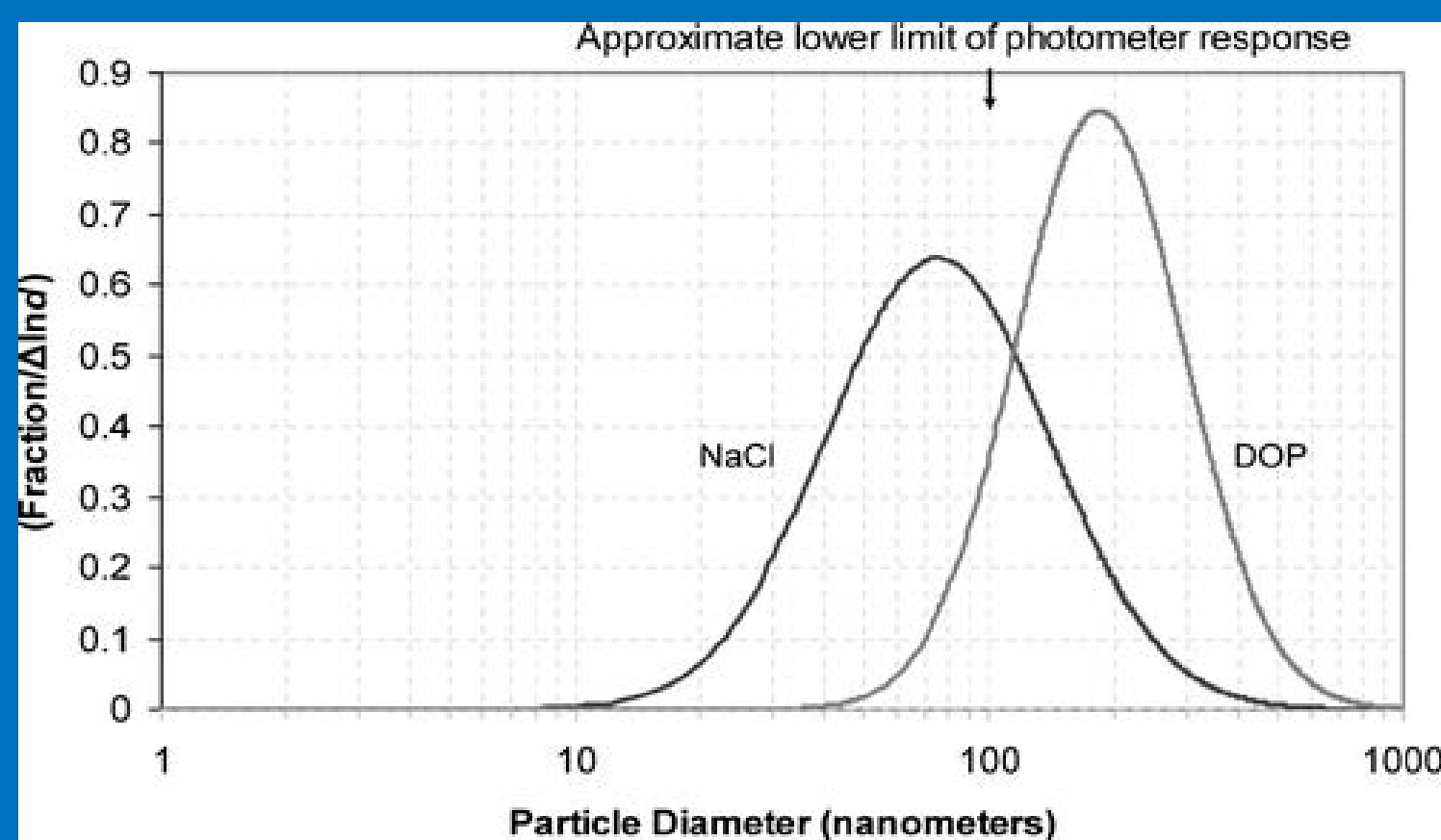
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Are respiratory protection standards protecting worker health against ultrafine diesel particulate matter emissions? An Australian Perspective.

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Background

- Respiratory protective devices commonly used to mitigate worker exposure to ultrafine diesel engine emissions known to cause health impacts like lung cancer, cardiovascular and irritant effects.
- Current standards to evaluate penetration through respirator filter media may not consider ultrafine particles.



Source: Adapted From Eninger, Honda et al 2008

Objective

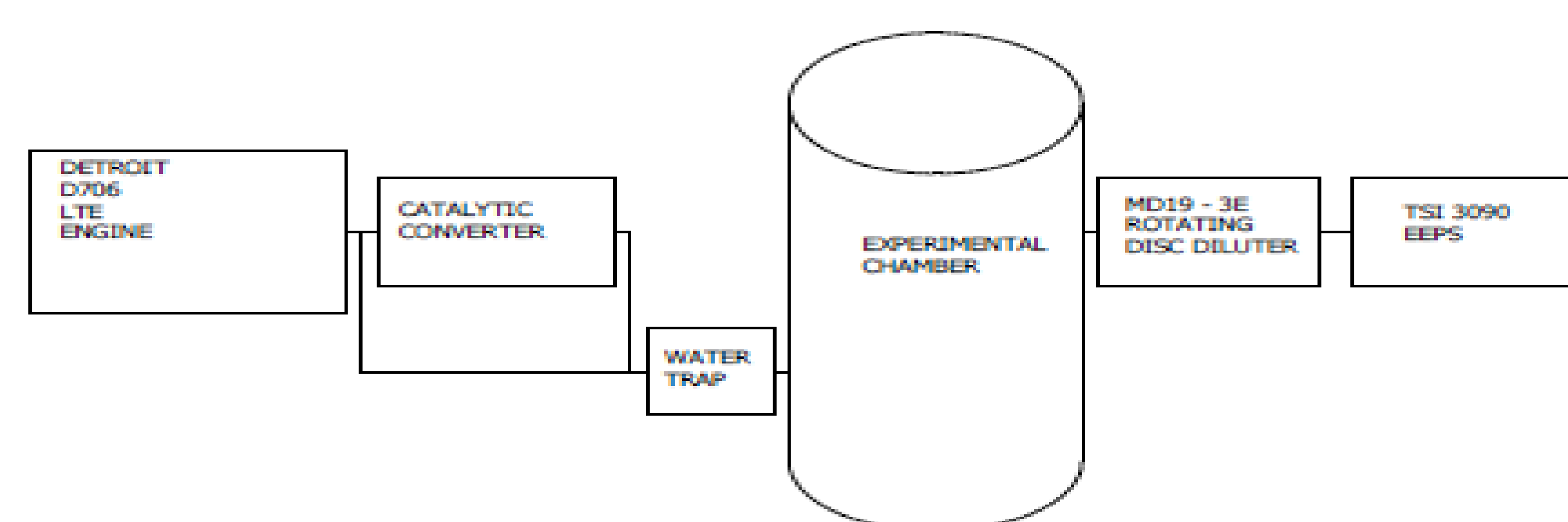
- Evaluate a range of commonly used respirators to determine penetration through the filter media by mass of Elemental Carbon and particle size.

Method

- Emissions from a Detroit D706 LTE diesel engine were fed into a purpose built experimental chamber, containing the respirator filters to be tested.

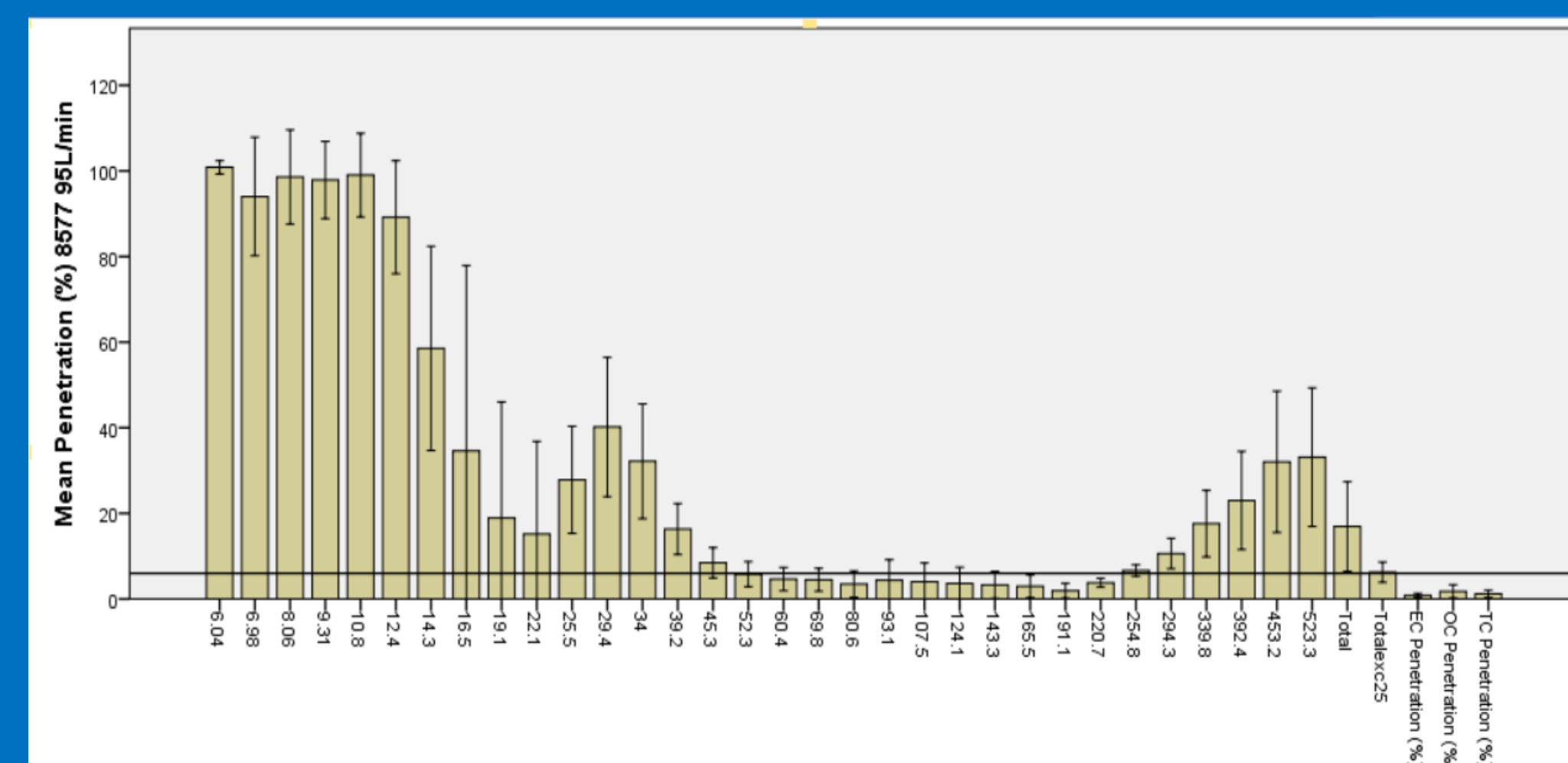


- Penetration was determined by particle count at diameters from 5.6 – 560nm, using a TSI Engine Emissions Particle Sizer (EEPS).
- Penetration also measured by mass of Elemental Carbon (EC), using NIOSH 5040.

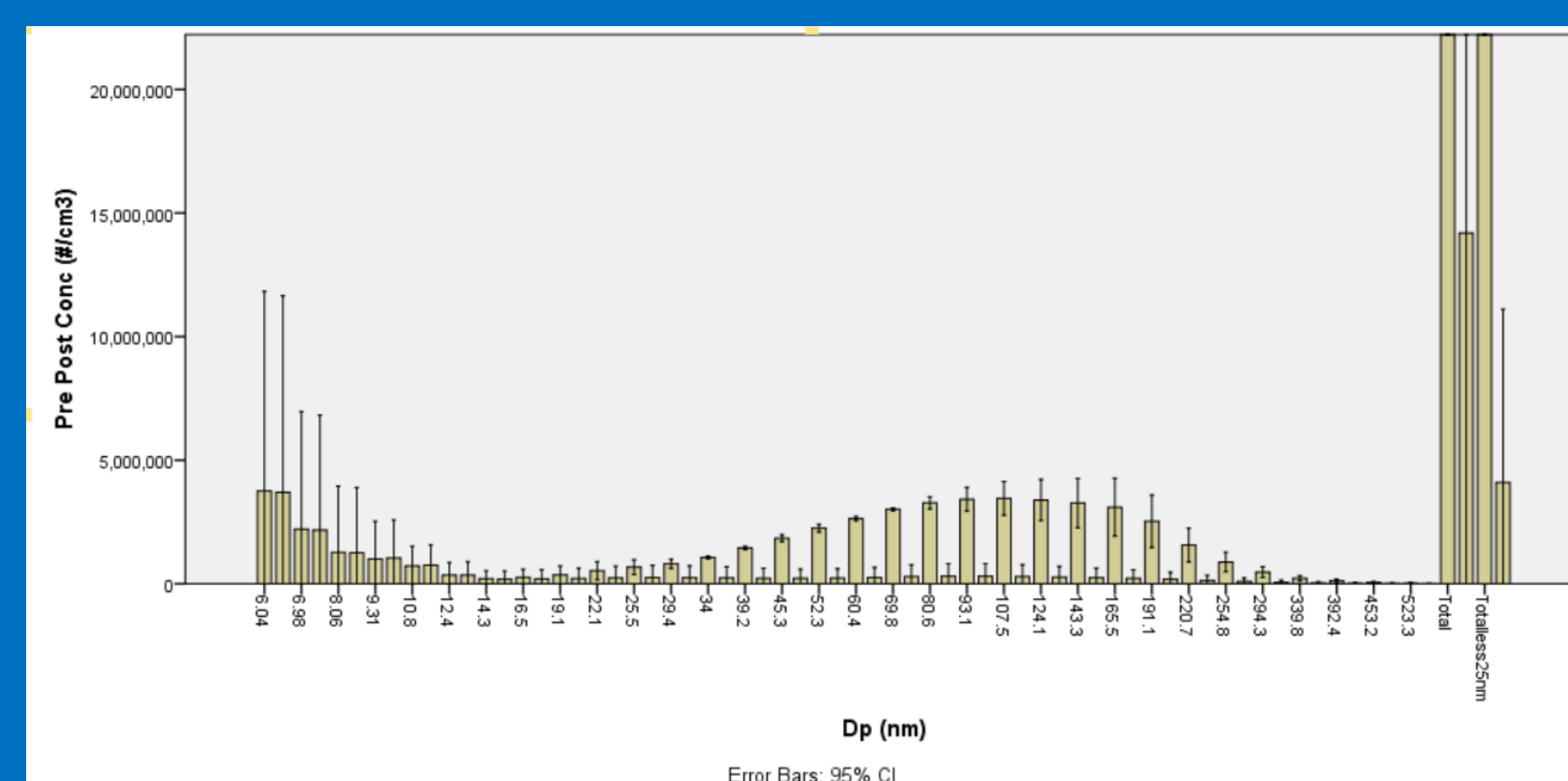


Preliminary Results

- Pre Filter EC concentration was ?, set to the rated protection factor of the P2 filters.
- Penetration exceeded standards specified filtering efficiency limits for the example filter, particularly in the size range <50 nm.
- When averaged across the entire measurement range by particle number $M = 16.9$, $95\% \text{ UCL} = 27.4$, $n = 7$. This exceeds the filtering efficiency requirement of <6% penetration.
- Penetration by mass of Elemental Carbon for the Example Filter was below the standards specified filtering efficiency limit of 6% ($M = 0.8$, $SD = 0.5$, $95\% \text{ UCL} = 1.3$, $n = 7$).



- These results differed from the penetration by mass of elemental carbon through the respirator filters, using a paired samples t-test at a significance level of 0.05.
- When number of particles is compared results pre and post filter were significantly different for the particle diameters, at a significance level of 0.05.



Conclusion and Future Work

- Initial findings indicate high penetration of ultrafine particles through commonly used respirator filters, which may lead to inhalation of these particles by workers.
- It has been postulated that ultrafine particles may contribute to adverse cardiovascular mortality and morbidity associated with diesel engine emissions (Martinelli, Olivieri & Girelli 2013).
- The absence of an occupational exposure standard with respect to particle number for these small diameter particles creates challenges in determining the subsequent health impact on workers.

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Acknowledgements

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