OPTICAL PARTICULATE MATTER MONITORING TECHNOLOGY IN TRAFFIC TUNNELS

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1. Introduction

An optical scattering system (FIDAS® 200) for online and simultaneous measurement of $PM_{2.5}$ and PM_{10} was trialled in a traffic tunnel environment using a modified mass correlation algorithm developed specifically for this application. The study was conducted to determine if a reliable and accurate alternative to the current TEOM monitors could be found in order to reduce the frequency of tunnel entries and improve safety for operators and motorists alike. The current TEOM monitors located in the tunnel require measurement filter changes at a ten day interval.

A FIDAS® 200 continuous particle monitor was installed in the fan chamber of a traffic tunnel alongside existing TEOM PM_{10} & $PM_{2.5}$ monitors and a 47mm reference method sampler for a period of ten weeks during summer and ten weeks during winter. The data from all instruments was averaged over five minute intervals and the results analysed.

2. Results

A total of 91 $PM_{2.5}$ and 47 PM_{10} reference samples were taken over varying periods from 9/02/15-2/03/15 and 30/5/15-12/6/15. Sample periods were programmed to provide for a spread of tunnel conditions including peak, off-peak and weekend periods. The FIDAS® 200 ran reliably in the traffic tunnel environment without intervention throughout the trial. The correlation between the reference method and the FIDAS® has been examined using "Guide to the Demonstration of Equivalence of Ambient Air Monitoring Methods" for both PM_{10} and $PM_{2.5}$ data sets. This method, adopted by the European Community, uses orthogonal regression to determine a linear correlation and expanded uncertainty assuming a 97.5% confidence interval.

For $PM_{2.5}$, when a multiplier of 0.942 and an offset of 15.3 $\mu g/m^3$ is applied, the expanded uncertainty of the FIDAS® readings becomes 10.2% (Figure 1).

For PM_{10}, when a multiplier of 1.01 and an offset of 28.0 $\mu g/m^3$ is applied, the expanded uncertainty of the FIDAS® readings becomes 12.4% (Figure 2).

These findings show that recent advances in optical monitoring technologies have made the accurate measurement of $PM_{2.5}$ and PM_{10} in the harsh and particle laden atmospheres of traffic tunnels possible. Continuous operation without intervention for the 12 weeks between tunnel shutdowns would lead to a sevenfold reduction in tunnel entries. This reduces the exposure of maintenance personnel to safety risks and the consequence of safety hazards from a road user perspective, by maximising the availability of ventilation and smoke extraction systems.

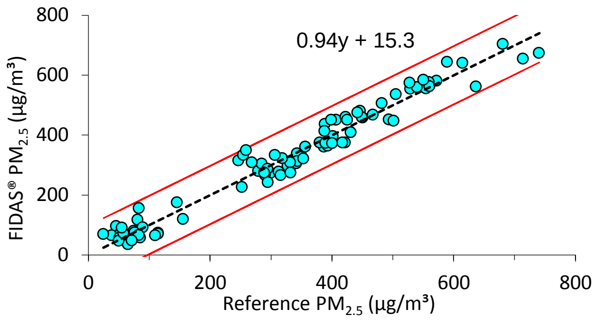

Figure 1. $PM_{2.5}$ FIDAS® vs Reference Method

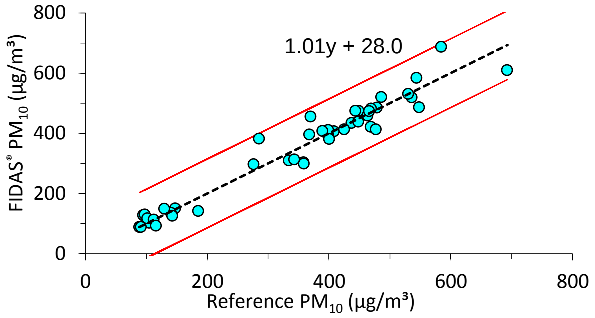

Figure 2. PM_{10} FIDAS® vs Reference Method

References

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