

DPM OC, EC and FT-IR data (Quantifying elemental and organic carbon in diesel particulate matter by mid infrared spectrometry)

Introduction

A method for the quantification of airborne organic carbon (OC) and elemental carbon (EC) within aerosolized diesel particulate matter (DPM) is described in the article cited below. DPM is a known carcinogen encountered in many industrial workplaces (notably mining) and in the ambient atmosphere. The method described here collects DPM particles onto a quartz fiber filter, after which reflection-mode infrared spectra are measured on a mid-infrared Fourier transform (FT-IR) spectrometer. Several infrared absorption bands are investigated for their efficacy in quantifying OC and EC. The thermo-optical (T-O) method is used to calibrate a linear regression model to predict OC and EC from the infrared spectra. The calibrated model, generated from laboratory DPM samples, is then utilized to quantify OC and EC in mine samples obtained from two metal mine locations under a variety of operating conditions. The feasibility of further improving these results by partial least squares (PLS) regression was investigated. A single calibration that is broadly applicable would be considered an improvement over currently available portable instruments, which require aerosol-specific calibration.

Methods Collection

Lab Generator diesel samples

- The lab-based system consisted of a diesel generator, an insulated sampling tube, a dilutor, a quiescence chamber, and a parallel multi-port sampling manifold. The generator was operated under multiple loading conditions from idle to 5 kW by way of a load bank; in this manner, samples with a broad range of EC to OC ratios were generated. Collection time ranged from 1 to 8 h. The sampling tube was insulated and fitted with heating tape to prevent premature condensation of volatile DPM aerosols. The hot stream of raw exhaust was drawn through the insulated sampling tube by means of the suction provided by an ejector-style dilutor, where it was immediately diluted with cool, dry air. The dilutor was configured to provide a dilution ratio of approximately 10:1. The DPM aerosol exiting the dilutor was directed under slight pressure into a quiescence chamber, where pressure was regulated to 0.05 in H₂O above atmospheric pressure by a separate fan and louver control to prevent ambient air from entering the chamber. The quiescence chamber was fitted with a 12-port manifold, with each port having a 1.7 liter/min critical orifice. The vacuum supplied to the manifold was maintained at >190 inH₂O to ensure critical flow through the orifices by way of a vacuum pump. Standard 37-mm quartz fiber filters in SKC cassettes (SKC Inc., Eighty Four, PA, USA) with 0.8-mm impactors were placed upstream from each critical orifice to collect the DPM.

Mine diesel samples

- Mine area samples were obtained using sampling pumps operating at 1.7 liter/min preceded by Dorr-Oliver cyclones, sampling cassettes containing 0.8-mm impactors and 37-mm quartz fiber filters (SKC Inc., Eighty Four, PA) as described in the NIOSH method 5040. The samples were collected at a variety of locations in the mine to provide samples that would be representative

of what workers might be exposed to during their work shift. This included samples taken in active stopes at the height of a workers breathing zone, where diesel powered equipment was traversing to haul ore and muck, as well as locations in the ventilation circuit that were upstream and downstream from such stopes. The samples were taken over a period of approximately 8 h of continuous sampling.

Blank samples

- Blank samples were created by cleaning the quartz fiber filters of any residual OC or EC. This was accomplished by performing the 5040 analysis on an unused filter to remove any OC or EC (almost entirely OC), and then immediately obtaining an FT-IR spectrum of the cleaned quartz fiber filter.

Citations

Parks DA, Griffiths PR, Weakley AT, Miller AL. Quantifying elemental and organic carbon in diesel particulate matter by mid-infrared spectrometry. *Aerosol Sci Technol*. 2021 May 9;55(9):1-14.

Acknowledgements

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