

Dataset: DPM OC, EC and FT-IR data

Mine Samples

The mine diesel particulate matter (DPM) 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 area 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 worker's 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.

Laboratory 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 elemental carbon (EC) to organic carbon (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.

Carbon analysis using NIOSH method 5040

An Organic Carbon/Elemental Carbon (OCEC) Laboratory Instrument Model 5 L (Sunset Laboratory, Inc.) was utilized to measure OC and EC according to the NIOSH method 5040. The 5040 method involves removing the filter from the cassette and punching a 1 or 1.5 cm² section from it. This filter section is then placed into a fused quartz oven, and the organic carbon is evolved in a flow of helium by raising the temperature in a series of temperature ramps up to 870 C. The evolved organic compounds are converted to CO₂, which in turn is converted to methane and quantified with a flame ionization detector (FID). The area under the evolution profile is proportional to the OC of the DPM. After all the OC has been evolved, the flow gas is switched from pure helium to 2% O₂:98% He, and the temperature is ramped stepwise to 930 C to remove any remaining carbonaceous material. The evolved CO₂ is again converted to methane before being measured by the FID. The area under this part of the evolution profile is proportional to the EC of the DPM. Total scan time is greater than 20 min. Correction for pyrolysis of OC is done by monitoring the He-Ne laser transmittance during OC evolution. Any reduction

in the laser transmittance during OC evolution is attributed to pyrolysis. Correction for this pyrolysis is then done by attributing the portion of EC evolved while the laser transmittance returns to its initial value to pyrolyzed OC. The FT-IR and 5040 analyses were done in quick succession to minimize loss of volatile OC between the two analytical methods.

FT-IR spectroscopy of DPM loaded filters

Mid-infrared spectra of each DPM-loaded quartz fiber filter were measured immediately prior to placing each into the T-O instrument for analysis. The spectra were measured using a Bruker Alpha FT-IR spectrometer equipped with an on-axis diffuse reflection (DR) accessory that incorporated a gold mirror backing on which the filters were mounted. Radiation reaching the room-temperature pyroelectric detector is reflected from the filter in two modes, specular reflection and diffuse reflection. Specularly reflected radiation is reflected from the front surface of the filter and does not penetrate the filter. Diffusely reflected radiation penetrates the filter and is scattered by the fibers before finally reemerging from the top surface of the filter. The single-beam DR spectrum of the filter mounted on a flat gold-coated mirror is ratioed against the corresponding spectrum measured with the filter removed. The resulting reflectance spectrum, $R(\nu)$ as a function of wavenumber, ν , is then converted to pseudo-absorbance, $-\log_{10}[R(\nu)]$