

Supplement of

Chemical composition of particulate matter from traffic emissions in a road tunnel in Xi'an, China

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Section A1 Selection of sampling site

In order to better capture the composition characteristics of PM emitted from vehicles, four sampling sites (#1, #2, #3, and #4) were initially set in each tunnel bore (southbound and northbound) considering the actual distribution of emergency parking areas in the tunnel. Site #1 was 700 m from the entrance, and site #2 was about 800 m from the exit. Moreover, site #2 and site #3 were located in the middle of the tunnel, and divided the tunnel into three parts; each part was about 2000 m in length (Fig. 1). During this experiment, PM sampling at site #4 in the northbound bore failed because of the malfunction of power supply at this site. Finally, PM samples were successfully collected at four sites (#1 to #4) in the southbound bore

and three sites (#1 to #3) in the northbound bore.

Section A2 Chemical analysis of PM

The contents of organic carbon (OC) and elemental carbon (EC) were analyzed by a model-4L semi-continuous aerosol carbon analyzer (Sunset Laboratory Inc.). The NOISH thermal-optical transmission (TOT) method was adopted for carbon analysis. Samples on a 1.5 cm² piece of quartz-filter were heated in a non-oxidizing environment (He), allowing OC to thermally decompose into organic compounds. The samples were subsequently heated in an oxidizing environment (He and O₂), allowing EC to thermally decompose into gaseous oxides. All the decomposed products were converted into CO₂ in the oxidation furnace (MnO₂) and measured by the non-dispersive infrared detection system (NDIR), with a detection limit of 0.05 μg cm⁻².

For water-soluble ions, half of each quartz-filter was cut into several small pieces and poured into a polyethylene vial with 20 mL of deionized water. The vials were placed in an ultrasonic water bath and shaken for 20 min at 40 °C to extract the ionic compounds. Then, the extracts were filtered with a 0.22-um microporous membrane for further analysis.

For trace elements, the Epsilon-5 X-ray fluorescence spectrometer (PANalytical Inc.) was operated at an excitation voltage of 100 kV and maximum power of 600 W, using a PAN 32 germanium detector. In order to detect various elemental species, this instrument can automatically adjust the tube current in the range of 0.5–24 mA.

Seventeen elements were recognized overall, including Na, Mg, Al, P, S, K, Ca, Ti, Cr, Mn, Fe, Cu, Zn, Br, Ba, Hg, and Pb.

Section A3 Quality assurance and control

Before sampling, all filters were preheated at 400–600 °C (quartz-fiber filter) or 50–60 °C (Teflon filter) for 2–5 h to reduce the influence of impurities. Moreover, all filters were balanced in a clean room under controlled conditions (temperature of 22–27 °C and relative humidity of 45–55%) for 24 h before sampling and weighing. Then, the filter samples were stored in a refrigerator (–4 °C) after sampling for subsequent chemical analysis. Field blanks and laboratory blanks were also collected and analyzed in the same way as mentioned above. The results of each sample were subtracted from the results of the filter blanks. Furthermore, the duplicate samples were examined after every two days of sampling, which ensured that the error was within 5%.