Analysis of airborne particulate matter by PILS-IC

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Ion Chromatography

Summary

This study compares air sampling data obtained by a filter-based method including off-line manual filter extraction followed by ion chromatographic analysis with those gained by an automated Particle-Into-Liquid-Sampler coupled to an ion chromatograph (PILS-IC). The daily time series data for the PILS sampler and the manual method showed a good agreement for nitrate, sulfate and chloride with correlation coefficients (R) better than 0.85542.

Concerning semi-continuous anion mass balance, PILS-IC provided results at a 19 minute resolution. While nitrate and sulfate concentration trends showed a good correlation with the water-soluble $PM_{2.5}$ trend, especially during the episode of high pollution between the 13th and 16th of May, the chloride time series did not match the $PM_{2.5}$ time series. This deviation is possibly due to the reactive nature of the halides forming other species not captured or detected by PILS-IC.

PILS-IC is a straightforward instrument for aerosol sampling that provides near real-time measurements for long-term unattended operation and is thus an indispensable tool to monitor rapid changes in aerosol particle ionic composition.

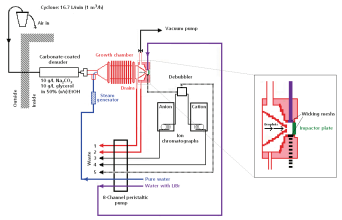
Introduction

Airborne particulate matter at sizes less than 1/20th the width of human hair can cause respiratory aggravation and may be linked to other more serious and chronic conditions. These particles are identified by their largest component sizes (e.g., 2.5 µm or Particulate Matter 2.5 – $PM_{2.5}$) and can be separated from larger particles by use of a cyclone. The ADI 2018 Particle-Into-Liquid-Sampler (PILS) is a device used to capture the particles in an air flow and dissolve the soluble constituents in a steam jet for analysis (in this case by ion chromatography – IC). The PILS-IC system provides analysis with fast cycle times giving the concentration of water-soluble components of the $PM_{2.5}$ such as nitrate, chloride and sulfate that may adversely impact human health.

In this poster, a comparison between the 30 day results obtained by the PILS-IC system and the results obtained by manual extraction and analysis of air filters will be presented. Airborne aerosol measurements were carried out at London Teddington, United Kingdom between the 8th of May 2009 until 7th of June 2009.

PILS-IC

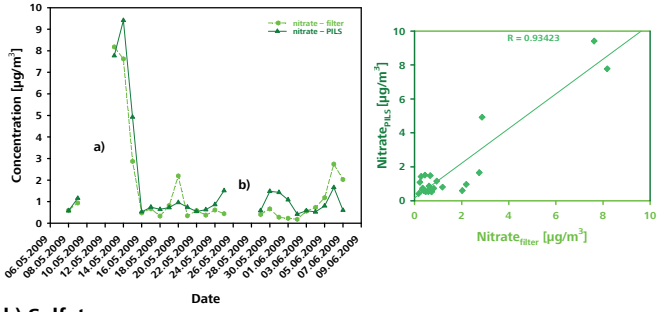
After air is sampled through a $PM_{2.5}$ cyclone, a carbonate-coated denuder removes any interfering acidic gas-phase species. The remaining aerosols subsequently enter the condensation growth chamber, where they are mixed with injected supersaturated steam. The rapid adiabatic mixing allows the aerosol particles to grow into droplets large enough to be collected by the impactor. A small flow of deionized water spiked with LiBr is introduced at the top of the impactor and transports the collected liquid to the base of the impactor from where it is transported to the sample loop of the IC system. 100 µL of sample are injected; the analysis lasts approximately 19 minutes.



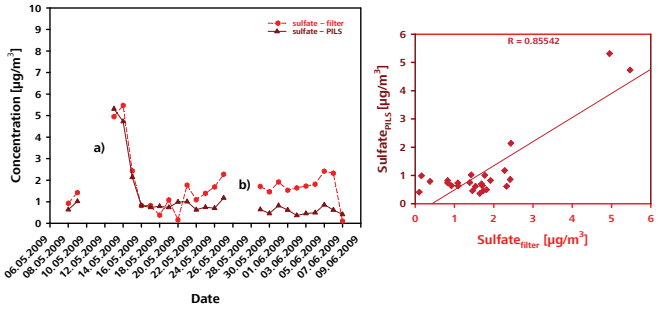
Daily measurements

Results obtained from the automated PILS system are compared to the results gained by manual extraction of air filters. A Thermo Partisol®-Plus Model 2025 Sequential Air Sampler was run to collect daily samples onto 47 mm ultrapure quartz filters.

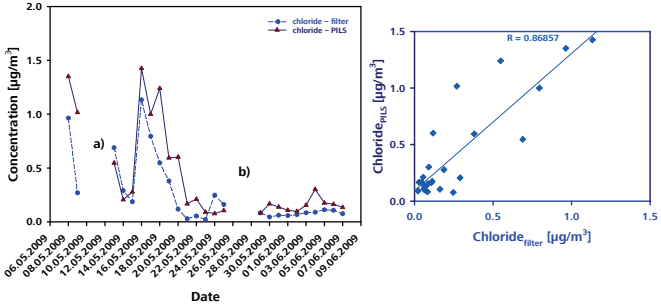
a) Nitrate



b) Sulfate



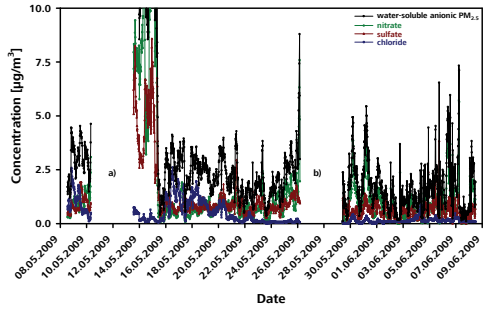
c) Chloride



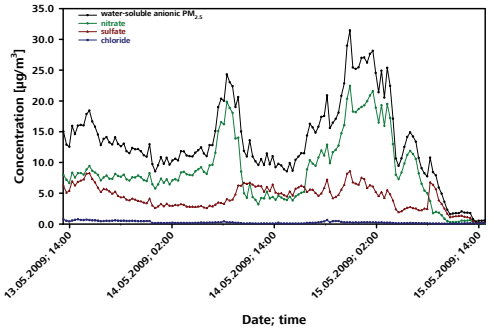
a), b): Monitoring was discontinued between 10 and 13 May as well as 26 and 29 May, 2009.

Semi-continuous anion mass balance

Nitrate, sulfate and chloride concentrations were determined by PILS-IC and compared to the concentration of water-soluble anionic particulate matter 2.5 – $PM_{2.5}$.



While the trends of nitrate and sulfate concentration correspond to the $PM_{2.5}$ trend, the chloride concentration trend, especially during the high pollution episode between May 13 and May 16, deviates significantly.



References

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(2) D.A. Orsini, Y. Ma, A. Sullivan, B. Sierau, K. Baumann and R.J. Weber, Refinements to the Particle-Into-Liquid-Sampler (PILS) for ground and airborne measurements of water-soluble aerosol composition, Atmos. Environ. **37**, 1243-1259 (2003).

(3) C. Emmenegger, R. Jansen and M. Laeubli, Determination of anions and cations in aerosols, Pittcon 2008, http://products.metrohm.com (search for 8.000.6014EN).

Acknowledgements

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