

MEASUREMENT OF AMBIENT PARTICLE NUMBER AND MASS DISTRIBUTIONS AT AN U.K. URBAN CENTRE SITE USING A NEW COUNTING INSTRUMENT

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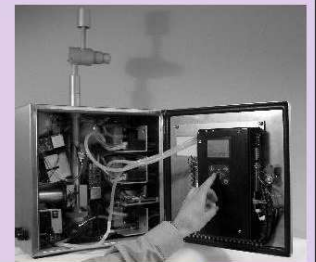
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INTRODUCTION

Precise measurement of fine and ultra-fine particles in the ambient air is a challenging aspect in the field of air quality monitoring. Although, current particulate matter standards are based on mass concentration, particle number concentration may be a critical parameter in relation to the effect of particulate matter on human health. No single current instrument allows the measurement of the complete wide distribution of particle sizes (from ultra-fine to coarse fractions) present in ambient air. This work reports on the development of a new real-time particle counter capable of measuring particle number concentrations in the coarse, fine, and ultra-fine ranges, from 10 µm down to 10 nm in various size fractions. The instrument works on the principles of light scattering and condensation nucleus counting. Provision is made for gravimetric measurements & chemical analysis of the deposited particles, as well as continuous data logging to a Personal Computer.

The new instrument has been deployed at an urban centre monitoring site courtesy of Birmingham City Council during the summer 2002. It has been collocated with a TSI Condensation Particle Counter (size range 7-1000 nm), a TEOM, and a Partisol. Particle number concentrations in the size sections of 10-360 nm, 360-500 nm, 500 nm-1 µm, 1-2.5 µm, and 2.5-10 µm have been measured and mass of particles in these size sections has been computed. The resultant data have been analysed in relation to meteorological parameters, pollution sources, and traffic parameters. Comparison of the instruments shows that the new counter shows excellent agreement with the TSI CPC in the sub micron size range. Although the mass concentrations derived from the new instrument are comparable with that of the Partisol and TEOM, certain differences are observed during some periods. Possible reasons for these differences are also discussed.

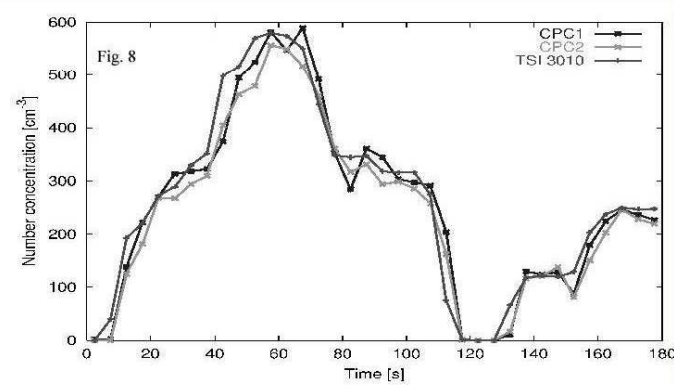
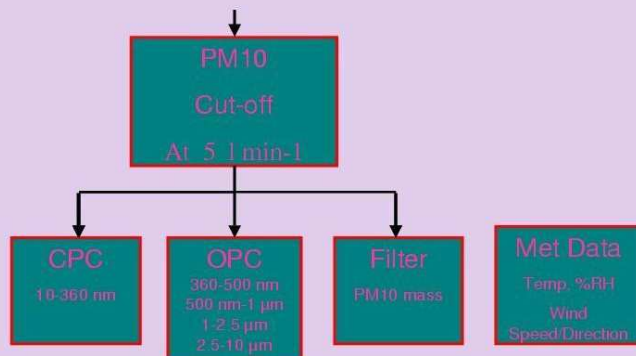
New Particle Counter



FEATURES

- Size classification between 10 nm and 10 µm
- Concentration range: 0.1 to 400,000 cm⁻³
- Calculated mass concentration
- Additional gravimetric mass concentration

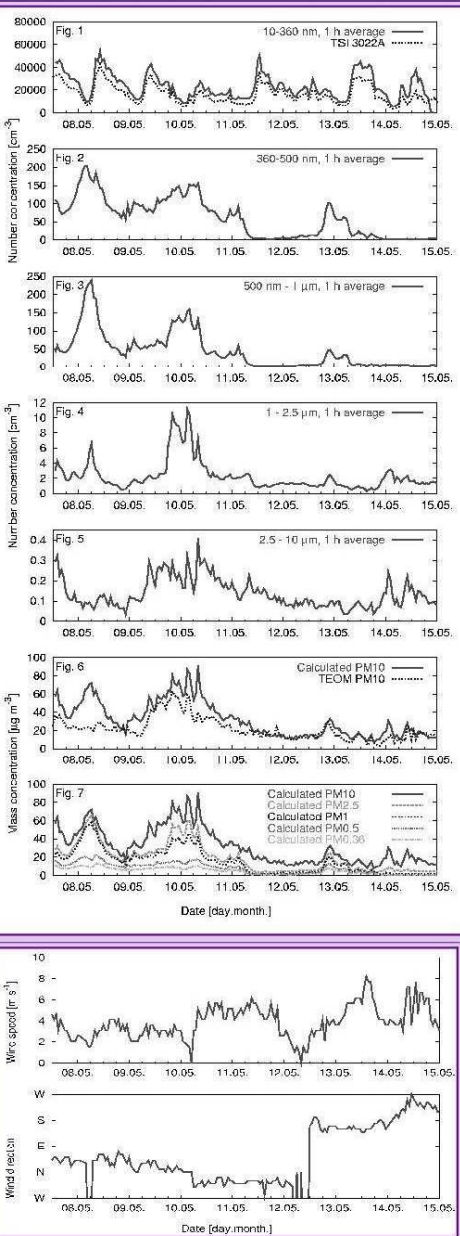
Instrument Overview



Calibration results

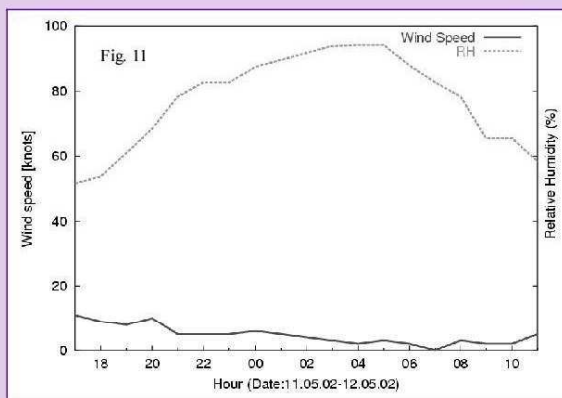
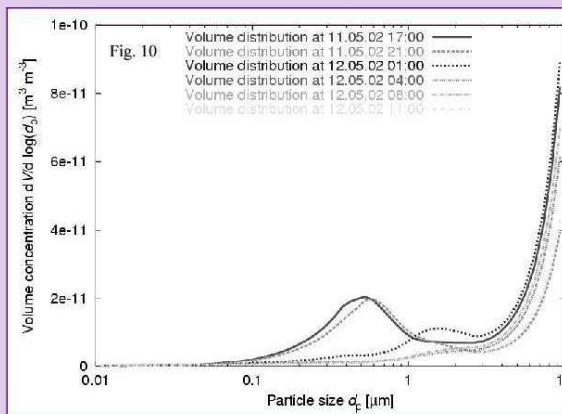
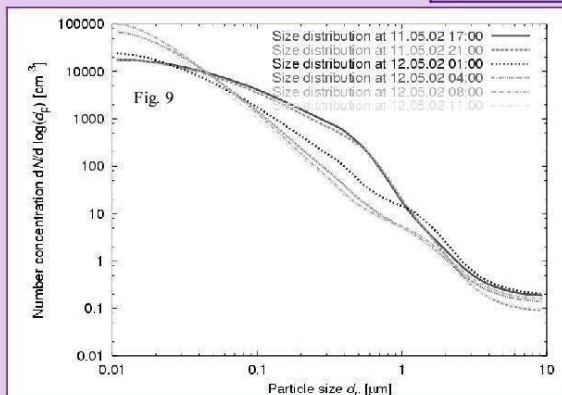
Comparison between the CPC performance of two replicas of the new instrument and a TSI CPC. Excellent agreement with TSI CPC was observed.

Time Series Plots of Ambient Aerosol Number and Mass Concentrations in various size ranges at Birmingham site

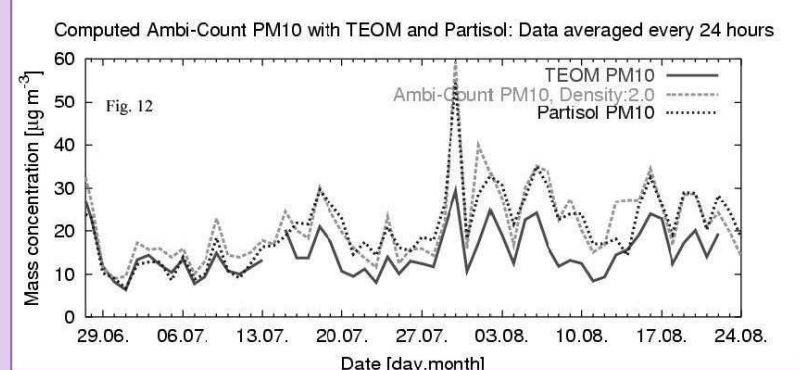


Meteorological Data observed at the monitoring site during the monitoring period

BIRMINGHAM SITE MONITORING RESULTS



Variation of Size and Volume Distributions of ambient aerosols with RH and Wind Speed on a typical day during monitoring campaign.



METHODOLOGY

- Monitoring has been done from 30.04.2002 to 10.09.2002
- Number concentrations in the size ranges of 10-360 nm, 360-500 nm, 500 nm-1µm, 1-2.5µm, 2.5-10 µm have been monitored every second and 1 hour average concentrations were computed.
- Mass concentration was computed by smoothing the particle distribution and compared with Partisol and TEOM data.
- Data was analysed with respect to Meteorological data.



RESULTS AND CONCLUSIONS

- The performance and accuracy of a new multi-channel ambient particle counter has been demonstrated. Excellent correlation has been observed with other CPCs (Fig. 8). The trends of calculated mass concentration followed closely with Partisol and TEOM measurements at the monitoring site. Lower values recorded by TEOM may be attributed to the loss of moisture and volatiles due to preheating of sample (Fig. 11).
- Contribution from PM1.0 represented up to 90% of PM2.5. PM1.0 was the major contributor to PM10 at the monitoring site (Fig. 7)
- Formation of particles of size less than 0.1 µm is enhanced with increasing Relative Humidity but a decreasing trend is observed in the subsequent ranges (Fig. 9).
- Anthropogenic activity during evening peak hour caused formation of ultra-fine and fine particulates, which dominated over coarse fractions. However, coarse fraction dominated during off-peak hours which could be attributed to coagulation process (Fig. 10).

FUTURE DEVELOPMENTS

- Detailed investigations of the variations with TEOM measurements.
- Extensive participating in international monitoring campaigns.
- Measurement of additional size fractions in the ultrafine region.
- Real-time mass measurements.

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