Redox Activity and Composition of the Organic Component of PM2.5 in Cork, Ireland

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INTRODUCTION

Particulate matter (PM) in urban air consists of a complex mixture of primary and secondary emissions from both anthropogenic and biogenic sources. Airborne particulates are typically comprised of a large number of ionic, organic and metallic species that are able to penetrate deep into the respiratory system and are known to have an adverse effect on human health (Pope et al., 2002). Some of these adverse health effects are due in part to oxidative stress which can be caused by the generation of reactive oxygen species (ROS) such as the superoxide anion radical. ROS generation can be catalyzed by organic species such as quinones (Kumagai et al., 2002). In Ireland, approximately one third of PM2.5 in urban areas is attributed to the organic fraction (Yin et al., 2005). The assay used in this study is specific for the organic fraction and is based on the ability of organic constituents such as quinones which are present on PM to catalyze the reduction of oxygen by DTT which is added in excess. Temporal and spatial trends with ROS activity and correlations with quinone and Polycyclic Aromatic Hydrocarbons (PAHs) were examined.

RESULTS

The HVCs (Fig. 3) with a flow rate of 900 L min⁻¹ enables a large volume of PM to be collected over a relatively short period of time. Polyurethane foam (PUF) was used to collect the submicron particles. PUF is a chemically inert material that can hold a large weight of PM (up to 2 g cm⁻²). Weekly samples were collected from January 2005 to December 2006. The results shown here are from PM collected at Znosharcas (rural background), Old Station Road (city site) and Heaferton Park (urban background site UBS).

500-2006 SAMPLING CAMPAIGN

A sample from each site/season is then added to a 250 mM Tris-HCl buffer adjusted to pH of 8.9 with KOH at 37 °C containing 100μM DTT. The solutions are incubated for 10 minutes to allow sufficient time for the catalysis of the DTT sulfhydryl oxidation to occur. 32 mM DTNB is added to develop the colour and the absorbances read at 414 nm to ascertain the ROS activity.

 Samples are treated with a derivatizing agent (acetic anhydride and zinc catalyst) which reduces the polarity and increases volatility which is required for GCMS. Samples are analysed using GC-MS (30 m x 0.25 mm x 0.75 μm column) at a flow rate of 1.5 ml min⁻¹ and a gradient temperature 60°C to 280°C at a rate of 8°C min⁻¹. The MS qualification parameters are illustrated in Table 1.

The PAHs in ambient samples are Soxhlet extracted and separated by flash chromatography (Fig. 5). These extracts are analysed using GC-MS, with a flow rate of 0.25 μl min⁻¹ and a gradient temperature profile. The MS qualification parameters are illustrated in Table 2.

CONCLUSIONS & FUTURE WORK

ROS activity at the highest in the Autumn/Winter Months

Increased combustion processes during these months (coal and oil) and vehicular cold-starts. The atmospheric load processes for organic species are less efficient in the low sunlight conditions of autumn and winter. Winter meteorological conditions such as temperature inversion also favour less pollutant dispersion.

Low molecular weight PAHs appear at very low concentrations compared with the high molecular weight PAHs.

The extent of partitioning between gas and solid-phase strongly depends on PAH volatility, temperature and the amount of available surface material.

Main PAH and Quinone sources are combustion processes (coal, oil, biomass), incineration and traffic emissions.

Component Principal Activity is carried out in order to provide more detailed information of the possible emission sources in the Cork urban area.

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