ABSTRACT

In situ electrostatic separation of ambient $PM_{2.5}$ into source-specific fractions

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Introduction

In July 1997, the EPA promulgated stricter primary and secondary National Ambient Air Quality Standards (NAAQS) for ambient airborne particulate matter (PM) by including particles smaller than 2.5 µm in diameter ($PM_{2.5}$) that are inhalable and can be deposited in the lower (thoracic) regions of the human respiratory tract. EPA has placed approximately 1000 monitors across the country to measure ambient amounts of $PM_{2.5}$, one of the six criteria pollutants. To correlate the data from this many measurements sites and monitors, EPA has established a federal reference method (FRM) sampling instrument for $PM_{2.5}$ collection and gravimetric measurement procedures to determine the mass of samples collected using the FRM sampler.

Toxicological studies have shown strong associations between elevated levels of source specific $PM_{2.5}$ instilled in the trachea of animals and adverse health effects. However, due to low gravimetric loadings of $PM_{2.5}$ in the ambient atmosphere, it is difficult to conduct inhalation exposure studies and to quantify the adverse health endpoints in animal as well as human subjects. For some time, toxicologists have been asking for an exposure environment enriched with the ambient as well as source specific $PM_{2.5}$ to conduct meaningful exposure studies to better understand the mechanisms of the adverse health effects of $PM_{2.5}$ and to further separate and identify specific adverse health effects of $PM_{2.5}$ from those of the other harmful gaseous components (e.g. CO, NO_x, and SO_x). The emission control technologies of coal fired utilities have significant interdependence in controlling various emissions. For example, technologies used to decrease NO_x and Hg emissions, usually increase PM emissions.

Objectives

1. To design, construct and incorporate an electrostatic deflector downstream of the $PM_{2.5}$ WINS impactor so that the fly ash particles generated from coal combustion are preferentially separated from the rest of the ambient $PM_{2.5}$ particles.
2. To collect these two, physically separated, source specific, ambient $PM_{2.5}$ streams onto a single standard filter.
3. To analyze the filters by SEM to quantitatively estimate efficiency and source specificity of the separation.

Accomplishments to date

1. We have designed, purchased necessary component and constructed the electrostatic separator. Our existing FRM sampler can be quickly modified to accept this electrostatic separator.
2. Several polycarbonate filters with varying pore sizes were bought and tested to optimize the capture efficiency while maintaining the required 16.7 l/min (1 m^3/hr) flow through the FRM sampler.
3. A Visual Basic program has been written to model the flow and predict deflection of $PM_{2.5}$ when passing through our design of electrostatic separator.

Future work

1. Actual samples will be collected on 0.8 micron polycarbonate filters as a function of the applied electrostatic potential.
2. A thin strip of the filter parallel to the applied electrostatic field will be cut, mounted and coated (to improve conductivity) for SEM examination.
3. $PM_{2.5}$ separation efficiency will be quantified as a function of the applied potential and reported.

Publications/Presentations/Patents

None

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