Measurement System for Determining Particulate Matter Pollution

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Environmental Problem

On a typical day, a person can inhale more than 10 million microscopic and submicroscopic particles with each breath; these particles are emitted from motor vehicles and industrial sources, resuspended by the wind, or formed in the atmosphere from gaseous pollutants. The particles occur in a wide range of shapes and sizes, and although individual particles are invisible to the unaided eye, the collective effect of high concentrations of these particles in the environment can have a variety of adverse effects. Only in the past 10 years have scientists begun to understand the magnitude of the health effects associated with particulate air pollution (see http://www.ioe.ucla.edu/publications/report01/ParticulateAirPollution.htm). Particulate pollution has been linked to reductions in lung function, increased hospital and emergency room admissions, and premature deaths. The Natural Resources Defense Council estimates that 64,000 premature deaths may be attributable to particulate pollution each year. Epidemiological studies indicate a linear relationship between exposure to particulate pollution and effects, but scientists have not been able to identify a threshold below which health effects do not occur. An ambient particulate matter (PM) mass measurement system is needed.

SBIR Technology Solution

With support from EPA's SBIR Program, Rupprecht & Patashnick Co., Inc. (R&P) developed the Series 8500 Filter Dynamics Measurement System (FDMS™) to account for both the volatile and non-volatile components of PM and report the combination as a mass concentration result. The device measures the volatile portion of the sample independently from the total incoming sample and uses this fraction in calculating the PM mass concentration. The device provides a new PM measurement approach that offers the ability to quantify more representatively PM mass concentration as it exists in ambient air.

The FDMS™ system takes into account the dynamics of PM that has been deposited on a sample collection filter and how that material behaves over time. It is designed to provide high-quality, representative PM mass concentration readings for both short-term averages (1 hour) and 24-hour averages. The system's basic output consists of running 1-hour average mass concentrations (in $\mu g/m^3$) of PM_{10} (particles smaller than 10 μm), $PM_{2.5}$ (<2.5 μnm), or PM_1 (<1 μm), updated every 6 minutes. It also computes the base mass concentration and reference mass concentration over the same averaging times.

The FDMS™ instrument computes its running PM mass concentration average based on independent measurements of the base and reference mass concentrations. To accomplish this, the FDMS™ unit constantly samples ambient air and uses a switching valve to change the path of the main flow every 6 minutes. The sampling process consists of alternate base and purge (filtered) to reference air streams passing through the exchangeable filter in a tapered element oscillating microbalance mass sensor.

During the base sampling periods, the sample air stream passes through the sample filter for determining the base level of PM mass in the atmosphere. During the base sample periods, the sampled gases are diverted through a chilled filter to remove and retain the ambient PM mass, including semi-volatile material. The FDMS continuously measures the change in mass on the sample filter, correcting the measurement during the base periods with the reference measurement periods, reporting the final ambient PM mass levels.

The Series 8500 FDMS™ unit has been selected by the California Air Resources Board as a California Approved Sampler for both $PM_{2.5}$ and PM_{10}.

Commercialization Information

The California Air Resources Board (CARB) evaluated the FDMS™ in Bakersfield, California, during a time of year when particulate nitrate concentrations are particularly high and ambient temperatures are at their lowest. Based on the results, the CARB selected the device as a California Approved Sampler for both $PM_{2.5}$ and PM_{10} as part of standards promulgated in June 2003. Whether for routine monitoring, regulatory monitoring, mapping, forecasting, or air quality index applications, the FDMS™ unit is the most accurate, precise, representative PM monitoring instrumentation available today.

Company History and Awards

Since its incorporation in 1981, R&P has commercialized a number of technologies in the form of advanced instrumentation to address critical measurement needs of customers around the world. The East Greenbush, New York-based company has experienced substantial growth over the years with an average growth rate during the 1990s of more than 25% per year. R&P specializes in the development, manufacture, and marketing of technology-leading products for applications that require accurate mass measurement or particle characterization. Customers include air pollution monitoring networks, diesel engine manufacturers, power companies, and catalyst producers. Due in part to the successful development of its particulate monitoring instruments, R&P was purchased by Thermo Electron Corporation in 2005.

R&P was awarded the ISO 9002 certification in early 1996 and the ISO 9001 designation in May 1997. R&P has been named by *R&D Magazine* as a 2004 R&D 100 Award winner in partnership with the National Institute for Occupational Safety and Health, the Bituminous Coal Operators' Association, the United Mine Workers of America, and the National Mining Association. In addition, R&P and two government laboratories jointly received a 2003 R&D 100 Award for a technology that monitored the venues of the 2002 Salt Lake City Winter Olympic Games for bioaerosols.

SBIR Impact

- An ambient particulate matter (PM) mass measurement system that fully accounts for the nonvolatile and volatile PM fractions when computing PM mass concentration is needed.
- Rupprecht & Patashnick Co., Inc.'s (R&P) Series 8500 Filter Dynamics Measurement System (FDMS™) unit accounts for both the nonvolatile and volatile components of PM.
- The California Air Resources Board selected the FDMS™ as a California Approved Sampler for both $PM_{2.5}$ and PM_{10}.
- R&P customers include air pollution monitoring networks, diesel engine manufacturers, power companies, and catalyst producers.