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Research and Development

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Project Summary

Metal Particulate Emissions from Stationary Sources

Volume 2. Characterization of Collection Filters

The literature on filtration theory and past experimental work was reviewed and critiqued with regard to the needs of EPA relative to stationary source sampling. A laboratory evaluation of aerosol collection efficiency and flow resistance of filters potentially useful in EPA sampling programs was designed with respect to several variables, including particle size (0.05,~0.1 and 0.5 μm mass median diameter - MMD); gas velocity (4, 12, 30, 83 and 126 cm/sec); and aerosol composition and density (g/cm^3) - dioctyl phthalate (DOP) 1.0, sodium chloride (NaCl) 2.17, beryllium sulfate ($BeSO_4$ $2H_2O$) 2.36, lead nitrate [$(Pb(NO_3)_2$] 4.53, and cadmium iodide (CdI_2) 5.67. Filter collection efficiencies were measured for the various evaluation parameters with a DOP penetrometer or sodium flame photometer. With two exceptions, collection efficiencies of greater than 99 percent were obtained for all filters and test conditions. The exceptions, tested with 0.3 μm MMD NaCl aerosol, were Millipore Mitex and Whatman 41 filters, with collection efficiencies of 75 to 50 percent, respectively. The other membrane filters (Millipore AA and Fluoropore) exhibited high flow resistance at 30 and 83 cm/sec and could not be tested at higher flow rates.

This Project Summary was developed by EPA's Environmental Sciences Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The objective of this phase of work under EPA Contract No. 68-02-1219, is to identify filter media having acceptable properties for the efficient collection of particles containing potentially hazardous metals for the following range of conditions encountered in stack sampling:

Variable	
Particle size	0.05, 0.1-0.2 and 0.5 μm MMD
Gas velocity	4, 12, 30, 83 and 126 cm/sec
Particle composition and density (g/cm^3)	DOP (1.0), NaCl (2.17), $BeSO_4 \cdot 4H_2O$ (2.36), $PbNO_3$ (4.53) and CdI_2 (5.67)
Temperature	Pretreatment at 500°C (effects of high temperature exposure is measured rather than efficiency at high temperature)
Electrostatic charge	Not evaluated (aerosol charge neutralized)
Aerosol concentration and filter loading	Not to be varied. Convenient concentrations and clean filters will be used.
Gas pressure and composition	Not to be varied. Ambient air will be used.
Gas humidity	Not to be varied. Dry air will be used.

This report also presents a review of the following filter characteristics to aid in the selection of the most promising type for stack sampling:

Media	Composition	Type
Millipore AA	mixed cellulose ester	membrane (0.8 micron pore size)
Millipore Fluoropore FA	teflon-polypropylene	membrane (1 micron pore size)
Gelman Spectro Grade (without silicone treatment)	glass	fiber
Mine Safety Appliance Co. 1106BH	glass	fiber
Arthur D. Little/Balston "Microquartz"	quartz	fiber
Millipore Mitex	teflon	membrane (10 micron pore size)
Whatman 41	cellulose	fiber

A collection efficiency of at least 99 percent for the hazardous metal containing particulate was deemed adequate.

Conclusions

Several types of filters suitable for stack sampling were evaluated for aerosol collection efficiency and flow resistance. From this work, the following conclusions can be drawn:

- Filter media including MSA 1106 BH, Gelman Spectro Grade (without silicone), Arthur D. Little/Balston Microquartz, Millipore AA and Millipore Fluoropore FA have collection efficiencies greater than 99 percent for the following ranges of conditions.

  Aerosols: 0.3 μm DOP and NaCl, $BeSO_4 \cdot 4H_2O$, CdI_2 and Pb $(NO_3)_2$.

  Sizes: 0.03 to 1.3 μm MMD with geometric standard deviations of 1.4 to 1.9.

  Flow rate: 12 to 125 cm/sec.

- The membrane-type filters, Millipore AA and Fluoropore FA, exhibited high flow resistance at 30 and 83 cm/sec, respectively (i.e., 78 and 114 mm Hg) and could not be test at higher flows.

- Within the limits of measuremer sensitivity, there was no differenc in efficiency for variations in aeros density (1.0 to 5.7 g/cm^3) or size (0. to 1.3 μm MMD).

- Millipore Mitex membrane an Whatman 41 cellulose fiber filte with efficiencies of 75 and 5 percent (for 0.03 μm NaCl) ar unsuitable for stack samplin applications.

In general, the filter media tested (e cepting Millipore Mitex and Whatma 41) have adequate collectio efficiencies for the collection particles containing hazardous metal Other factors (such as thermal stabili and background levels of trac elements) may influence filter sele tion for a particular stack samplir application.

Recommendations

Areas in which further work is reco mended include the following:

- Measure filter efficiencies for selected particulate challeng sample as a function of prior filt loading, aerosol charge and g humidity.

- Measure the utility of organic mem brane filters at temperatures of 12 150°C for times up to two hours, simulation of stationary sourc sampling. For example, the test filt could be backed up by a quartz filt maintained at ambient temperatur nitric acid digestion and atom absorption spectrophotometr analysis of the metal component the particulate challenge for the tw filters would provide a measure efficiency.

- Carry out efficiency measuremen for trace levels of hazardous met particulate (10-100 μg/m^3) in th presence of typical levels particulate emissions fro stationary sources (20-200 mg/m to determine if there is a preferenti penetration of hazardous met particulate during particula sampling.

- Screen candidate filters for their suitability in carrying out trace hazardous metals analysis by various analytical methods, including x-ray fluorescent analysis and atomic absorption spectrophotometry.

This Project Summary was authored by the Staff of the Center for Environmental Research Information, USEPA, Cincinnati, OH 45268.
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The complete report, entitled "Metal Particulate Emissions from Stationary Sources: Volume 2. Characterization of Collection Filters," (Order No. PB 81-121 154; Cost: $8.00, subject to change) will be available only from:
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