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# Project Summary

# Development, Design, and Operation of a Cascade Impactor to Collect Aerosol Samples for Wavelength-Dispersive X-Ray Fluorescence Analysis

L. G. Felix, D. H. Hussey, and J. D. McCain

**The goal of this research project was to design and construct a particle-sizing device that will collect and size source-emitted aerosols on 47-mm diameter substrates for subsequent wavelength-dispersive x-ray fluorescence analysis.**

**A five-stage slit impactor was designed to accomplish this goal. The impactor uses an oscillating drum beneath each jet to collect the sample evenly over a 31- x 34-mm area. The impactor is constructed from 316 stainless steel and will fit through a 4-in. sampling port. A right-angle pre-impactor is used at the inlet to reduce inlet losses and to provide a 15-$\mu$m aerodynamic cut.**

**Special substrates and substrate coatings offered good particle retention at sampling temperatures and provided low x-ray background.**

**Calibration studies were conducted with a prototype unit designed to allow various slit widths and jet-to-plate spacings. These studies provided the design criteria used to dimension the final impactor.**

**With this sampling system, readily collected samples can be analyzed directly by wavelength-dispersive x-ray fluorescence analysis for elemental composition. No sample preparation will be required beyond mounting the substrate in a carrier for analysis.**

***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

A new cascade impactor was designed and constructed to obtain size-fractionated particulate samples in forms suitable for direct elemental analysis by x-ray fluorescence. The report describes the design and operating principles of the device and provides instructions for its use. Potentially, the device can be used to obtain particle size distributions of chemical elements in industrial source emissions and "elemental fingerprints" for source-receptor studies.

## Impactor Design

Particulate analysis by x-ray fluorescence requires the sample to be a thin, uniform coating on a noninterfering substrate. Conventional size fractionating samplers are not useful because samples obtained with them are either in bulk material from which aliquots must be removed and redeposited (cyclones) or in multiple, discrete deposits of varying thickness (cascade impactors). The new sampler is a slit-type cascade impactor similar to the Lundgren impactor. The design incorporates five collection stages, an inertial preseparator, and an integral backup filter holder. Aerodynamically, the fractionation diameters are 15, 8, 4, 2, 1, and 0.5 $\mu$m respectively, for the preseparator and the five collection stages.

The collection substrates are mounted on drums that oscillate beneath the jets many times during sample collection. This procedure yields samples of highly uniform surface density over a 31- x 34-mm area.

Mylar is used as a base for the collection substrates. A polymeric coating such as vynathene, amorphous polypropylene, or butyl rubber also is applied to minimize errors due to particle bounce and to retain the sample after collection. The polymeric materials have superior properties to the greases normally used in cascade-impactor sampling, especially relative to elemental background concentrations.

The sampler was constructed of 316 stainless steel; a high-torque, digital-stepping motor mounted on the outboard end of the sampling probe was used to drive the drums on which the collection substrates are mounted. A minimum sampling port diameter of 4 in. is required to insert the sampler onto the stack.

## Calibration

A one-and-one-half stage, adjustable slit width prototype of the proposed design was constructed and tested for uniformity of particle deposition and predictability of size-fractionated particle. The measured fractionation diameters of the prototype configurations tested were, within experimental uncertainties, equal to the values predicted by Marple's impactor theory. Calibrations were not made on the final sampler.

## Field Trials

The sampler was tested in the field with emissions from four sources at a pulp and paper plant. There were no significant operational problems during these trials. The samples obtained were submitted for x-ray fluorescence analysis, but results were not available for inclusion in this report.

## Conclusions and Recommendations

Satisfactory mechanical performance of the impactor and associated equipment (probe, drive system, flow control, etc.) has been demonstrated. Although wall losses and predictability of fractionation diameters should not be troublesome, some calibration should be carried out before the device is used for any extensive or critical field sampling programs. If more devices are to be constructed, a simpler (and cheaper) drive system should be used to provide the drum motion.

*L. G. Felix, D. H. Hussey, and J. D. McCain are with Southern Research Institute, Birmingham, AL 35255*

***Kenneth T. Knapp** is the EPA Project Officer (see below).*

*The complete report, entitled "Development, Design, and Operation of a Cascade Impactor to Collect Aerosol Samples for Wavelength-Dispersive X-Ray Fluorescence Analysis," (Order No. PB 83-246 157; Cost: $10.00, subject to change) will be available only from:*

*National Technical Information Service*
*5285 Port Royal Road*
*Springfield, VA 22161*
*Telephone: 703-487-4650*

*The EPA Project Officer can be contacted at:*

*Environmental Sciences Research Laboratory*
*U.S. Environmental Protection Agency*
*Research Triangle Park, NC 27711*

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